Designing and managing protected and conserved areas to support inland water ecosystems and biodiversity

Tara Moberg, Robin Abell, Nigel Dudley, Ian Harrison, Shiteng Kang,
Flavia Rocha Loures, Natalie Shahbol, Michele Thieme and Hannah Timmins



IUCN WCPA Technical Report Series No. 8

WCPA WORLD COMMISSION ON PROTECTED AREAS
The Nature Conservancy
WWF
FCC Freshwater Conservation Committee
Part of IUCN SSC Species Survival Commission

IUCN WCPA PUBLICATIONS

IUCN WCPA publishes two landmark series providing authoritative resources for managers of protected areas and other effective area-based conservation measures (OECMs), policy makers and scientists. Definitions and details of guidance on protected areas and OECMs can be found on the inside back cover of this publication.

The Good Practice Guidelines and Technical Reports involve collaboration among specialist practitioners dedicated to supporting better implementation of conservation in the field, distilling learning and advice drawn from across IUCN WCPA. Applied in the field, they build institutional and individual capacity to manage conservation systems effectively, equitably and sustainably, and help cope with the myriad of challenges faced around the world. The Guidelines also assist national governments, protected area agencies, non-governmental organisations, communities and private sector partners in meeting their commitments and goals, and especially to the Convention on Biological Diversity.

For more information on all WCPA publications see: https://www.iucn.org/our-union/commissions/world-commission-protected-areas/our-work/wcpa-publications

For information on publishing with WCPA see: https://iucn.org/our-union/commissions/world-commission-protected-areas/our-work/wcpa-publications/publishing-wcpa.

Complementary resources are available at: www.30x30.solutions

Contribute to developing capacity for a Protected Planet at: www.protectedplanet.net

Designing and managing protected and conserved areas to support inland water ecosystems and biodiversity

IUCN – International Union for Conservation of Nature

International Union for Conservation of Nature IUCN helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, non-governmental organizations, the United Nations and companies together to develop policy, laws and best practice. IUCN is the world's oldest and largest global environmental organization, with more than 1,400 Members from government and nongovernmental organizations and more than 15,000 volunteer experts volunteer experts. IUCN's work is supported by around 950 staff in more than 50 countries and hundreds of partners in public, non-governmental organizations and private sectors around the world.

iucn.org

IUCN World Commission on Protected Areas

IUCN World Commission on Protected Areas IUCN's World Commission on Protected Areas (WCPA) is the world's premier network of protected and conserved areas expertise. The Commission has over 2,500 members spanning 140 countries who provide strategic advice to policymakers and work to strengthen capacity and investment for protected areas establishment and management. The Technical Reports series is one of the Commission's flagship products, providing timely guidance on aspects of protected area planning, management and assessment.

iucn.org/wcpa

IUCN Species Survival Commission– Freshwater Conservation Committee

The Species Survival Commission (SSC) is a science-based network of volunteer experts from almost every country in the world, all working together to prevent the loss and aid recovery of the diversity of life on earth. The FCC helps coordinate freshwater species conservation activities through the SSC, giving increasing attention freshwater biodiversity conservation. This includes assessments of the conservation status of freshwater species via IUCN's Red List of Threatened Species, and providing these and other data to support species conservation action plans and guide policy in the highest priority areas.

The Nature Conservancy

The Nature Conservancy is a global conservation organization dedicated to conserving the lands and waters on which all life depends. Guided by science, we create innovative, on-the-ground solutions to our world's toughest challenges so that nature and people can thrive together. Through a collaborative approach, we are tackling climate change, conserving lands, waters and oceans at an unprecedented scale, providing food and water sustainably and helping make cities more sustainable around the world.

nature.org

WWF

For more than 60 years, WWF has been protecting the future of nature. The world's leading conservation organization, WWF works in 100 countries and is supported by more than 1.3 million members in the United States and close to 5 million globally. WWF's unique way of working combines global reach with a foundation in science, involves action at every level from local to global, and ensures the delivery of innovative solutions that meet the needs of both people and nature.

worldwildlife.org

Equilibrium Research

Equilibrium is an action research organisation, carrying out a mixture of desk and field-based projects throughout the world offering practical solutions to conservation challenges, from concept, to implementation and evaluation of impact. With partners ranging from local communities to UN agencies across the world, Equilibrium explores and develops approaches to natural resource management that balance the needs of nature and people.

equilibriumresearch.com

Designing and managing protected and conserved areas to support inland water ecosystems and biodiversity

Tara Moberg, Robin Abell, Nigel Dudley, Ian Harrison, Shiteng Kang,
Flavia Rocha Loures, Natalie Shahbol, Michele Thieme and Hannah Timmins

IUCN WCPA Technical Report Series No. 8

The designation of geographical entities in this publication, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN or other participating organisations concerning the legal status of any country, territory or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The views expressed in this publication do not necessarily reflect those of IUCN or other participating organisations.

IUCN is pleased to acknowledge the support of its Framework Partners who provide core funding: Ministry of Foreign Affairs, Denmark; Ministry for Foreign Affairs, Finland; Government of France and the French Development Agency (AFD); Ministry of Environment, Republic of Korea; Ministry of the Environment, Climate and Sustainable Development, Grand Duchy of Luxembourg; the Norwegian Agency for Development Cooperation (Norad); the Swedish International Development Cooperation Agency (Sida); the Swiss Agency for Development and Cooperation (SDC); and the United States Department of State. The Nature Conservancy funded the development, design and publication of this technical report.

Published by: IUCN, Gland, Switzerland

Produced by: IUCN World Commission on Protected Areas

Copyright: © 2024 IUCN, International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorised without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Citation: Moberg, T., Abell, R., Dudley, N., Harrison, I., Kang, S., Rocha Loures, F., Shahbol, N., Thieme, M., & Timmins, H.L. (2024). *Designing and managing protected and conserved areas to support inland water ecosystems and biodiversity*. IUCN WCPA Technical Report Series No. 8. IUCN.

ISBN: 978-2-8317-2314-3 (PDF)

DOI: https://doi.org/10.2305/ZOKC6253

Cover photo: The Japanese stream toad (*Bufo torrenticola*), endemic to Japan, is the only species of toad in the country known to spawn in streams rather than lentic habitats. © David Herasimtschuk / Freshwaters Illustrated

Back cover: Kingfishers (*Alcedinidae*) are highly adept at catching fish and other prey below the water surface, Croatia © Petar Sabol/ TNC Photo Contest 2018

Layout: Miller Design

Contents

Executive summary VIII
Acknowledgements and additional information XIV
Acronyms XV

Chapter 1. The need for a focus on inland water ecosystem conservation 1

1.1 About this guide 2
1.2 The importance and status of inland water ecosystems and their biodiversity 5
1.2.1 Biodiversity importance 5
1.2.2 Value to humans 5
1.2.3 Status of inland water ecosystems and their biodiversity 8
1.3 Global status of inland water coverage by PCAs and gaps in representation 10
1.3.1 Developing an indicator for tracking inland water coverage 10
1.3.2 Coverage of inland waters – global baseline and representation 11
1.3.3 Beyond coverage – the necessity of tracking effectiveness, connectivity and areas important for biodiversity 12
1.4 Integrating implementation across global commitments and initiatives 13

Chapter 2. What makes inland waters unique when approaching PCA design, designation and management? 15

2.1 The importance of basin/landscape context 16
2.2 Key ecological attributes to support inland water ecosystem integrity 18
2.2.1 Hydrologic regime and environmental flows 19
2.2.2 Connectivity 20
2.2.3 Water quality 21
2.2.4 Physical habitat 21
2.2.5 Biotic composition 22
2.3 Persistent threats to the ecological integrity of inland waters 23
2.4 Putting it together – using PCAs as a tool for effective conservation of inland waters 27

Chapter 3. Starting with human rights, equity and inclusion 29

3.1 Foundational dimensions of human rights, equity and inclusion 30
3.2 Particular characteristics of inland waters to consider relative to human rights, equity and inclusion 35

Chapter 4. Expanding and strengthening the protected and conserved area network to support inland water biodiversity and ecosystems 37

4.1 Guidance for representing inland water biodiversity and ecosystems in conservation area network planning 38
4.1.1 The case for integrated planning – terrestrial, inland water, coastal and marine 39
4.1.2 Expanding PCA networks to be resilient and representative of inland water biodiversity, ecosystems and services 40
4.2 Delineating geographic and ecological boundaries to inform site-specific design and designation 49
4.2.1 Geographic boundaries 49
4.2.2 Defining site-specific environmental standards 50

Chapter 5. Designation and governance mechanisms 54

5.1 Area-based conservation in inland waters 55
5.2 IUCN protected areas 58
5.3 Other effective area-based conservation measures 60
5.3.1 Considerations in applying the OECM framework to inland waters 61
5.3.2 Potential types of inland water-related OECMs 64
5.4 International designations 65
5.4.1 Wetlands of International Importance (Ramsar sites) 65
5.4.2 UNESCO Biosphere Reserves 69
5.4.3 World Heritage Convention 70
5.5 Emerging mechanisms and concepts for conserving inland waters 72
5.5.1 Rights of nature 72
5.5.2 Sacred and cultural species and areas 73
5.5.3 Riverine-focused protections 74
5.5.4 Groundwater-supported ecosystem protections 78
5.5.5 Geographically-defined environmental flow protections 79
5.5.6 Nature-based solutions for water and climate 79
5.5.7 Community fisheries reserves for rivers, lakes and wetlands 82
5.5.8 Transboundary inland water mechanisms 82
5.6 Governance 85
5.6.1 Privately protected inland waters 89
5.6.2 ICCAs and IPAs 89

Chapter 6. Managing for inland water ecosystem integrity in protected and conserved areas 91

6.1 Updating and developing management plans 92
6.2 Common management interventions and activities for inland water ecosystem integrity 97
6.3 Measuring management effectiveness and supporting adaptive management 103
6.3.1 Developing a monitoring plan for a PCA 104
6.3.2 Existing tools for measuring management effectiveness 108
6.4 Budgeting and sustainable financing 110
6.4.1 Budgeting for inland water conservation and management within protected areas 110
6.4.2 Conservation finance 112

Appendix Case study compendium 117

References 132

Figures

1.1 Key elements of KM-GBF Target 3 2
1.2 Global trends for inland water biodiversity 9
1.3 Global coverage of the inland waters realm by protected and conserved areas 11
1.4 Global coverage of the river and stream biome and ecosystems by protected and conserved areas 12
2.1 A basin/landscape protection approach tailored to inland water ecosystems 17
2.2 Five key ecological attributes (KEAs) combine to determine the ecologicalintegrity of inland waters 18
2.3 Dimensions and critical functions of environmental flow components 20
2.4 Dimensions and critical functions of aquatic connectivity 20
2.5 Global river connectivity status and future threats 24
3.1 Map of the Nushiño-Curaray-Villano Fluvial Reserve 34
4.2 Map of Nepal's High Conservation Value Rivers and assessment results 48
5.1 Map of Bita River Management Plan Conservation Zoning 68
5.2 Map of Gayini (formerly Nimmie-Caira) and the Great Cumbung in relation to Yanga National Park 88

Boxes

1.1 Guiding resources for improving PCAs in the service of inland water ecosystem and biodiversity conservation 4
1.2 What do we mean by inland waters? 7
1.3 Basins, catchments and watersheds – terminology 8
3.1 Inland water-specific guidance on human rights, equity and inclusion 36
3.2 Summary checklist of human rights, equity and inclusion considerations 36
4.1 Moving away from using rivers as PCA geographic boundaries 50
4.2 Environmental standards for protected areas – terminology 51
5.1 Key resources on OECMs 61
5.2 Relationship between the Convention on Biological Diversity and the Convention on Wetlands 65
5.3 Enforcement of Ramsar site obligations through adjudication 66
6.1 Contents of a PCA monitoring plan 107

Tables

2.1 Summary of key ecological attributes for inland waters, examples of first order threats and their sources 23
4.1 Summary of KM-GBF policy elements as they apply to conservation planning 39
4.2 Seven foundational principle and key components to integrate inland waters into regional and national spatial planning 44
4.3 Example approaches to include environmental standards in PCA design and designation 52
5.1 Case studies of area-based conservation mechanisms across management objectives and designation types 56
5.2 Examples of inland water protected areas in different IUCN management categories 59
5.3 Governance types in protected areas 86
6.1 General outline of a protected area management plan with notes on inland water application 94
6.2 Checklist of management actions to support inland water conservation in PCAs 97
6.3 Example monitoring plan indicators for water flow and water quality from Serengeti National Park 105
6.4 What makes and effective indicator? 106
6.5 Example site level management effectiveness tools 109
A.1 Summary table and index to case studies 117
A.2 Case study index by thematic area 19

Field studies

Field study 1: Nushiño-Curaray-Villano Community Fluvial Reserve, Ecuador 33
Field study 2: Participatory spatial planning to identify High Conservation Value rivers (HCVRs), Nepal 47
Field study 3: An illustrative application of the site-level tool for identifying OECMs, Mae Ngao Community Fish Reserve Network, Thailand 63
Field study 4: A basin-scale Ramsar site and OECM, Bita River, Colombia v 67
Field study 5: Community Fisheries Reserve, Lake Tanganyika 83
Field study 6: Returning legal rights to First Nations, Gayini, Australia 87

Executive summary

Inland water ecosystems – such as lakes, rivers and streams, marshes and peatlands – are among the most threatened on the planet. Since 1970, monitored populations of freshwater species have declined by 85 per cent on average, a much faster rate than marine and terrestrial realms, and almost one in three species is threatened with extinction.

The well-being of inland water ecosystems is inextricably tied to ours. One third of the global food resource depends on rivers, and 40 per cent of the global fish protein consumed by humans comes from species dependent on inland waters. Recent research estimates inland waters contribute a value of US$ 50 trillion annually through the provision of natural processes that support human well-being. And more locally, they serve as sacred spaces, supporting cultural and spiritual values as well as mental and physical health.

The world needs to prioritise reversing the curve of inland water biodiversity and ecosystem loss, and that means using the range of available tools in smart, deliberate and creative ways. Protected areas and other effective area-based conservation measures (OECMs) are among the most important conservation tools to halt and reverse the global decline in biodiversity and to sustain irreplaceable ecosystem services. However, to date, the intentional use of, and investment in, protected and conserved areas for safeguarding inland water biodiversity and values has been limited. The reasons for this under-investment are many:

- Inland water biodiversity is literally invisible to most people, and those who depend on it most directly are often unempowered.
- For generations, internationally dominant perspectives have often viewed water and inland water ecosystems as commodities to be diverted or drained to support economic growth, rather than as home to a disproportionately large fraction of Earth's biodiversity and life sustaining services.
- Land protection has been the dominant area-based conservation mechanism and confers some, but often limited, protection to inland water ecosystems. Typical notions of protected areas, in which external threats are kept at bay, are often misaligned with the connected and much-used nature of inland water systems.
- Measurement approaches designed for lands rather than waters, and lack of an indicator for assessing and tracking inland water protections, have kept these systems off the radar of the protection community.

It is true that conserving inland waters is complicated by their connectivity, dynamism and position in the landscape: in most cases, area-based conservation approaches will be insufficient on their own for safeguarding inland waters against the range of threats originating upland, upstream, and even downstream and underground. In fact, this is the reality for terrestrial and marine protections as well, but inland waters bring that reality to the forefront. Recognising this apparent limitation can ultimately catalyse more effective, inclusive, holistic and creative conservation solutions that will benefit all realms.

This report summarises these challenges and showcases the diversity of solutions that are emerging around the world to address them, as led by Indigenous peoples, local communities, government and civil society. It is motivated by the Kunming-Montreal Global Biodiversity Framework's (KM-GBF) target of 30 per cent of inland waters conserved globally, and its primary objective is to facilitate achievement of that target by providing a consolidated resource for practitioners. Specifically, it provides guidance for parties with a vested interest in designing, designating and managing protected areas and OECMs, or protected and conserved areas (PCAs), for shorthand, and/or those with a vested interest in conserving inland water biodiversity and ecosystems. While the focus of the report is on the use of PCAs as a conservation tool, important complementary measures that can and often should be layered with area-based conservation – such as restoring aquatic connectivity, best management practices on working landscapes, and integrated water resources management across basins – are briefly introduced by suggesting approaches for their integration into PCA design, planning and management.

Four main questions guide the use of PCAs for inland waters:

1. What are the inland water values or conservation objectives, and who are the vested parties?
2. What key ecological attributes are critical to achieving inland water conservation objectives? And, of those, which are or will likely be under pressure or threat, and where do the threats originate in the basin?
3. Can the PCA design, designation and/or management be used, or adapted, to reduce those pressures to a functional degree, and if so, how?
4. Are there opportunities to work with stakeholders within the broader basin to reduce external threats that the PCA cannot address on its own?

The content of this report, including numerous case studies representing diverse contexts, is designed to provide readers with the resources to address these questions for their inland waters of interest. The report covers:

- the current state of inland water protections and key representation gaps,
- what makes protection of inland waters distinct,
- how and why human rights, equity and inclusion must feature prominently in inland water protections,
- key principles for spatial conservation planning and protected area design,
- setting legal environmental standards for protected areas,
- the application of IUCN management categories, OECMs, international designations, and emerging protection mechanisms in inland waters,
- the design of management and monitoring plans,
- budgeting for inland water protections, and
- potential sources of sustainable funding.



Mountain mullet (*Dajaus monticola*), Puerto Rico. © David Herasimtschuk / Freshwaters Illustrated

Key messages

To reverse the trends of nature and biodiversity loss, inland waters must be conserved and managed in a way that includes but goes beyond conventional land conservation, taking into account their unique characteristics and including them explicitly in conservation objectives, targets and indicators.

- ✔ **The ecological integrity of inland waters is tied to their basin context, hydrologic regime, connectivity, water quality, physical habitat and biotic composition**. Designing area-based protections for inland waters must start with an understanding of key ecological attributes, and of current and future threats to them. Given the highly connected nature of inland waters, an individual protected or conserved area may be unable to deliver ecological integrity on its own, but layering well-designed and managed area-based protections with additional interventions in the broader basin landscape can produce effective and lasting results.
- ✔ **It is possible to measure and track the extent of inland water protection coverage now,** using available global datasets or, where they exist, better national-level data. Disaggregating tracking by inland water ecosystem type shines a light on gaps to be filled. Further work is needed to build from protection coverage to represent and track protection effectiveness. This includes consideration of aquatic connectivity and representation of areas important to inland water biodiversity.
- ✔ **Integrating inland waters explicitly into area-based conservation objectives and targets in National Biodiversity Strategy Action Plans,** large-scale spatial conservation planning, management plans, onsite and offsite activities, monitoring, and financing of existing and new PCAs is critical.
- ✔ **Inland water and terrestrial areas interact in a matrixed landscape and inland waters are directly connected to coastal and marine systems, as such their effective conservation is critical to all three realms.** The healthy functioning of inland waters underpins the productivity of other systems via water, nutrient and sediment processes and flows.

Inland water ecosystems are intertwined with human lives, livelihoods and well-being. Understanding these relationships sets the foundation for durable conservation approaches that prioritise human rights, equity and diverse governance.

- ✔ **Human rights, equity and local values are central to conserving inland waters.** Human lives, livelihoods and cultures are inextricably tied to water and aquatic life. It is critical to recognise the rights, knowledge and contributions of Indigenous peoples and local communities, including their role in stewarding lands, waters and biological heritage. Protecting and conserving inland waters is not about excluding people but about ensuring that values will be sustained for generations to come.
- ✔ **A range of actors will have a vested interest in the health of any given inland water ecosystem, providing opportunities to diversify governance and improve equity.** New models for Indigenous and community-led governance of inland water ecosystems through PCAs are expanding rapidly. Explore opportunities for community-led protections and/or management at the earliest stages.
- ✔ **Well-managed inland water areas that accommodate sustainable use, while making a significant contribution to the conservation of inland water biodiversity, may qualify as OECMs.** People rely on inland waters around the world for the benefits they provide, and a range of sustainably managed human uses can be compatible with inland waters' integrity. Emerging guidance can be used to assess when OECMs might be recognised for making significant contributions to inland water biodiversity.
- ✔ **Overlapping and complementary multilateral agreements should be optimised to co-deliver solutions for biodiversity, climate and sustainable development.** The UN Sustainable Development Goals, UN Framework Convention on Climate Change, the Convention on Wetlands, the Convention on Migratory Species, UN Convention to Combat Desertification and the UN Decade on Ecosystem Restoration, among others, can all complement the KM-GBF.



Sandhill crane (*Antigone canadensis*).© Roxana Walters/TNC Photo Contest 2019

There is an unprecedented opportunity to strengthen and expand protected and conserved area networks to be effective, representative, well-connected and resilient to a changing climate through integrated planning and site-scale design.

- ✔ **Integrated spatial conservation planning across terrestrial, marine and inland water realms is both efficient and critical to ensure that new and existing protected areas and OECMs deliver effective conservation.** Such planning needs to be participatory, efficient, effective and covering an area of sufficient size and configuration to connect key elements of the basin, maintain biodiversity, and build climate resilience. It is essential that all such planning prioritises the maintenance of aquatic connectivity, ecological function and dynamism.
- ✔ **Improved representation of inland water ecosystem types, and improved effectiveness, can be achieved through the intentional expansion of protected and conserved networks** to capture and address inland water values. Globally, existing PCAs cover at least 16 per cent of inland water areas, but there is wide variation in protection coverage across inland water ecosystem types and among regions.
- ✔ **New and expanded PCAs should consider site-scale design principles for inland waters**, such as ensuring sufficient size and configurations to account for aquatic connectivity and basin influences, including full water bodies where possible and incorporating riparian and floodplain buffers. Consider the unique role rivers can play in building a well-connected PCA network and avoid using them as PCA boundaries.
- ✔ **Environmental standards defining the bounds within which protected inland waters should be functioning can and should be set.** Standards that are tied to the PCA are important for evaluating whether objectives are being met and can be useful for managing current and future threats external to the area. Standards can be written as a general articulation of conservation objectives or link explicitly to environmental flows, connectivity and water quality. Lack of full information at the time of designation should not preclude setting standards, which can be made more measurable over time.

An array of legal and other effective mechanisms can provide the opportunity to align inland water conservation needs with suitable policy tools at the appropriate scales.

- ✔ **Inland water protections can draw on a range of established and emerging mechanisms.** Conventional protected areas, sitting along the IUCN management category spectrum from I to VI, can and do provide protections for inland waters. Additionally, an array of emerging mechanisms like fluvial reserves, rights of rivers and wetlands, community fish reserves, source water and groundwater protection areas, migratory corridors or swimways, water flow reserves, climate adaptation corridors, carbon capture areas and transboundary reserves are being adapted to meet the conservation needs of inland water ecosystems.
- ✔ **The coverage of areas designated as Ramsar sites equates to almost 5 per cent of the global coverage of inland waters by PCAs, presenting a unique opportunity to strengthen inland waters' protection.** Where inland Ramsar sites neither overlap spatially with nationally recognised protected areas nor are managed as part of national protected area systems, they may lack legal protection, management mandates, plans and resources. National policies that clarify legal and management regimes for Ramsar sites and ensure that they are adequately managed and resourced, can substantially and meaningfully expand effective inland water protections. This includes clarifying geographic boundaries, management zones and alignment with IUCN protected area management categories, or as applicable, assessing whether sites qualify to be recognised as OECMs.
- ✔ **Within any given country, there will likely be numerous policies that can be leveraged, alone or together, to safeguard inland water systems.** Understanding the policy baseline and what durable protection mechanisms may be available for inland waters and their key ecological attributes is an important starting point, especially when objectives include safeguarding water flows, connectivity and water quality. Often PCA policies were developed for the terrestrial and/or marine context. It may be necessary to review the PCA legal framework, including category definitions and allowable and prohibited uses within them, to be inclusive of inland waters.

Effective conservation will require specific considerations in management planning, implementation and monitoring. The same aspects of inland waters that make them complex to conserve, enable diverse approaches to management and financing.

- ✔ **Site-specific inland water objectives can and should be built into protected area management plans, and into the budgets for implementing them.** Many of the categories of management activities common to terrestrial protected areas will be the same for inland waters, but inland water management may require special training and equipment, along with adjustments to current practices and engagement with a broader set of stakeholders.
- ✔ **Collaboration is key to effective management of inland waters in PCAs.** Water is a shared resource. Cooperative agreements or cross-institutional management arrangements among local communities, protected area authorities, Ramsar site management authorities, water resource agencies, and water-based ecotourism sectors can build trust and collective knowledge while leveraging expertise, capacity, equipment and often scarce resources to deliver effective management.
- ✔ **Long-term financing for inland water management may tap into the many benefits that inland waters provide to people**, through payments for water-related ecosystem services like water provision and regulation, climate mitigation and adaptation, as well as tourism and recreation fees. For a sense of scale, a third of the world's hundred largest cities get a significant portion of their drinking water from protected areas.

Although complex, area-based conservation solutions for inland waters are possible and are actively being applied throughout the world, with rapid innovations over the last several years. The range of approaches is illustrated through 40 cases including six in-depth field studies. These messages add up to a positive outlook for new and strengthened protected and conserved areas.

The global community can meet its obligations, contribute to bending the curve of inland water biodiversity loss, and sustain delivery of services for generations to come by fully embracing and integrating area-based solutions for these critical ecosystems.



Camp for scientists monitoring peatland restoration in Sebangau National Park, Indonesia. © Markurius Sera/TNC Photo Contest 2022

Acknowledgements

The value of this technical report is attributed to the collective investment of guardians, stewards, practitioners and scientists to both call attention to and find creative pathways for effectively protecting inland water ecosystems and life that depends on them. We are especially grateful to the individuals and organizations who generously shared their successes and lessons through case studies including Gabriela Celi (Ecuador); Rajesh Sada (Nepal); Grant Wilson, Constanza Prieto, Monti Aguirre, Matthew Simpson (Colombia, Rights of Nature); Pía Weber, Corporación Puelo Patagonia, Bestias del Sur Salvaje, Futaleufú Riverkeeper, Ngenko Foundation, The Pew Charitable Trusts, Programa Austral Patagonia, from Austral University and Centro de Investigación en Ecosistemas de la Patagonia (Chile); Cesar Suarez and Fernando Trujillo (Colombia); Sergio Salinas (Mexico); David Moryc, Stephen Chesterton and Corita Waters (USA); Tamara Preininger Horvat (Croatia); Lauren Oates (USA); Ana Beccar and ProYunga (Argentina); Nari Nari Tribal Council, James Fitzimons and Peta O'Donohue (Australia); Fridolin Nzambimana, Machaya Chomba and Colin Apse (Tanzania and Zambia); and Jody Bragger (Ukraine). We sincerely thank Caitlin Doughty and Suman Jumani for their expertise and contributions to the development of Chapters 3 and 4, respectively.

We extend our gratitude to peer reviewers Jamie Pittock, Australian National University and Sevvandi Jayakody, Wayamba University of Sri Lanka and Ramsar STRP Co-Chair for K-M GBF implementation, for their constructive reviews of the ideas and content expressed in the guidelines. We thank colleagues who provided review and expertise throughout the drafting process including Ritesh Kumar, Convention on Wetlands and Wetlands International; Paulina Arroyo, Enduring Earth; Virgilio Hermoso Lopez, Universidad de Sevilla; Ulrika Åberg, Eresha Fernando, Raphaël Glémet, Jennifer Kelleher, Kevin Smith, Thomas Starnes, Khalid Pasha, Mizuki Murai and Lisa Kopsieker, IUCN; Harry Jonas and Stephen Woodley, IUCN WCPA OECM Specialist Group (Co-chairs); Rebecca Flitcroft, IUCN WCPA Freshwater Specialist Group (Co-chair); Deniell Perry, Northern Arizona University and Global River Protection Coalition (Co-lead); Colin Apse, Katie Bacon, Silvia Benitez, Mari-Beth Delucia, Ximena Escovar-Fadul, James Fitzsimons, Anna Gomes, Mike Heiner, Natalie Ingle, Nathan Karres, Nick Miller, Amy Newsock, Goran Sekulic, Kathleen Swana and Stasi Turnbull, The Nature Conservancy; Laura Graham, University of Birmingham; Jeff Opperman, WWF. We also recognise Chris Baker, Wetlands International; Lucy Bastin, Aston University; Heather Bingham and Benjamin Lucas, UNEP World Conservation Monitoring Centre; Stuart Crane, UNEP; Nick Davidson, Consultant; Chris Dickens, IWMI; Günther Grill, Confluvio; Bernhard Lehner, McGill University; Diego Juffe Bignoli, Consultant; Aaron Koning, University of Nevada, Reno; Simon Linke, Commonwealth Scientific and Industrial Research Organization; Zau Lunn, Fauna and Flora International; Wanjya Nyingi, National Museums of Kenya; Harmony Patricio, WCPA FSG (Co-chair); and Dave Tickner, WWF for their contributions and review of the discussion draft prepared for COP-15. We thank Freshwaters Illustrated and many others for bringing inland water biodiversity into our field of vision through film and photography.

In particular, we thank IUCN WCPA Series Editors, active members of the IUCN WCPA and other IUCN Commissions, Caroline Snow for proofreading services and Helen Miller and Jonathan Gledson for design services. We express our sincere thanks to the IUCN publishing team, Global Communications Unit and IUCN WCPA Chair Dr Madhu Rao for their support and encouragement throughout the development and review process.

Any errors or omissions are the responsibility of the authors and editors.



© David Herasimtschuk / Freshwaters Illustrated

Acronyms and abbreviations

ACUS	Conservation and Sustainable Management Areas (Ecuador)
BMU	Beach Management Units
BOSF	Borneo Orangutan Survival Foundation
BR	Biosphere Reserve
CBD	Convention on Biological Diversity
CCS	Complementary Conservation Strategy (equivalent to an OECM in Colombia)
CFA	Conservation Finance Alliance
CMP	Collaborative Management Partnerships
CMS	United Nations Convention on Migratory Species
COP	Conference of the Contracting Parties (of the Convention on Wetlands)
CTF	Conservation Trust Fund
FAO	Food and Agriculture Organization of the United Nations
FPIC	Free, Prior and Informed Consent
GAPA	Governance Assessment for Protected and Conserved Areas
GEF	Global Environment Facility
HCV	High Conservation Value
HCVR	High Conservation Value River
HRBA	Human rights-based approach
IBA	Important Bird Area
IBI	Indices of Biotic Integrity
ICCA	Territories and areas conserved by Indigenous peoples and local communities or 'territories of life'
ICJ	International Court of Justice
ILO	International Labour Organization
IPA	Indigenous Protected Area
IP&LC	Indigenous peoples and local communities
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
KEA	Key Ecological Attribute
KM-GBF	Kunming-Montreal Global Biodiversity Framework
LDN	Land Degradation Neutrality
MAB	Man and the Biosphere
METT	Management Effectiveness Tracking Tool
NBSAP	National Biodiversity Strategy and Action Plan
NCS	Natural climate solutions
NDC	Nationally Determined Contribution
NGO	Non-governmental organisation
NNTC	Nari Nari Tribal Council (Australia)
OECM	Other effective area-based conservation measures
PA	Protected area
PA-BAT	Protected Area Benefits Assessment Tool
PCA	Protected and conserved area (a shorthand for protected areas and OECMs)
PEM	Participatory Environmental Management
PES	Payment for Ecosystem Services
PFP	Project Finance for Permanence
PPA	Privately protected area
PPP	Public-private partnership
R-METT	METT modified for use on Ramsar sites
SAGE	Site-level Assessment of Governance and Equity
SAPA	Social Assessment of Protected Areas
SDG	Sustainable Development Goal
SFM	Sustainable finance mechanism
SINAP	National System of Protected Areas (Colombia)
TNC	The Nature Conservancy
TUF	Tourism User Fee
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNEP	United Nations Environment Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNWC	UN Convention on the Law of the Non-Navigational Uses of International Watercourses
USAID	US Agency for International Development
VBC	Voluntary Biodiversity Credit
WCPA	IUCN World Commission on Protected Areas
WD-OECM	World Database on OECMs
WDPA	World Database on Protected Areas
WHC	World Cultural and Natural Heritage
WHS	World Heritage Site
WWF	various – World Wildlife Fund in North America or World Wide Fund for Nature elsewhere (same organisation)

Chapter 1

The need for a focus on inland water ecosystem conservation



Morelet's crocodile (*Crocodylus moreletii*) swimming in a freshwater cenote in the Yucatan peninsula, Mexico © Luis Javier Sandoval /TNC Photo Contest 2019

Key messages:

- Inland waters around the world are disproportionately important in terms of their biodiversity, level of threat, and the benefits that they provide to people.
- Inland waters are connectors, and their health also supports the functioning of terrestrial and marine ecosystems.
- Inland waters underpin essential ecosystem services: water provision and regulation, water quality regulation, climate mitigation and adaptation, food security, livelihoods, and health and well-being.
- Aquatic species are in perilous decline: monitored populations of freshwater species have declined by 85 per cent since 1970; migratory fish populations have declined by 81 per cent; aquatic megafauna have declined by 88 per cent; and mega-fishes have declined by 94 per cent.

Inland waters – such as lakes, rivers and streams, marshes and peatlands – are amongst the most biodiverse but also the most threatened ecosystems on the planet. Despite their importance, they have often been under-represented in protection, restoration and sustainable management priorities and investments.

1.1 About this guide

Purpose. The Kunming-Montreal Global Biodiversity Framework (KM-GBF) was adopted in 2022, under the auspices of the UN Convention on Biological Diversity, with the explicit inclusion of inland waters in area-based conservation targets. Area-based conservation is defined as a conservation approach that "involves governing and managing defined geographical spaces for the in-situ conservation of biodiversity and other values."[1]

This guide is being published during a period when governments are developing their biodiversity and finance plans to meet KM-GBF Target 3, for 30 per cent of terrestrial, inland water and marine areas to be effectively conserved and managed through protected and conserved areas by 2030 (see Figure 1.1 for the key components of Target 3). This creates a renewed opportunity to achieve effective conservation of inland waters. Representative, connected, well-designed and located, and effectively-managed protected and conserved

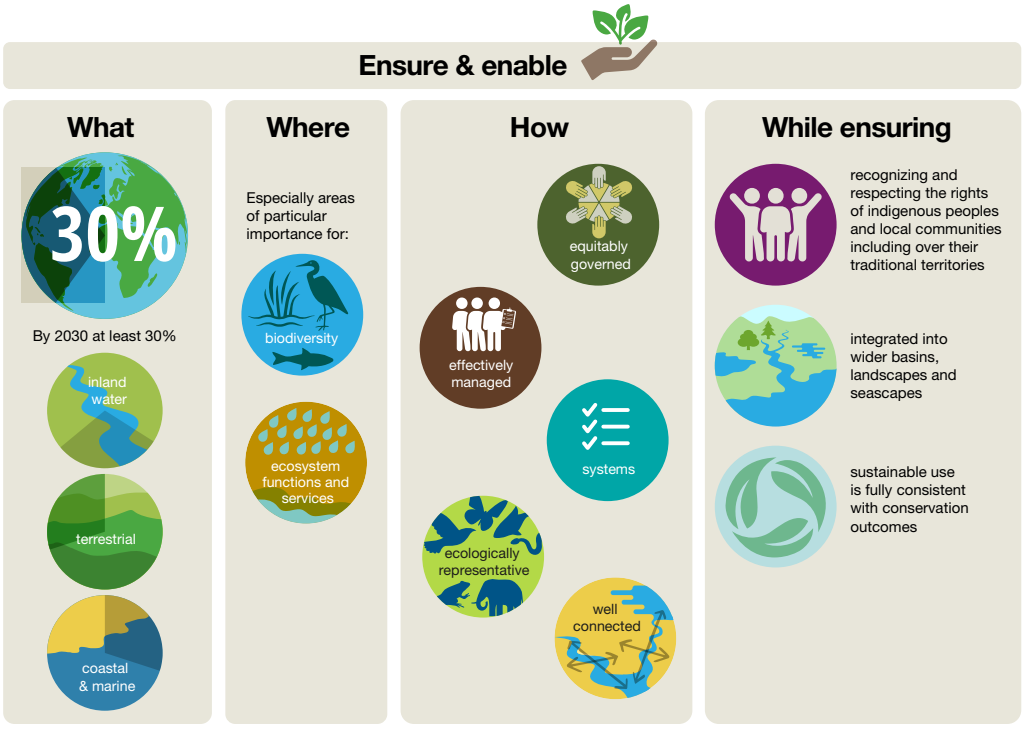


Figure 1.1 KM-GBF Target 3 goes beyond 30 per cent coverage including key elements that guide where, how and under what conditions the target should be met (Adapted from WWF & IUCN WCPA, 2023).

areas (PCAs) – both existing and new – are a key strategy to halt and reverse biodiversity loss. While written to support achievement of current global policy needs, the guide's utility is likely to extend beyond 2030 and the text is generally applicable to designation and management of area-based conservation in inland waters, irrespective of formal contributions towards the '30 x 30' target.

Intended audience. This technical guidance serves as a reference for parties responsible for, and with a vested interest in, PCAs. This includes ministries, agencies and actors responsible for PCA management, monitoring and expansion; Indigenous peoples and local communities; and those responsible for conserving inland water ecosystems, their biodiversity, and linked services (e.g. inland fisheries). We note that the authorities responsible for PCA management and for managing inland water ecosystems are often organised in separate institutions, making liaison important.
Considering the intended audience, the guidance is structured to:

- Be practical and provide readily adoptable advice.
- Synthesise scientific publications and practitioner guidance.
- Provide clear checklists with hyperlinks to resources that can provide more in-depth information.
- Emphasise case studies to illustrate key points, with case studies threaded throughout the main document and summarised in Appendix 1.

The report is organised in six primary chapters:

- **Purpose and baseline.** Chapter 1 summarises research emphasising the need to focus attention on conserving inland water ecosystems, their status and level of threat, and why conservation strategies must consider these systems to meet biodiversity, climate and sustainable development goals. It introduces a global baseline for coverage of inland waters by protected and conserved areas and offers observations about geographic and ecosystem representation. This provides a starting point for considering key gaps and opportunities as countries and vested parties translate global commitments into national targets and local implementation.
- **What makes inland waters unique when approaching PCA design, designation and management?** Chapter 2 introduces specialised considerations when approaching and implementing protection of inland water ecosystems. This includes the importance of the landscape/basin context and an overview of the key ecological attributes (KEAs) that combine to determine inland waters' ecological integrity (hydrologic regime, water quality, connectivity, physical habitat and biotic composition).
- **Starting with human rights, equity and inclusion.** Through the lens of inland waters, Chapter 3 highlights key frameworks and models for incorporating these issues into all aspects of PCA scoping, design, designation, governance and management.
- **Strengthening and expanding the PCA network.** Chapter 4 outlines important considerations for planning at the regional, national and transboundary scale. It includes key principles and resources for assessing the existing network and planning a pathway for achieving effective area-based conservation of inland waters through design, geographic boundaries and environmental standards.
- **Designation and governance.** Chapter 5 focuses on a range of legal and other effective mechanisms that can be used to designate aquatic habitats for protection as well as governance approaches to support implementation.
- **Management and financing.** Chapter 6 focuses on key considerations for developing management plans for one or more PCAs, and on evaluating management effectiveness. It starts with a brief guide to the process and content of management plans, followed by a more in-depth look at key components of management planning, implementation and evaluation for inland water ecosystems. In addition, this chapter summarises financing approaches to support sustainable management over the long term.

Box 1.1

Guiding resources

Over the last several years, a number of resources have been published that can serve as guideposts for improving protected and conserved area establishment and management in the service of inland water ecosystem and biodiversity conservation. Those references serve as guiding resources throughout the report and include:

- **Abell et al. 2007.** Unlocking the Potential of Protected Areas for Freshwaters.
- **Abell et al. 2016.** Looking Beyond the Fenceline: Addressing Protection Gaps for the World's Rivers.
- **Acreman et al. 2020.** Protected Areas and Freshwater Biodiversity: A novel systematic review distils eight lessons for effective conservation.
- **Dudley and Abell 2008.** Section 6. Specialized Applications, Inland Water Protected Areas in *Guidelines for Applying Protected Area Management Categories*.
- **Finlayson et al. 2017.** Freshwater Ecosystems in Protected Areas: Conservation and Management.
- **Gell, Davidson and Finlayson 2023.** *Ramsar Wetlands: Values, Assessment, Management*.
- **Higgins et al. 2021.** Durable Freshwater Protection: A Framework for Establishing and Maintaining Long-term Protection for Freshwater Ecosystems and the Values They Sustain.
- **Pittock et al. 2015.** Managing Freshwater, River, Wetland and Estuarine Protected Areas Chapter 19 in Worboys et al. (eds.) *Protected Area Governance and Management.*
- **Tickner et al. 2020.** Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency Recovery Plan.



Salmonids (*Salmonidae*) like the Colorado River cutthroat trout require healthy and connected inland water ecosystems for spawning and reproduction. © David Herasimtschuk / Freshwaters Illustrated

1.2 The importance and status of inland water ecosystems and their biodiversity

1.2.1 Biodiversity importance

Inland waters, while covering a small fraction of the planet, are disproportionately rich in biodiversity.[2,3,4] Fresh waters, a subcategory of inland waters excluding saline and some brackish systems, cover 2 per cent of the planet yet are home to about (and probably more than) 12 per cent of known species,[5] one-third of known vertebrate species,[6,7,8] and more than half of all fish species,[9] with a significant number of range-restricted endemics.[10] Over 200 new species of freshwater fish have been described each year since 2020.[11]

Inland waters, particularly rivers and their riparian habitat, also provide vital connectivity between different freshwater, terrestrial and marine ecosystems. As a result, maintaining or restoring longitudinal, lateral, vertical and temporal connectivity of inland waters is particularly important, and a range of proven measures exist to do so.[12] Restoring and/or protecting hydrological connectivity in rivers has a positive effect on biological diversity.[13] Strong connectivity supports habitat heterogeneity essential for riverine fish abundance and diversity.[14] Connectivity is especially important in allowing terrestrial and freshwater species to disperse to climatic refugia.[15,16,17] Riparian zones, often protected *de jure*, can also provide corridors for terrestrial species navigating between habitat patches in human-dominated landscapes.[18] Indeed, riparian ecosystems are often conservation priorities for both freshwater and terrestrial biodiversity due to the high species diversity they support, their role in connectivity, their buffering of runoff and erosion from adjacent lands, and as refugia for terrestrial fauna, as well as for the ecosystem processes that they sustain.[19]

Aquascapes, analogous to landscapes, are recognised where fresh water, transitional waters and marine waters support ecological and socio-economic connectedness. Aquascape management and source-to-sea conservation are approaches for integrating the conservation and restoration of inland, transitional, coastal and marine waters.[20,21] These approaches emphasise the interdependence of various threats, biodiversity and ecological processes. For instance, strong connectivity between and among these realms aids nutrient exchanges. Anadromous fish such as salmon (migrating between salt- and fresh water) accumulate over 95 per cent of their body weight in the oceans and migrate inland to spawn. This migration transfers nutrients to terrestrial ecosystems through the direct consumption of salmon by terrestrial predators and scavengers, through decomposition of salmon remains into the soils, through subsurface water flows transporting nutrients into riparian zones, and more.[22] These ecological interactions benefit inland terrestrial and aquatic ecosystems in numerous ways that scientists are only just beginning to understand.

1.2.2 Value to humans

Natural inland water ecosystems provide important services,[23,24,25] including the provision of reliable water for drinking and irrigation,[26] support for food security through freshwater fishes and other species, the reduction of flood damage by natural floodplains and riparian vegetation, pollution control,[27] and delivery of sediments and nutrients to downstream areas. It is estimated that above and below ground inland water habitats provide over US$ 4 trillion in ecosystem services globally each year.[28] A recent report estimated the value of the natural processes that rivers, lakes, wetlands and aquifers provide to support human well-being to be as high as US$ 50 trillion.[29]

Inland waters play a crucial role in regulating the global carbon cycle and climate.[30] They store the majority of the world's carbon;[31] lakes account for less than 4 per cent of the world's surface but are recognised as indispensable for carbon transformation and storage,[32] and peatlands, despite covering only 3 per cent of the land surface, store twice as much carbon as the world's forests.[33] Rivers also play a key role in transporting sediment organic carbon from sequestering lakes and wetlands to the oceans.[34] Mangrove forests, sustained by freshwater inflows, contribute significantly to carbon storage,[35] while their sediment trapping counters sea-level rise.[36]





Covering less than 6 per cent of the planet, inland water ecosystems support a stunning proportion of the world's biodiversity, hosting more than 80 per cent of all turtle and tortoise species and more than 50 per cent of all fish species.
Musk turtle (USA) and creek tetra (Costa Rica)
© David Herasimtschuk /Freshwaters Illustrated

Communities depend on inland waters for protein, fats and micronutrients from freshwater species;[37] for building materials; for water; and as a means of transportation.[38] This includes both naturally occurring and man-made inland water areas (e.g. reservoirs, rice paddies). One third of the global food resource depends on rivers, and 40 per cent of the global fish protein consumed by humans comes from freshwater fish species.[39] Meanwhile, a third of the world's hundred largest cities get a significant proportion of their drinking water from protected areas[40] (see Upper Nile Basin Case Study 28). Finally, inland waters serve as sources of learning, inspiration, tourism and recreation, while supporting cultural, spiritual, sensory and sacred values from local to landscape/aquascape scales,[41] mental and physical health,[42,43] and a sense of place.[44]

Yet, despite overwhelming recognition for the value of these services, challenges persist in garnering increased investment for their conservation and effective management.[45]

Box 1.2

What do we mean by inland waters?

Inland waters are defined by the UN Convention on Biological Diversity as ***"aquatic-influenced environments located within land boundaries"*** whether fresh, saline or brackish, including "*those located in coastal areas, even where adjacent to marine environments*."

Under this framing, inland waters fall within the scope of the more encompassing concept of **wetlands**, as outlined by the Ramsar Convention: "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6m*."

Inland waters include lakes and lagoons, rivers and their estuaries, ponds, streams, groundwater, springs, cave waters, floodplains, as well as peatland bogs, marshes and swamps.

Freshwater ecosystems are a subset of inland waters, in that they refer only to *fresh* aquatic environments; and inland waters are a subset of wetlands – the latter including a broader set of aquatic systems.

In this report, we use each of the above terms consistent with the above definitions, in conformity with the legal framework provided by the two conventions taken together. In practice, all such terms are approximate with boundaries between inland and coastal waters best defined locally

Inland water realm "aquatic-influenced environments located within land boundaries"			
Inland water biomes			
Rivers and streams	Palustrine wetlands	Lentic/lakes	Artificial wetlands
Examples of inland water ecosystem types			
Ephemeral headwaters Small streams Permanent upland streams Medium tributary rivers Large lowland rivers Great rivers	Floodplain wetlands Seasonal wetlands Peatlands Flooded forests Fens	Large permanent Small permanent Salt lakes Lagoons Artesian springs Permanent pools Vernal pools	Rice paddies Reservoirs Recreational ponds

1.2.3 Status of inland water ecosystems and their biodiversity

Inland waters face severe threats from habitat loss and modification, overexploitation, pollution, invasive species, climate change and fragmentation, and have lost a greater proportion of their species and habitat than the terrestrial or ocean realms (Figure 1.2). Many species are confined to just one lake or river system, making them highly vulnerable, especially when these habitats are spatially restricted. Of the 40,527 species assessed in the IUCN Red List of Threatened Species and categorised as 'freshwater', about 21 per cent are threatened.[46] However, this includes groups for which not all species have been assessed.

The conservation status of freshwater fish species has been comprehensively assessed, and about 21 per cent are classified as threatened. Decline is not limited to vertebrates. Decapod crustaceans include 18 per cent threatened species, and dragonflies and damselflies include 11 per cent, but both groups include many Data Deficient species, which may also be threatened. One third of assessed freshwater molluscs are also deemed to be at risk of extinction.[47] General estimates of threats to freshwater species suggest nearly one in three species is threatened with extinction, proportionately higher than on land and in the ocean. The decline in monitored freshwater species' population sizes averages 85 per cent since 1970.[48] Migratory fish populations have seen a decline of 81 per cent,[49] while aquatic megafauna and mega-fishes have declined by 88 per cent and 94 per cent, respectively[50] (Figure 1.2).

IUCN has developed a Red List of Ecosystems[51] for assessing and categorising the status of habitats, based on IUCN's Typology of Ecosystems. While this has not been applied to many inland waters, there are some useful case studies including 'Critically Endangered' systems such as the Karst Rising Springs Wetland Community of South Australia, or the collapsed ecosystem of the Aral Sea. Globally, over a third of inland waters have experienced declines from 1970 to 2015[52] andonly one-third of large rivers remain free-flowing from source to sea.[53]

Box 1.3

Basins, catchments and watersheds

In this report, we use the term 'basin' to refer to the hydrographically-defined area (inclusive of lands and waters) that drains to any water body. A basin can be at almost any spatial scale, ranging in size from the area draining to the smallest first-order stream to the over 6 million square kilometre Amazon River Basin. Except for basins with no external drainage or those draining to the ocean, all basins are nested within larger ones. For that reason, we do not distinguish between basins and sub-basins in this report.

The terms 'watershed' and 'catchment' are used in different parts of the world as synonyms for 'basin'. We use 'basin' here to align with broadly accepted concepts like integrated basin management.

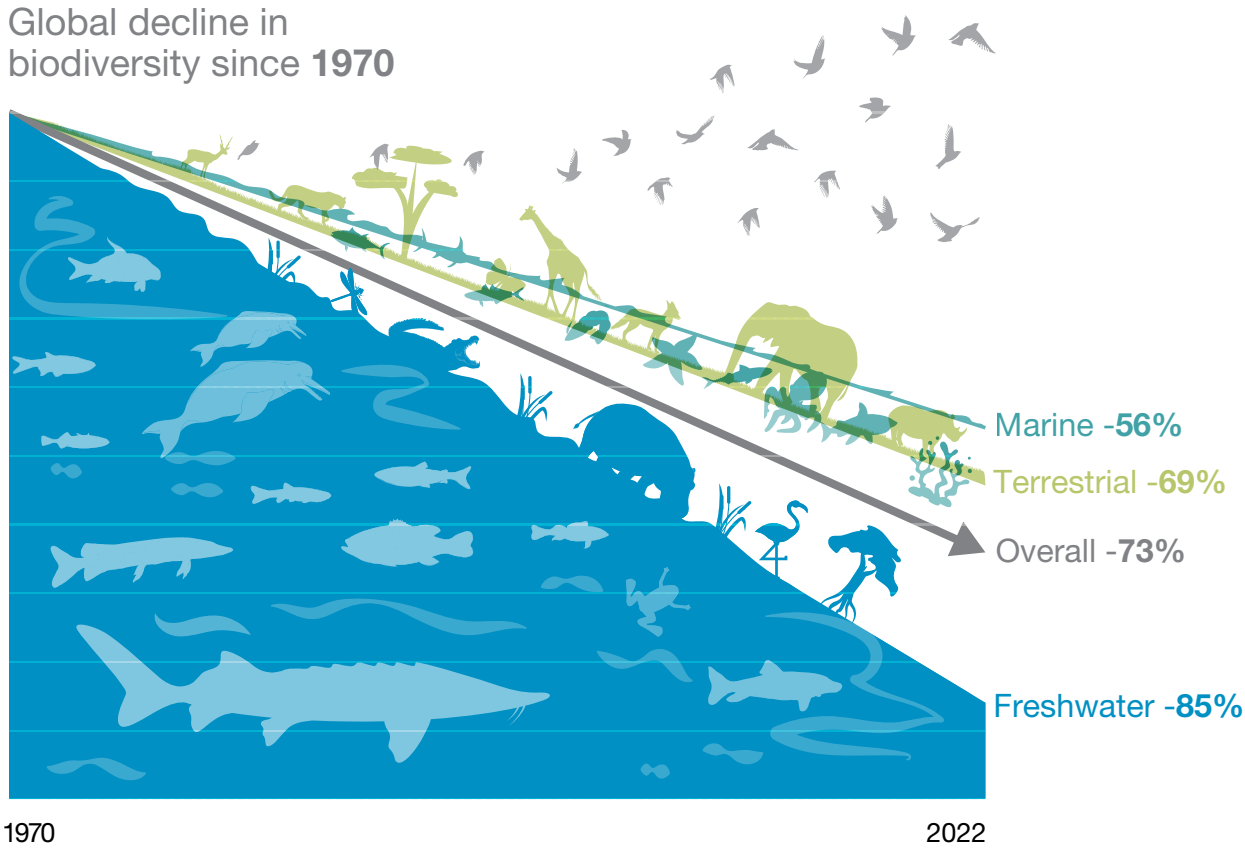


Figure 1.2
Species dependent on inland water ecosystems are in perilous decline including a loss of 85 per cent of monitored populations of freshwater species (figure adapted from WWF Living Planet Report 2024), 81 per cent of migratory fishes like salmon and river herring, 88 percent of megafauna like hippos, river dolphins and crocodile and 94 per cent of megafishes like sturgeon and giant freshwater rays.

1.3 Global status of inland water coverage by PCAs and gaps in representation

1.3.1 Developing an indicator for tracking inland water coverage

The explicit inclusion of inland waters within global area-based targets for conservation requires establishing a baseline against which to measure progress. The World Database on Protected Areas (WDPA) is the most comprehensive global database of protected areas, which is updated monthly and can be searched via the Protected Planet website. However, historically, Protected Planet statistics on coverage have not differentiated inland water areas from terrestrial.

In recent years, several methods and datasets have been proposed for measuring global coverage of inland waters by PCAs. Preceding the Convention on Biological Diversity's fifteenth Conference of the Parties (COP 15) in 2022, two expert workshops were held to review best available data to represent the extent of inland waters and define coverage. **The conclusion was that sufficient data are available to develop and apply a method to estimate coverage of inland waters by PAs and OECMs** that is simple, has clear caveats, and can serve as a foundation that can accommodate growth and complexity over time (including methods to assess component indicators of effectiveness, connectivity, and areas important for biodiversity).[54] Consistent with these recommendations, a methodology was designed with the following foundational principles:

- ✔ Align with the UN CBD definition of inland waters.
- ✔ Follow and build from the well-established methodology of tracking global coverage of protected areas under the CBD.
- ✔ Be readily implementable, using best available data with a foundation for growth and complexity.
- ✔ Allow for downscaling by providing a methodology and tools for tailored calculations at regional, subnational and national scales.
- ✔ Avoid double-counting.
- ✔ Disaggregate to track change across different biomes (e.g. rivers and streams, lakes, artificial wetlands, peatlands).
- ✔ Be compatible with, and not made redundant by, inland water indicators for other multilateral environmental agreements.

Building from these principles, a global consortium supported the development of a set of unified indicators that, for the first time, can track coverage of inland water areas apart from terrestrial. The indicators use the World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures (WD-OECM) to capture PCAs. The new Global Lakes and Wetlands Database Version 2 and RiverATLAS are proposed datasets for use in global analyses and where better country-level data are unavailable, to represent the extent of the inland water realm and river and stream biomes, respectively.[55,56] The proposed datasets are the best available global data at the moment, and as improved global data for inland waters become available, they can be considered by the parties and UNEP-WCMC and adopted.

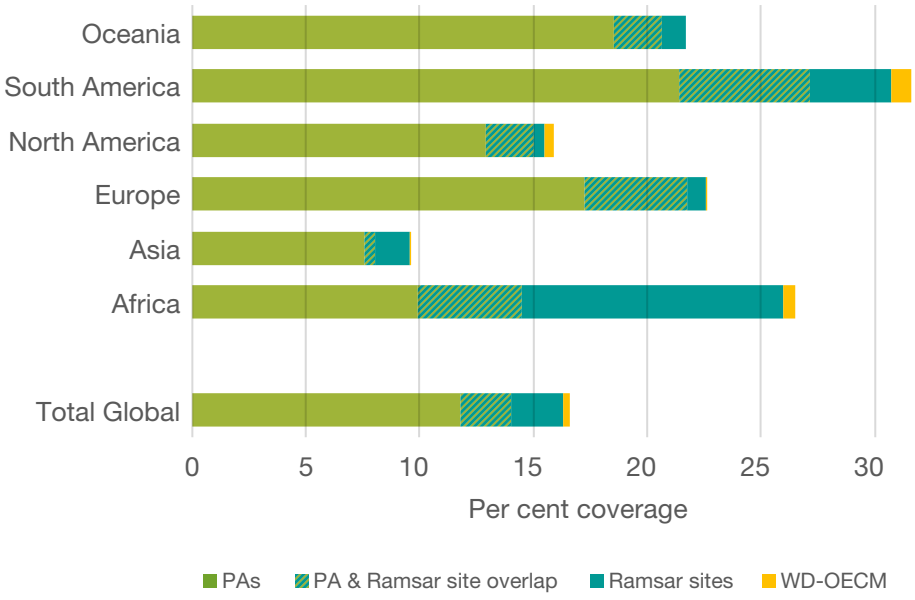


Figure 1.3 Per cent coverage of inland waters by protected areas, Ramsar sites and OECMs. Note this percentage represents *coverage* only and does not yet represent effectiveness. All data come from WDPA and WD-OECM databases. Countries with restricted data could not be included in this analysis.[58]

1.3.2 Coverage of inland waters – global baseline and representation

Using these global datasets (WDPA and WD-OECM, downloaded April 2023), it is estimated that the **global baseline of coverage of the inland water realm by PCAs is at least 16 per cent** (Figure 1.3) and includes all inland waters as defined by CBD, including peatlands and some coastal ecosystem types (e.g. mangroves) that fall within land boundaries, as well as artificial inland water ecosystems (reservoirs and paddy rice). This is similar to the ranges reported previously, and also aligns roughly with the status of the terrestrial realm. This latter finding is unsurprising, as inland waters are embedded within a terrestrial matrix, suggesting that PCAs have been designed neither to preference nor to avoid the inland water ecosystems within them.[57] There are, however, differences across regions, designation mechanisms and ecosystem types.

Looking across regions and designations, the results show important variations in coverage that can help to assess opportunities moving forward. A few notable trends can be seen:

1. Parsing out different designation types reveals opportunity.

- **Areas under Ramsar site designations are a substantial component of the current baseline and could benefit from being strengthened.** Ramsar sites contribute close to 5 per cent globally of inland water coverage and range from 2 to 16 per cent across regions, with notable contributions in Africa and South America. All inland (as opposed to coastal) Ramsar sites have inland water objectives, but sites in some countries lack binding protection mechanisms or authorities and resources for management. In particular, Ramsar sites with no overlap with nationally designated PCAs can offer an opportunity for strengthening protection and management to deliver lasting inland water outcomes (Figure 1.3, purple areas). This opportunity is discussed in more detail in Chapters 5 and 6.
- **While few countries have submitted OECM data to the WD-OECM, for those that have, it is apparent that OECMs are contributing to inland water protection coverage**, in particular for South America. Of note, Colombia has demonstrated a novel approach to inland waters and OECMs that is shared in a case study in Chapter 5. Chapter 5 also touches on considerations for OECMs specific to inland waters and points to existing guidance.
- **Globally, 11.8 per cent of existing inland water protection coverage is within those protected and conserved areas with no Ramsar site overlap.** This highlights important opportunities for strengthening management of inland water ecosystems within those areas.

2. Additional disaggregation of indicators across biomes by ecosystem type, of rivers and streams by size, and across freshwater ecoregions or freshwater Key Biodiversity Areas, can guide implementation towards those under-represented ecosystems and the biodiversity they support.
   - As an example, Figure 1.4 shows that when the global baseline coverage is disaggregated for rivers and streams, the extent of coverage looks similar to the coverage of all inland water areas, at an estimated 17.6 per cent. However, further disaggregation by size class reveals significant differences. **The smallest headwaters are highly represented, with almost 31 per cent of coverage globally. Conversely, larger tributaries and the largest rivers are under-represented**, with an estimated coverage of 15.5 per cent and 4.4 per cent, respectively. It is noted that the coverage estimate for the largest river class will be sensitive to the definition of boundaries between inland and marine areas.
   - A separate analysis of level of protection coverage across freshwater ecoregions – delineated based on freshwater species biogeography – can reveal important gaps that are, in many cases, shared across countries. Similarly, an analysis of freshwater Key Biodiversity Areas can identify gaps that are more localised but equally important.

Coverage statistics were calculated using best available global datasets (WDPA and WDOECM download April 2023) and without the official boundaries for inland and marine areas used by UNEP-WCMC. The official coverage indicators for the inland water realm and inland water biomes will be published by UNEP-WCMC in the forthcoming 2024 Protected Planet Report.

1.3.3 Beyond coverage – the necessity of tracking effectiveness, connectivity and areas important for biodiversity

Area-based targets include many more components than merely coverage by PCAs. An important future step will be to conceptualise how to assess management and conservation effectiveness, with connectivity as an essential element, and to design indicators to measure those aspects. Inclusion of information on inland water management objectives into WDPA and WD-OECM reporting would be a step forward, allowing for the identification of protected and conserved areas that are more likely to 'count' as we move from protection coverage to protection effectiveness. Effectiveness indicators should get to the heart of questions around what is required to protect inland water ecosystems durably, and how conservation efforts and investments should best be designed. Further, comprehensive global data on important areas for inland water biodiversity will allow for improved evaluations of whether protected and conserved networks are in critical locations for bending the curve of inland waters' biodiversity loss. The governance of PCAs, including recognising, respecting and supporting diverse governance types and systems, is equally crucial for enabling effective conservation.

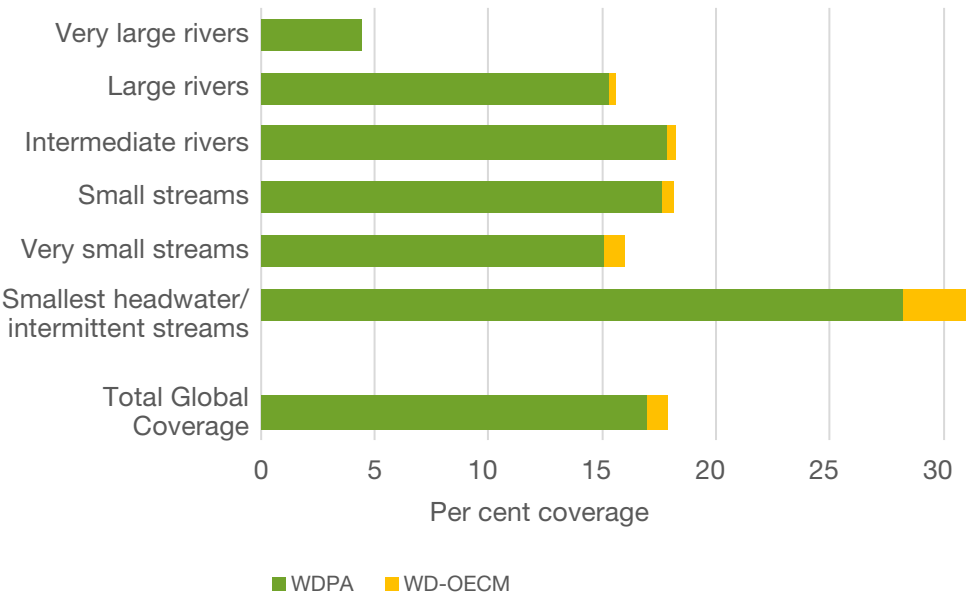


Figure 1.4 Per cent coverage of river and stream size classes by protected areas and OECMs. Size classes are based on average annual discharge of cubic metres per second (cm): headwaters (<0.001), very small streams (0.001–0.1), small streams (0.1–10), intermediate rivers (10–1,000), large rivers (1,000–100,000), very large rivers (>100,000).[59]

1.4 Integrating implementation across global commitments and initiatives

Protected and conserved area planning and management should take full advantage of and integrate existing and planned investments across relevant global conventions and commitments, including and going beyond the KM-GBF. These targets encourage collaborative efforts among nations, organisations and communities to address various challenges that cannot be tackled without the explicit inclusion of pollution, overexploitation, habitat degradation and climate change impacts on inland water ecosystems. Several global and regional goals and commitments exist for the protection of inland waters.

Convention on Biological Diversity: The Kunming-Montreal **Global Biodiversity Framework** (KM-GBF), the latest global agreement on biodiversity conservation, has 23 targets, three of which address or apply to the area-based management of inland waters specifically:

- **Target 1:** Ensure that all areas are under participatory integrated biodiversity inclusive spatial planning and/or effective management processes addressing land and sea use change, to bring the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030, while respecting the rights of Indigenous peoples and local communities.
- **Target 2:** Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.
- **Target 3:** Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognising Indigenous and traditional territories, where applicable and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognising and respecting the rights of Indigenous peoples and local communities including over their traditional territories.

Addressing these goals for inland waters will directly contribute to many other KM-GBF goals, including halting species extinction (**Target 4**); ensuring sustainable, safe and legal harvesting and trade of wild species (**Target 5**); managing wild species sustainably to benefit people (**Target 9**); enhancing biodiversity and sustainability in aquaculture and fisheries (**Target 10**); and restoring, maintaining and enhancing nature's contributions to people (**Target 11**). As well, the effective and durable conservation of inland waters cannot be achieved by area-based efforts alone, but instead must be combined with investments in the reduction of additional threats (e.g. pollution, **Target 7**).

The United Nations' 17 **Sustainable Development Goals** (SDGs) includes **Goal 6**, which specifically focuses on ensuring the availability and sustainable management of water and sanitation for all, including Target 6.6: Protect and restore water-related ecosystems. The success of Goal 6 is highly interdependent with **Goal 15**, which aims to conserve and restore terrestrial and freshwater ecosystems, with indicator 15.1.2, the "Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type."

The **Convention on Wetlands** is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. One hundred and seventy-two countries are contracting parties to the Convention, committing to the "wise use" of 2,517 wetlands across more than 257 million hectares. Of these, 2,040 are classified as inland wetlands, covering 239,832,855 ha.

Water and sanitation issues run through all of the United Nations' focus areas. **UN Water** is tasked with coordinating this work across 30 UN organisations, supporting member states in sustainably managing water and sanitation through informing policy, supporting monitoring and reporting, addressing emerging issues and building knowledge. UN Water is composed of UN members and partners (international organisations) working on water and sanitation issues.

As the only global convention specialising in migratory species, the UN's **Convention on Migratory Species** (CMS) fosters global cooperation for the conservation of migratory animals and their habitats. It unites range states and facilitates internationally coordinated conservation efforts across migration routes. Many CMS focal species rely on inland water habitats. For example, migratory birds often rely on wetlands as stopover sites providing food, shelter and breeding grounds.[60]

The **Minamata** Convention aims to protect human health and the wider environment from anthropogenic mercury release. As of 2024, 128 countries were signatories. The Convention is significant for inland waters both in helping to address industrial pollution and particularly mercury use in small-scale and artisanal gold mining.

While the UN's **Convention to Combat Desertification** (UNCCD) focuses on *Land* Degradation Neutrality (LDN), it implicitly includes degraded inland waters and simultaneously relies on the restoration of inland waters. Land degradation can significantly impact the quality and extent of inland water ecosystems – increasing sedimentation and altering hydrological patterns. Thus, efforts to protect and restore inland waters can support the LDN target and vice versa.

Lastly, the UN **Framework Convention on Climate Change** (UNFCCC) must take into account the impacts of climate change and climate change mitigation measures on inland waters, which have often been neglected in climate change discourse despite their high vulnerability. Hydropower development, often promoted as an alternative energy solution to fossil fuel use, can severely harm inland water systems.



Iguaçu Falls in Iguaçu National Park, Brazil. The Park is estimated to contribute $258M/year in ecosystem services and $37M/year in tourism. © Oscar Mendizabal/ TNC Photo Contest 2022

Chapter 2

What makes inland waters unique when approaching PCA design, designation and management?



Krka River, Croatia.
© Chip Carroon/The Nature Conservancy

Key messages:

- When designed and managed to achieve inland water objectives, protected and conserved areas are an essential tool to prevent biodiversity loss.
- Because of the dynamic and connected nature of inland waters and the importance of drainage basin influences, designing, designating and managing protected and conserved areas for inland water conservation requires special considerations.
- Five key ecological attributes (KEAs) combine to determine the ecological integrity of inland waters: hydrologic regime, water quality, connectivity, physical habitat and biotic composition. Protected and conserved areas should be designed and managed to maintain these KEAs, to the greatest extent possible.
- Understanding threats to KEAs should inform the protected or conserved area design, designation mechanism, and management.

Inland waters' unique characteristics require specialised considerations when approaching and implementing protection to achieve effective and durable biodiversity conservation and human well-being outcomes.[61] These characteristics include the importance of landscape/basin context and the combination of key ecological attributes that support ecological integrity (hydrologic regime, connectivity, water quality, physical habitat and biotic composition). The ecosystems are also subject to complex management regimes.[62]

When designed and managed to achieve inland water objectives, protected and conserved areas are an essential tool to prevent inland waters' biodiversity loss. They safeguard key habitats for inland water species, guard against overexploitation, prevent the fragmentation of critical ecosystems, and help to maintain water quality and quantity within natural ranges of variation. However, because of the connected, dynamic and nested nature of inland water systems, PCAs cannot mitigate all threats, as many of these originate upstream, downstream or in external drainage areas. To achieve lasting, effective inland water conservation, complementary management and sustainable development interventions outside PCAs will often be necessary.[63,64]

Chapter 2 outlines key considerations such as **basin/landscape context** and complex management authorities, as well as the **five key ecological attributes** that support the integrity of inland water habitats. Each key ecological attribute includes a brief description of what it is and why it's important. **Building from this foundation, Chapters 3, 4, 5 and 6 outline how to incorporate basin context and key ecological attributes into PCA network planning, designation, design, governance and management.**

2.1 The Importance of basin/ landscape context

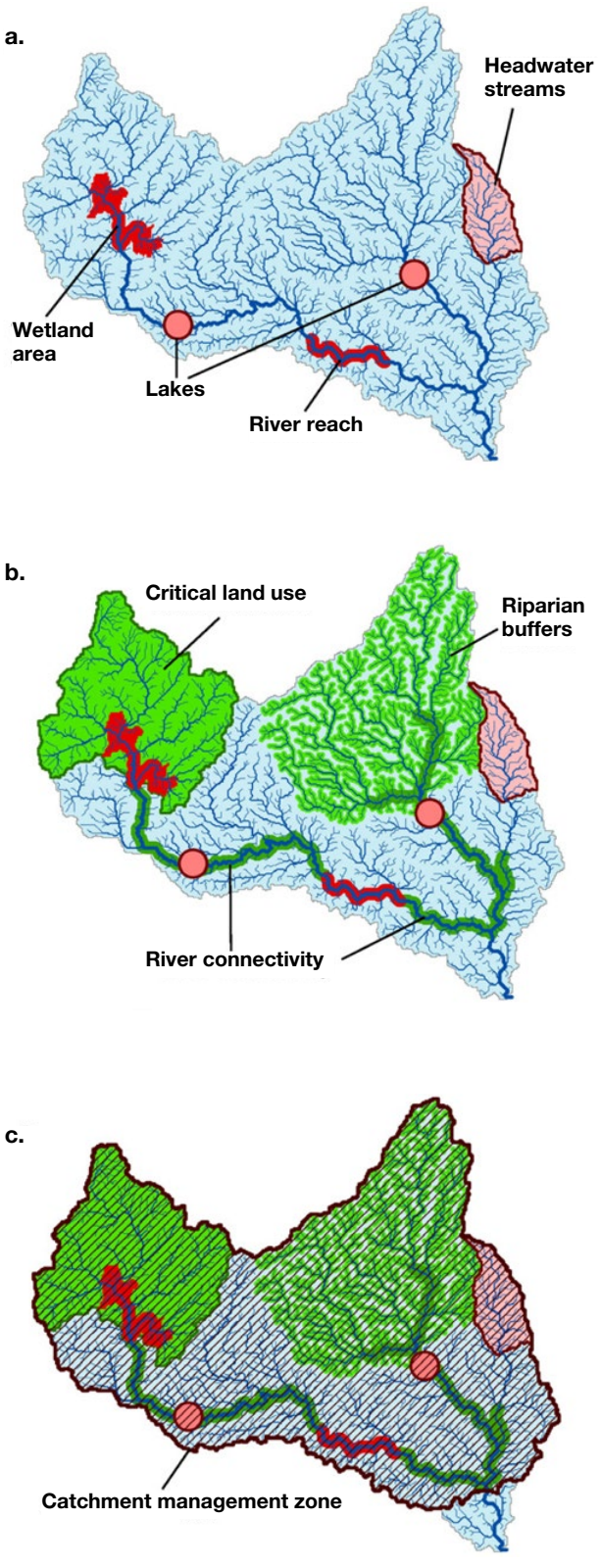
A basin (also called a catchment or watershed) is an area that drains into a water body – a river, stream, lake or other wetland (Box 1.3). This can be defined both in terms of surface area as well as subsurface area (for a groundwatershed). Inland water ecosystems are deeply influenced by the characteristics and condition of their basins in several ways including:

- Inland waters sit and flow within a landscape matrix, and the character of inland waters is determined in large part from basin influences.
- Inland waters typically sit at the lowest point in the landscape, and as a result they integrate impacts from land and water uses across their upstream drainage areas. These impacts are generally manifested in changes in hydrology (water quantity and timing), connectivity and water quality (e.g. sediments and nutrients, as well as other contaminants).
- Intact lands will benefit the inland water ecosystems within and downstream of them. Best management practices applied on working lands can minimise impacts to inland waters. Protected and conserved riparian zones can be effective for mitigating non-point source pollution derived from land-based activities and for providing corridors for species across a landscape.

- Protecting entire basins is often not a viable option, but good management practices combined with targeted interventions in vulnerable areas (e.g. steep slopes and riparian zones) is an important complement to protection.[65]

Taking into account basin context and relative position, Abell et al. (2007)[66] outline a basin protection approach tailored to inland water ecosystems. The approach uses three concepts to illustrate how a mosaic of conservation and sustainable management activities across the basin can deliver effective conservation for defined inland water focal areas. The components include inland water focal areas, critical land and water management areas and catchment (basin) management zones (Figure 2.1).

Figure 2.1 A basin/landscape protection approach tailored to inland water ecosystems including (a) focal areas, (b) critical management areas and (c) catchment (basin) management zones.[67]



Inland water focal areas describe the location and area of a specific feature requiring protection. This could include a *focal wetland area* hosting a globally significant population of amphibians, a lake or a *focal river area* providing spawning or nursery areas for migratory fish or headwater streams that provide climate resilience and refugia for cold-water species (Figure 2.1 a).

Critical land and water management areas. The ecological integrity and functionality of inland water focal areas are most influenced by their upstream drainage areas and by their upstream and downstream connectivity, here defined as critical land and water management areas. Allowable uses would be tailored to the ecological function of the zone (Figure 2.1 b). For example:

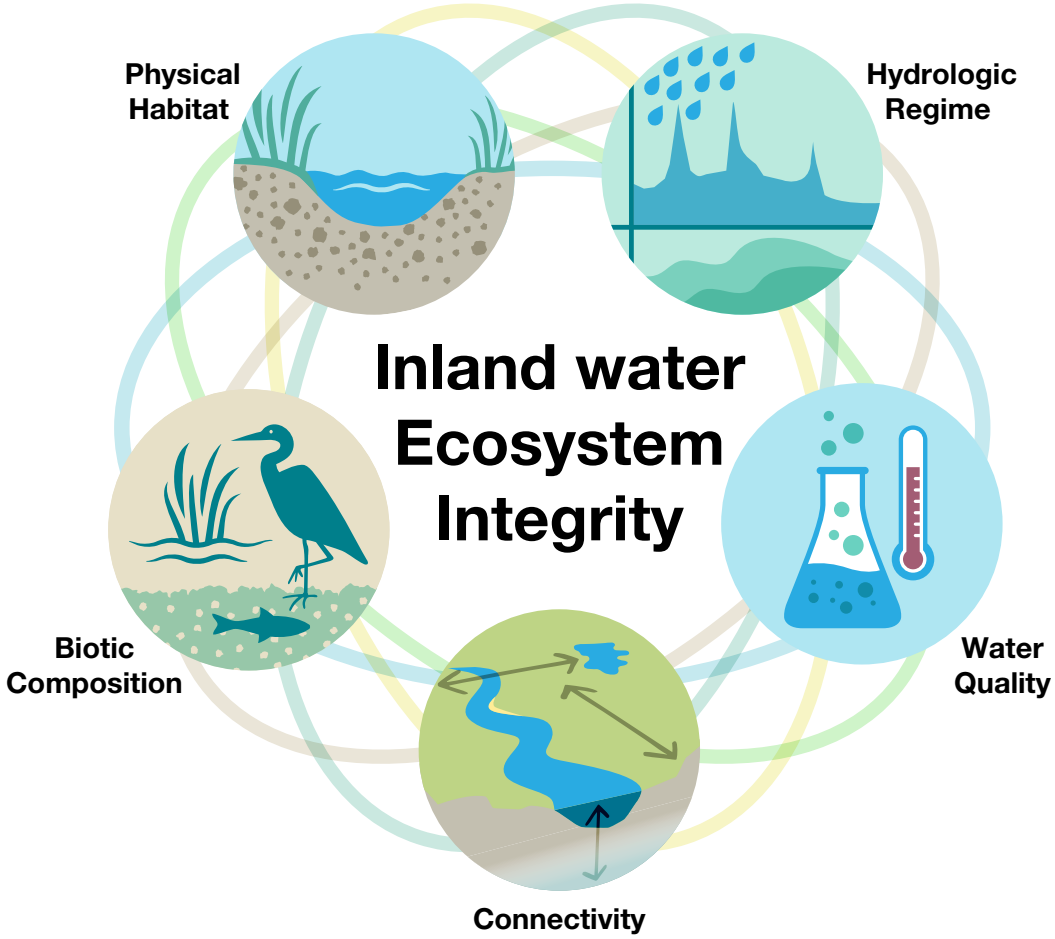
- The drainage area upstream of a *focal wetland area* for amphibians may allow limited agriculture, prohibit use of particular pesticides, and require aquatic organism passage for all road–stream crossings.
- *A focal river area* providing critical habitat for migratory fish spawning will require the maintenance of stream flows and connectivity to seasonal feeding and resting habitats downstream – including, for some fish species, connectivity to marine habitats.

Catchment (basin) management zones (Figure 2.1 c) describe the entire contributing upstream drainage area of a critical land and water management zone. Here, general best practices apply including taking an integrated river basin management approach, restricting activities on steep slopes, treating wastewater to general standards and applying fertilisers using good practice standards.

2.2 Key ecological attributes to support inland water ecosystem integrity

An ecosystem exhibits integrity when it can withstand, and recover from, natural perturbations and anthropogenic disturbances.[68] Ecosystem integrity is determined and can be assessed through the collective contribution of key ecological attributes (KEAs), defined as fundamental ecosystem aspects that, if degraded or lost, would compromise that ecosystem's functioning and ability to deliver services for nature and people. KEAs are interdependent, where a change of condition in one KEA may affect one or more KEAs and influence overall integrity of the ecosystem. For inland waters, KEAs include hydrologic regime, connectivity, water quality, physical habitat and biotic composition (Figure 2.2).[69,70] In addition to ecological integrity, each of these attributes is linked to a variety of ecosystem services that support human well-being and resilience.

Figure 2.2 Five key ecological attributes (KEAs) combine to determine inland waters ecological integrity[71]



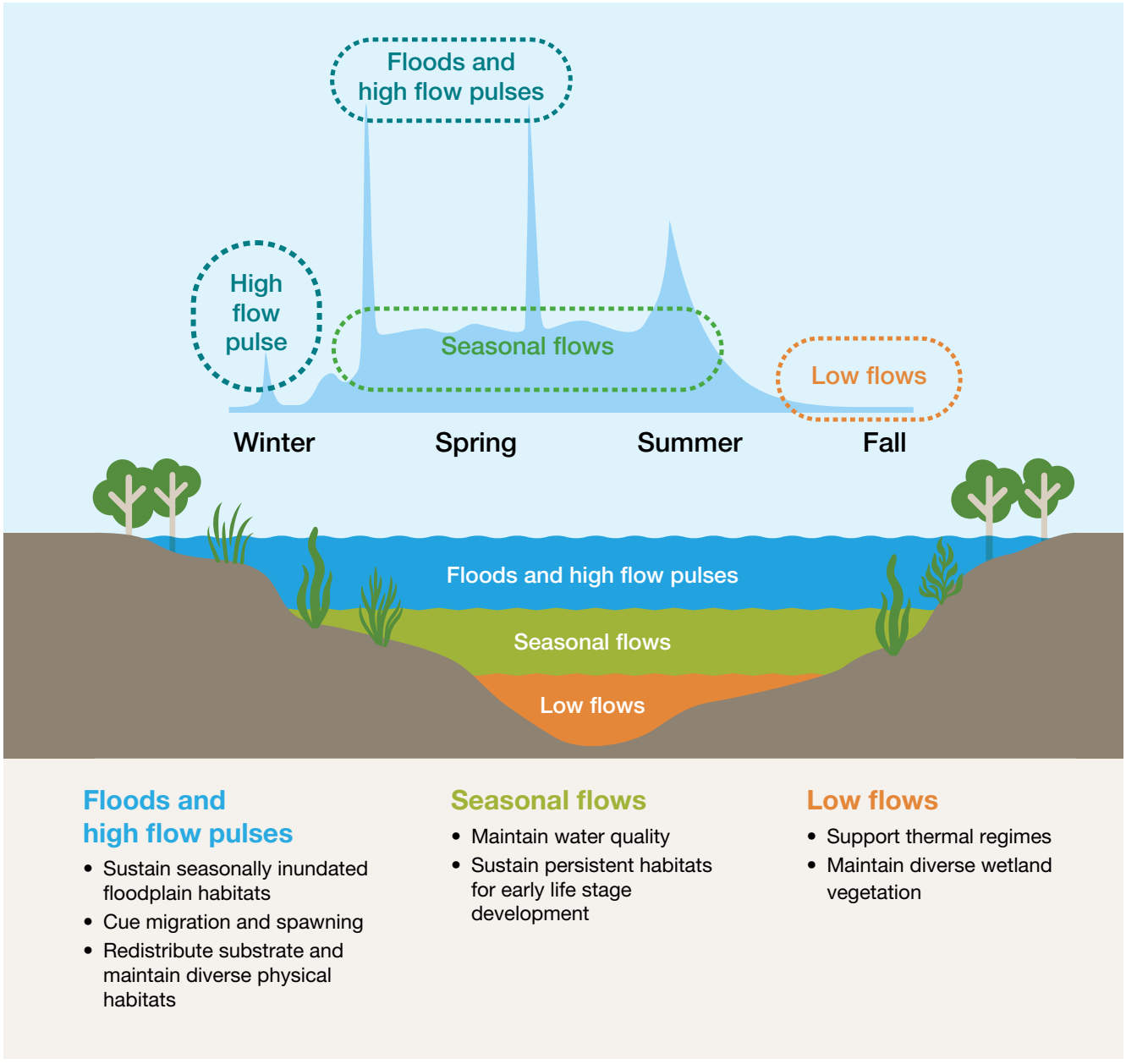
2.2.1 Hydrologic regime and environmental flows

The hydrologic regime (also sometimes referred to as the hydropattern or flow regime) of an aquatic ecosystem is the characteristic pattern of water quantity, timing and variability in lakes, rivers and other wetlands.[72] Aquatic species have evolved life history strategies to synchronise with these patterns over timescales from sub-daily variability to interdecadal events.[73] The hydrologic regime can be further characterised in terms of magnitude, timing, frequency, duration and rate of change.[74] It is considered a 'master variable' in rivers and streams, because it controls the status of other KEAs.[75] Hydrologic regime may also be influenced by other KEAs such as connectivity.

As a subset of the hydrologic regime, 'environmental flows' or 'ecological flows' describe the magnitude, timing and duration of freshwater flows and levels *necessary to sustain* aquatic ecosystem functions, biodiversity, resilience, services, and associated livelihoods. The concept recognises that all components of the hydrograph are ecologically important, but some degree of hydrologic alteration can occur while still meeting ecosystem needs.[76,77]

Environmental flow needs, or criteria, should be defined for the inland water ecosystems within a PCA. This assessment can take many forms, from desktop presumptive standards to site-specific processes for quantifying environmental flow components of floods, high-flow pulses, seasonal flows, low flows and extreme low flows (Figure 2.3).[78] Example approaches to establish and implement environmental flow protections for PCAs are discussed further in Chapters 4–6.

Figure 2.3 Dimensions and critical functions of environmental flow components

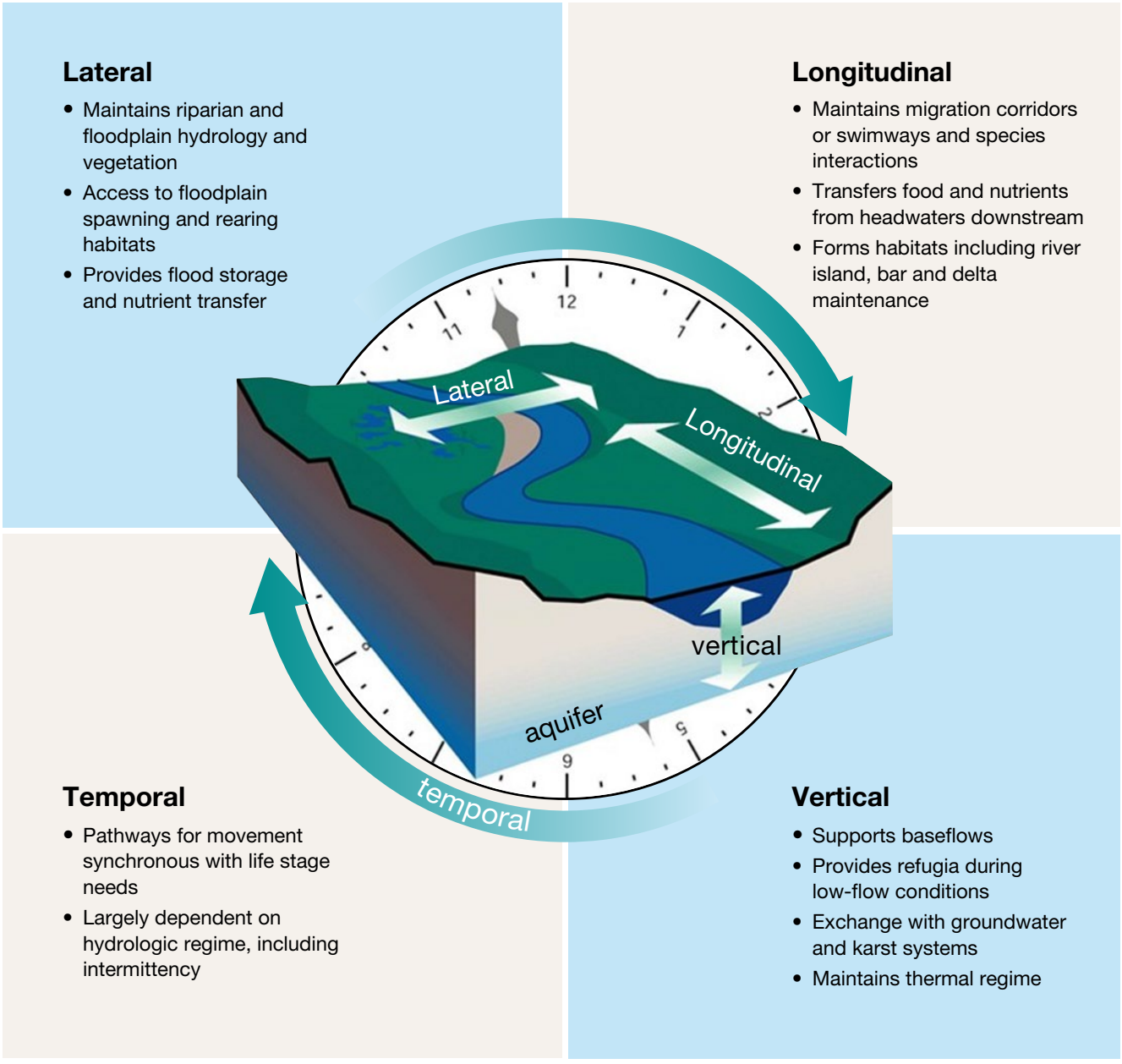


2.2.2 Connectivity

Inland water ecosystems, and in particular rivers, are defined by their connectivity. From macro-invertebrates and cottonwood seeds to sturgeon and river dolphins, aquatic-dependent species rely on connectivity to complete their life cycles, disperse and access refugia.[79] Connectivity is also essential for natural biogeochemical processes like nutrient and sediment transport and cycling. Aquatic connectivity is characterised through three spatial dimensions – longitudinal, lateral, vertical – and temporal.[80] Longitudinal connectivity describes the upstream and downstream, or source to sea, connection. Lateral connectivity is the connection between a river mainstem, wetland or waterway and its adjacent riparian area and floodplain. Vertical connectivity describes the connectivity between groundwater and the hyporheic zone (the saturated portions of streambeds, banks and floodplain) with surface waters. Temporal connectivity describes the connection between ecosystems and habitats over time.

Similar to the hydrologic regime, connectivity can have a strong and direct influence on all other KEAs. The maintenance and restoration, where needed, of connectivity should be a central focus of inland water PCA planning and management. Readily available tools and methodologies, like the Connectivity Status Index, can be used to support the development of site-specific standards for aquatic connectivity for individual or for a network of PCAs.[81] Example approaches to establish and manage connectivity for PCAs are discussed further in Chapters 4–6.

Figure 2.4 Dimensions and critical functions of aquatic connectivity



2.2.3 Water quality

Water quality broadly encompasses waters' physical, chemical and in some cases, biological properties (e.g. algae concentration). Without human influence, water quality is determined by factors such as weathering bedrock minerals, deposition of dust and salt by wind, leaching of organic matters in soil, hydrological factors, and biological processes that can impact water's physical and chemical composition.[82] The term 'water quality' is also commonly used in relation to the suitability of water for different purposes, such as for drinking. Most commonly water quality is assessed based on the following parameters:

- **Temperature:** Affects the rate of chemical reactions, determining the rate of photosynthesis, nutrient growth, and how pathogens interact with the aquatic environments. Many aquatic species have a low range of temperature tolerances.
- **Dissolved oxygen:** Nearly all plants and animals need oxygen in the water and high levels of dissolved oxygen are often related to high water quality.
- **pH:** A measure of the acidity or basicity of water. Many inland water species have a low tolerance for acidic environments.
- **Turbidity:** Refers to water clarity. Plants, solids, sediments and organic discharge can affect turbidity, which can limit the amount of sunlight penetrating through the surface of the water. Generally, higher transparency (i.e. low turbidity), is associated with good water quality.
- **Salinity:** Refers to the dissolved salt content of water. Salts can be toxic to inland water plants and animals, and salinity also governs conductivity and heat capacity.
- **Nutrients:** Nutrients such as carbon, hydrogen, nitrogen and potassium, among others, are essential for aquatic plants and wildlife to metabolise, grow and survive. When there is too high or too low a level of nutrients, water quality may not be able to support the aquatic ecosystem.
- **Bacteria:** Bacteria such as *Escherichia coli* and *Salmonella* can cause illnesses. Bacteria can come from human and animal waste.

Good water quality can look different for different aquatic ecosystems. For instance, rivers like the Amazon are naturally sediment-rich, whereas some inland waters will be crystal clear. For the purposes of assessing ecological integrity, water quality should be evaluated relative to a natural or near-natural baseline that would support native aquatic species and associated services, like fisheries (noting that some systems will be naturally depauperate).

2.2.4 Physical habitat

Physical habitat is defined as the resources and physical conditions, including food, cover and space, required for individual organisms to survive.[83] In inland water ecosystems, physical habitat is characterised by elements such as water depth, velocity, cover or hiding places, and substrate type. Physical characteristics within a water body are influenced by the surrounding geology, climate, geomorphology, soils, vegetation and location within a basin.[84]

Physical habitat provides the template that defines which species are able to survive and thrive in any particular location within an aquatic environment. In general, a higher diversity of habitats or habitat complexity is associated with higher richness across many taxonomic groups, because increased physical space, refuge, and resource availability leads to higher numbers of organisms with different niche requirements.[85,86] This relationship also holds true in many inland water environments; for example, diversity in stream habitat has been shown to be associated with higher fish species diversity in both temperate and tropical streams.[87]

When physical habitat is fragmented, altered or lost, then the resources and conditions that species need to survive are affected and, in the worst-case scenario, species may be exterminated either locally or across their range. Interventions that maintain or restore inland water habitats are key to safeguarding focal habitats for native species, but long-term viability of species populations may require additional interventions in critical management zones and catchment (basin) management zones, which may require collaboration and joint efforts with other authorities or communities (see Figure 2.1 and Chapter 6 for more details and examples).

2.2.5 Biotic composition

Biotic composition refers to the complement and abundance of species using a particular ecosystem or area for some or all of their life stages. The assemblage of native species occurring in a given river reach, lake, spring or wetland is determined by a series of biophysical processes across scales, ranging from continental (including mountain building, speciation and glaciation), regional (such as broad climatic and physiographic patterns, and dispersal barriers such as regional catchments) to subregional and finer scale habitat factors (e.g. distinct physiographic types and macrohabitats) acting on the regional species pool.[88]

Assemblages of native species can be characterised through taxa richness, a measure of the number of different types of organisms; species composition, a measure of the total number and types of organisms; endemism; and adaptive strategies, a measure of the diversity and range of behavioural, morphological and ecological traits of species that have evolved to a particular habitat niche. An example would be the streamlined body shape (morphological trait) of darter fishes (*Etheostoma* spp.) equipped for fast moving currents in riffle habitat.

Changes to any of the other KEAs can affect biotic composition, and changes to biotic composition can affect the other KEAs. For example, freshwater mussels are known to play essential roles in filtering pollutants from water, and the widespread extirpation and in some cases extinction of freshwater mussel species from rivers and streams has had impacts on the water quality KEA.[89] And, one reason why mussels have disappeared from systems is because dams and other barriers have affected the connectivity KEA, reducing populations of the mussels' host fish species.[90]

Biotic composition is an excellent proxy for ecosystem health as it reflects the collective condition of water quality, connectivity, physical habitat and environmental flows. This is why in inland water systems, Indices of Biotic Integrity (IBI) are often used as an indicator of overall basin or water body health.[91] By the same logic, however, restoring or maintaining biotic composition may require looking beyond direct threats to species populations – typically overexploitation and invasive species – and addressing the other KEAs.



Freshwater mussels, like the western pearlshell mussel (*Margaritifera falcata*), can live to more than 100 years old and over their lives, play an essential role in maintaining water quality by filtering the water column. © David Herasimtschuk / Freshwaters Illustrated

2.3 Persistent threats to the ecological integrity of inland waters

When planning, designing, designating and managing PCAs to achieve inland water objectives, it is critical to understand and address, to the greatest extent possible, the threats to those objectives, assessed principally through the lens of KEAs.[92, 93] This section includes an overview of widespread and persistent threats specific to inland waters, organised by KEA, including examples of threat sources (Table 2.1).

Table 2.1. Summary of key ecological attributes for inland waters, examples of first order threats and their sources (adapted from Higgins et al., 2021, Convention on Wetlands, 2021)[94,95]

Key Ecological Attribute	Threats		Sources of threat
Hydrologic regime *timing, magnitude, frequency, duration, rate of change*	Climate Change	Flow and lake level regime alteration, water withdrawals, inter-basin transfers	Dams, irrigation, energy or water resource development, land use change
Connectivity *longitudinal, lateral, vertical, temporal*		Fragmentation from obstructions; obstructions to species migration/ movement; obstructions to sediment and nutrient transport	Dams, energy or water resource development, levees, berms and channel lining for flood-risk, road development/ undersized and poorly designed culverts
Water quality *temperature, clarity, chemical, biological*		Basin runoff or point sources of excess sediments and/or nutrients, bacteria, toxic chemicals, thermal pollution from dams	Agriculture, deforestation, animal management, sewage or wastewater, industry, mining, hydroelectric developments
Physical habitat *distribution, abundance, structure, condition*		In-stream and lake shoreline gravel mining, channelisation, floodplain and/or riparian and other wetland destruction/ conversion	Land use change, development, aggregate extraction, agriculture including crops and livestock grazing and watering
Biotic composition *composition, abundance, distribution*		Over-harvesting, invasive alien species (which may include species that may be found elsewhere in the region but are invasive to a particular habitat)	Poorly managed fisheries, aquaculture, pet and landscaping trades, aquascaping, introduced species, species range changes due to habitat modification (e.g. changes in flows) and climate change

Altered flow regimes and water quantity, resulting from water abstraction (e.g. for irrigation), impoundments (e.g. for hydropower and water storage), water diversions, groundwater pumping, river channelisation and levees, urbanisation and land use change (e.g. sealing and draining), and climate change,[96] are a key threat to inland water ecosystems. In particular, climate change is altering the frequency and intensity of floods and droughts, and sea level rise is 'drowning' inland wetlands by moving the tidal front upstream and creating longer inundation periods. Flow regime alterations disrupt the dynamic balance between the movement of water and sediments in free-flowing rivers, with implications for habitat.[97]

Changes to **connectivity** caused by fragmentation (dams, levees, infrastructure or development in the floodplain or river, etc.) or by artificial hyperconnectivity (e.g. canalisation or removing natural barriers that otherwise block the intermingling of species' populations) can severely impact inland waters' ecology.[98] Dams pose a significant threat to inland waters, with the world's large rivers at a heightened risk; only approximately one third of long rivers remain free-flowing[99] and the construction of proposed dams threatens the free-flowing status of 260,000 kilometres of rivers (see Figure 2.5).[100]

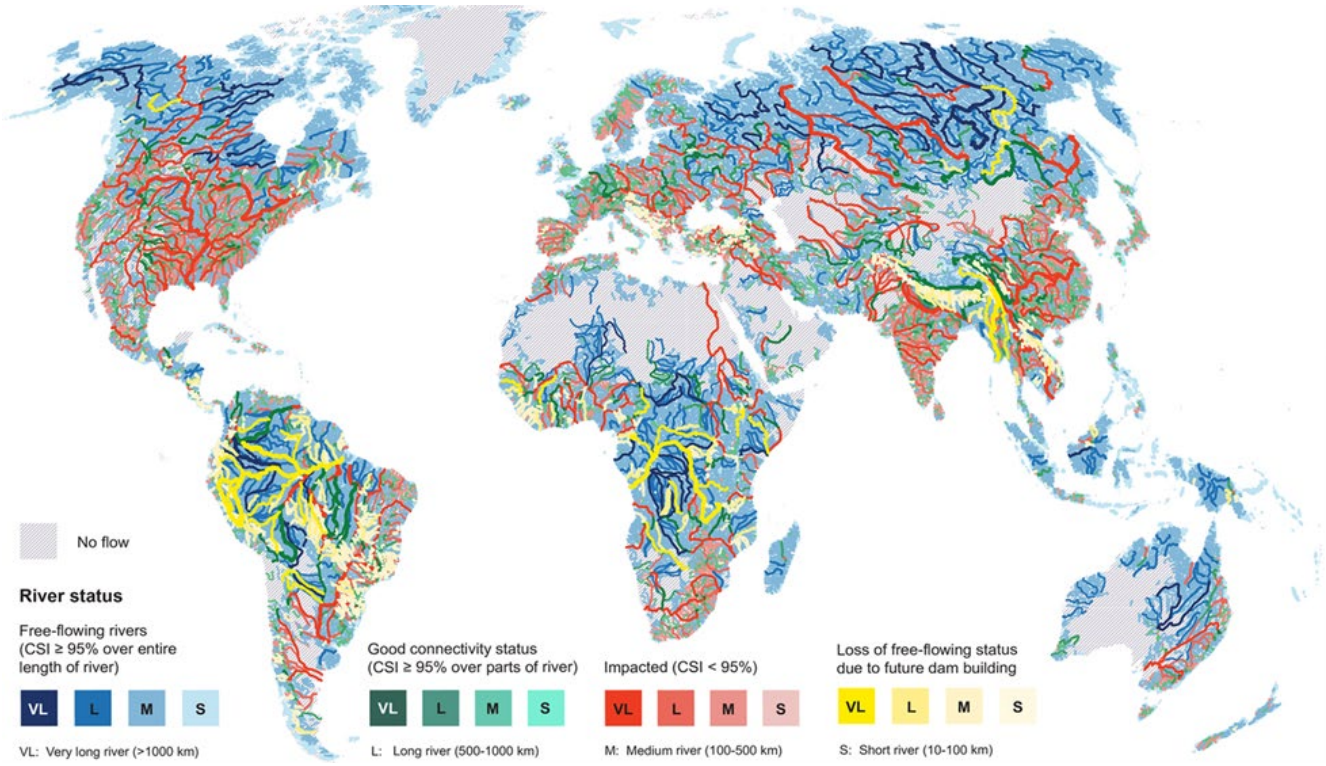


Figure 2.5 (above) Global river connectivity status and distribution of rivers that lose their free-flowing status between current and future dam scenarios.



(left) While important for regulating water supplies and other services, dams are a source of threat to all KEAs, especially connecitivty and the hydrologic regime. © Ken Geiger/TNC

Water quality is declining due to contamination from multiple sources. Pesticides, fertilisers and sediments in agricultural runoff are a major issue,[101] with global assessments revealing that over half the detected concentrations of insecticides in inland waters exceed regulatory limits.[102] Pollution from wastewater and pervasive micro- and nano-plastics[103] in inland waters now significantly impact human health,[104,105] along with pollution from mining, oil spills and other industries.

Habitat loss, **including fragmentation**, contributes to the decline of 80 per cent of freshwater species currently facing extinction.[106,107] Since 1700, 3.4 million km^2 of natural inland wetlands have been converted, corresponding to 21 per cent net loss.[108] If current trends persist, wetlands are projected to decrease to less than one-tenth by 2050.[109] Agricultural expansion is frequently the primary driver behind the degradation and loss of wetlands in particular.[110,111,112,113] A high rate of global inland wetland area loss, estimated at 2.2 per cent a year occurred during the 1950s primarily in North America, Europe and China, due to drainage for agriculture and forestry. Major river basins in populated temperate areas, such as Danube, Yangtze and Mississippi, were subject to a high rate of wetland losses, leading to increased flood risk and a decline in water quality.[114] For peatlands alone, roughly 50 million hectares are currently drained, predominantly for agriculture.[115] The conditions of wetlands are declining at the same rate as their extent: in 2017, more Ramsar Parties reported deterioration than improvement in their wetlands' ecological character state.[116]

Overexploitation of freshwater species is a major threat to the biotic composition of inland water ecosystems.[117,118] A wide range of aquatic species are harvested, including plants, invertebrates, fish, amphibians, reptiles, waterbirds and mammals for food, livelihoods, revenue, recreation or cultural practices. Large-sized freshwater species are particularly vulnerable to overexploitation, as they are selectively targeted for their meat, skin and eggs, and tend to be prized as high-value commodities, major trophies of recreational fishing, and also frequent victims of incidental bycatch.[119] Overexploitation has contributed to the substantial decline of



Amphibians are highly vulnerable to water pollution, wetland habitat loss and impacts to connectivity. © David Herasimtschuk / Freshwaters Illustrated

freshwater species' abundance and range, leading to extirpation of local populations. Lack of data, inadequate evidence-based management, and insufficient enforcement of robust legal frameworks are the main barriers to reducing overexploitation.

Invasive alien species can wreak havoc, especially in closed inland waters like lakes, and they can spread rapidly in connected systems like rivers, particularly when systems have been homogenised and natural barriers breached. While less common, they can also establish in undisturbed ecosystems. Invasive alien species can reorganise food webs and biotic interactions, alter biochemical conditions, introduce pathogens, and hybridise with native species. The introduction of invasives, like the water hyacinth, is often unintentional, but inland waters are also impacted by intentional introductions of fish, amphibians and crustaceans for aquaculture, sport, the aquarium trade and biological control.[120]

The compounding effects of these threats are exacerbated by **climate change,** which is acutely disruptive to the delicate balance of inland water temperature, biochemical attributes and flow dynamics.[121] Sensitive river and riparian systems[122] and Arctic and montane wetlands[123] are particularly threatened, along with their ecosystem services. Naturally isolated or anthropologically disconnected inland waters lack dispersal routes for obligate aquatic species to more favourable climate envelopes.

Abiotic regime shifts caused by climate change can transform wetlands from carbon sinks into carbon sources.[124] The 50 million hectares of drained peatlands contribute about 4 per cent of all anthropogenic greenhouse gas emissions each year.[125] Without comprehensive protection, this percentage is projected to surge. In total it will account for 12–14 per cent of the emission budget needed to maintain global warming at a level below 1.5°C by 2100.[126] Furthermore, people's responses to climate change can themselves have detrimental impacts on inland water ecology, such as farmers storing more water on their land, tree planting for carbon sequestration, and production of biofuels, all reducing inflows into inland water ecosystems.[127,128]



Cattle ranching in the Magdalena basin, Colombia. © Paul Smith/ TNC

2.4 Putting it together – using PCAs as a tool for effective conservation of inland waters

The application of area-based conservation for terrestrial and marine areas is well recognised and established.[129] This chapter has introduced the unique characteristics of inland waters that need to be integrated into conventional area-based conservation approaches to achieve effective conservation and management.[130] Pulling together foundational themes of basin/landscape context, inland water KEAs and persistent threats, as well as recognising the intimate connection between water resources and human rights, equity and livelihoods, four questions can be used as a general guide to assess whether, how, and to what extent, PCAs can be effective in a given situation (Table 2.2). Guidance for assessing each of these questions is the focus of the remaining chapters of the report.

Table 2.2. Four general questions to guide the use of PCAs for effective conservation of inland waters

Question	Guidance
1. What are the inland water values or objectives and who are the vested parties?	Chapters 1, 3, 4
2. What key ecological attributes are critical to achieving your inland water conservation objectives? Of those, which are or will likely be under pressure or threat, and where are those threats originating in the basin?	Chapters 2, 4
3. Can protected and conserved area design, designation and/or management be used or adapted to reduce those pressures to a functional degree, and if so, how?	Chapters 5, 6
4. Are there opportunities to work with stakeholders within the broader basin to reduce the external threats that the protected or conserved area cannot address on its own?	Chapters 5, 6

Some examples of how the questions might be applied:

- **Example 1. Peatlands and grazing:** If we are interested in conserving the ecosystem integrity of a peatland within an existing protected area (question 1) and have noticed that permitted grazing activities within the protected area have led to significant compaction and habitat degradation (question 2), the stressor can potentially be addressed by working with the permitted communities to create and manage riparian buffers around the peatlands to rebuild vegetation and secure remaining carbon (question 3). These practices could also be explored outside of the protected area (question 4).
- **Example 2. Aquatic megafauna and future water withdrawals.** If we are scoping the establishment of a new area of protection to support a hippopotamus population (question 1) and we know they require a river depth of about 1.5 to 2 metres and there are potential future upstream water withdrawals that could lower the river depth during the dry season (question 2), the threat could potentially be addressed by designing the protected area designation with a defined water reserve or environmental flow standard that clarifies the river conditions needed to maintain the objectives of the area (question 3), while at the same time, working proactively with upstream water users to assess alternative water sources to reduce future demands (question 4). Alternatively, if these threats cannot be abated, the ability of the area to support the objectives over the long term should be re-evaluated and alternative areas of conservation investment should be considered.
- **Example 3. Freshwater mussels and river scour:** If we are focused on conserving threatened freshwater mussel species and their benthic habitat within a specific reach of river (question 1), and if upstream channelisation has increased the risks of sudden flood events, threatening riparian vegetation and scouring out benthic habitat and species (questions 2), there may be little the managers can do within the protected area to mitigate the threat to a functional degree (question 3). However, they could investigate opportunities upstream to increase flood storage by reconnecting the floodplain to the main channel, thus reducing both the scour damage from flood events and further impacts downstream (question 4).



Kabalega National Park, Uganda.
© Matthew Hickey

- **Example 4. Migratory fish habitat and a potential dam:** If we are focused on maintaining migratory fish populations, and in particular access to their spawning and rearing habitats (question 1) and have learned that the same area of focus is also being considered for a new hydropower dam that will alter flows, reduce connectivity and destroy habitat (questions 2), the threat can potentially be addressed by exploring in parallel a protected area designation type that explicitly protects the connectivity and flow within river corridors (question 3), while working with the proponent and basin stakeholders to identify lower conflict, feasible alternatives to the proposed site (question 4).
- **Example 5. Native lake fish and pollution.** If we have the objective of supporting populations of native fish and community fisheries in a lake (question 1) and nutrient enrichment from surrounding agriculture is causing algal blooms and loss of oxygen (question 2), this is outside the immediate control of managers (question 3). It may be worth trying to restore additional reedbeds in the critical management zones/riparian areas around the lake to slow nutrient dispersal and provide some natural cleaning (question 4), but ultimately the issue will need to be addressed by working with other landowners and with the authorities to reduce the level of pollution (question 4).

In the end, PCAs will rarely, if ever, be effective when used in isolation. Their utility must be considered in the context of the basin, its water governance, resource users and Indigenous people and local communities. PCA design, designation and management should be customised to address the inland water objectives and threats at the right scale, and over the long term.[131,132] Often this will result in a mosaic of protection, conservation, governance and other management mechanisms that, when combined, are most likely to abate or mitigate threats in the long-term. And in all cases, durable conservation of inland waters will depend on the combination of societal support and engagement, appropriate policy and management mechanisms and sustainable financing.[133]

Chapter 3

Starting with human rights, equity and inclusion



Morning gillnet fishing with Samuel Evoung on a lake within the Bas Ogooué Ramsar site, Gabon. Samuel has fished his whole life. He fishes five days a week to feed his household of eleven family members, however, if there is extra fish, he will sell it. © Roshni Lodhia

Key messages:

- Human rights, equity and inclusion must be central to all efforts to protect and conserve inland waters. Communities depend both directly and indirectly on the services that healthy inland waters provide.
- The distinct characteristics of inland waters and of freshwater resources affect human rights, equity and inclusion, and in turn can affect area-based protections. For instance, access to fresh water is a basic human right and water rights will vary across and even within countries.
- The explicit consideration of water rights and of connected uses that depend on water availability and ecosystem health such as subsistence agriculture, fisheries, aquaculture and tourism, must inform PCA siting, designation, management and financing.
- PCA design and designation should consider not just established water rights under formal legal systems, but also the rights that communities hold under Indigenous or traditional law, which often encompass cultural, religious and subsistence dimensions.

Human rights, equity and inclusion considerations are fundamental to conservation, as ethical and moral imperatives and instrumental preconditions for long-term, effective conservation. This has been acknowledged in various global and regional agreements and commitments, which have increasingly interlinked the right to a healthy environment, to water and access to participation, information and justice. There are well-developed binding and non-binding instruments (e.g. UN Declaration on the Rights of Indigenous Peoples)[134] that define key legal concepts, as well as step-by-step guidelines and tools on how to incorporate equity and human rights into conservation actions and decision-making.[135, 136]

Inland water ecosystems are inextricably intertwined with human lives, livelihoods and well-being. This chapter focuses on aspects of equity, inclusion and human rights that are more prominent in inland water conservation. Section 3.1 provides a brief overview of commonly accepted and adopted human rights, equity and inclusion considerations. Section 3.2 summarises the unique characteristics of inland waters to consider relative to human rights, equity and inclusion, ending with a checklist for conservation practitioners.

3.1 Foundational dimensions of human rights, equity and inclusion

The KM-GBF calls for implementation through a human rights-based approach (HRBA) and acknowledges the right to a healthy environment.[137] Principles and rules of international law in the fields of human rights and the environment enable the fulfilment of all human rights that depend on healthy inland water ecosystems and the vital services they provide for people and nature. Without attention to water, there is no chance for society to realise the rights to life and adequate standards of living, as well as to food, health, education, public services and, ultimately, a sustainable environment. All human rights are universal, indivisible, interdependent and interrelated, with the rights to water and sanitation (UN General Assembly Resolution 64/292) and to a healthy environment (UN General Assembly Resolution 73/300) having a central role in the implementation of Target 3. The following aspects of human rights are important in the creation of PCAs:

- **Duty-bearers in relation to human rights:** Recognising that all stakeholders and rightsholders bear responsibilities in relation to human rights strengthens the legal argument for the adoption of area-based protection measures around inland water ecosystems that provide drinking water and support a healthy environment, whether or not specific legislation or regulations to respect, protect and fulfil human rights are developed by the state. All stakeholders involved in the designation and management of PCAs or in projects that might affect those areas are responsible for respecting human rights and, in particular, the rights, rules and traditions of Indigenous peoples and local communities (IP&LCs).

- **Non-discrimination:** All individuals have human rights that must be respected; and, accordingly, equity and inclusion considerations apply across society. In particular, Target 23 of the KM-GBF addresses gender equality explicitly, envisioning an implementation process that recognises their equal rights and access to land and natural resources, including water and fisheries.
- **Self-determination:** Human Rights Covenants codify all peoples' right to pursue their economic, social and cultural development; and, for their own ends, to dispose of, enjoy and utilise their natural wealth and resources. Indigenous peoples, in particular, have the right to decide their own development priorities as regards their lives, cultures, beliefs, institutions, spiritual well-being and the lands they use or occupy, including their waters. Inland water conservation must consider IP&LCs inhabiting PCAs and/or their ancestral lands that may count towards global conservation targets, or populations who depend upon the natural resources those areas conserve. This entails acknowledging and advancing their priorities, values, knowledge, practices, authorities and laws – all of which are likely to contribute to the sustainable management of water resources and the protection and restoration of inland water ecosystems within the boundaries of a given protected area or its basin. At the same time, protected and conserved area management plans that fail to account for the water-related needs and dependencies of IP&LCs are likely to violate their rights under international law, local customary law and/or national legal systems.
- **Free, Prior and Informed Consent (FPIC):** The requirements of FPIC are articulated in the United Nations Declaration on the Rights of Indigenous Peoples and further unpacked, for example, by the Food and Agriculture Organization,[138] The Nature Conservancy,[139] USAID,[140] and Cultural Survival.[141] FPIC is an iterative process, achieved through continuous dialogue, information-sharing, and the building of trust and cooperation over time. FPIC is essential to maximise the benefits associated with the designation and management of PCAs, while minimising potential detrimental effects for people. For example, consent should be obtained before the planning and implementation of projects or plans affecting inland waters located within PCAs or in Indigenous territories, and which may negatively affect IP&LCs. In this sense, FPIC may play a crucial role in protecting PCAs against external threats. Field study 1 offers an example of implementing FPIC in practice.

Well-designed safeguards for mitigating risks and upholding human rights can help conservation teams navigate human rights considerations in their PCA projects. Examples of environmental and social safeguards standards and frameworks developed by conservation organisations and funding agencies include those from WWF,[142] Critical Ecosystem Partnership Fund[143] and the Global Environment Facility.[144]

Equity and inclusion are core components of any well-governed system of PCAs.[145] Inclusion refers to approaches to in situ biodiversity conservation that are supported by and welcome different worldviews, cultures, knowledge systems and approaches.[146] Equity is a multi-dimensional concept with legal and ethical concerns and social justice foundations, and is interconnected with issues of human rights, rights to lands, waters, territories and other resources, as well as the inclusion of IP&LCs, women and youth in decision-making.[147] It covers aspects of fairness and justice that go beyond what is normally understood by the term 'inclusion'.

Equity can be described in the following three dimensions:[148, 149]

- **Distributive equity:** Who benefits, who bears the burdens of conservation, what form of benefits are accrued (economic, social, health, environmental, etc.), and how are those benefits distributed?
- **Procedural equity:** Who participates in the design, implementation and decision-making? Have marginalised groups participated in a meaningful way and with sufficient support?
- **Recognitional equity:** Have the rights and diversity of identities, values, knowledge systems and institutions of rightsholders and stakeholders been acknowledged and respected? With regard to IP&LCs, in particular, have their traditional legal systems and authorities been respected? Whose values and worldviews shape the design and implementation? Have underlying social, economic, environmental and political history been considered? Does the PCA proposal aim to acknowledge and remedy prior and present harms faced by communities negatively impacted by conservation and development?

Implementing area-based conservation for inland waters should take into account equity and inclusion considerations in the early stages of siting and design and throughout the process of PCA management planning and implementation. For existing PCAs, equity and inclusion can be improved by refining management and governance activities (e.g. review who was involved in setting up the PCA and include those previously excluded, make space for inclusive adaptive management with under-represented stakeholders, invest in assessments and diagnostics on equity and social safeguards).

Example application: To illustrate, consider the following scenarios: A conserved area is proposed for a specific inland fishing area. One process proposes the location of the fisheries reserves be based on conversations with fishing cooperative leaders (all men) about where they fish and using monitoring data (where fish breed, intactness of system, etc.). In a more inclusive and equitable scenario, the proposed areas are based on a diverse sample of key informant interviews that includes an equal number of men and women, below and above 35 years old, and explores how and where they fish, the information each group or individual holds about the fish (where they breed, cycles in population, etc.), as well as monitoring data.

Questions to ask when designing an equitable and inclusive process could include:

- Where are meetings about the project held, and at what time? Is food provided? Childcare? Are there men and women? Why? How far do people have to travel to access the meeting? How much work are they missing? Is it safe for women to travel there?
- What language is the meeting in? Do men and women both speak this language? What about elders? Which cultural groups are excluded by using this language?
- Are there documents to read? How can you be inclusive of illiterate people? Are communities given appropriate time to read the documents, spend time processing them and discussing?
- Who on your team is leading the project? Do any of them come from the communities where you are working? Is there representation, at a minimum, across age, gender, ethnic groups? (what is the capacity/diversity of the team)?

Questions specific to the conservation area could include:

- How was the location for the conservation area decided?
- What are the potential unintended consequences of the PCA? How can one mitigate those or compensate for them? Are any of them avoidable through a change in the process or project?
- What traditional knowledge exists about the water resources and connected ecosystems, including fisheries?

Field study 1
Nushiño-Curaray-Villano Community Fluvial Reserve, Ecuador



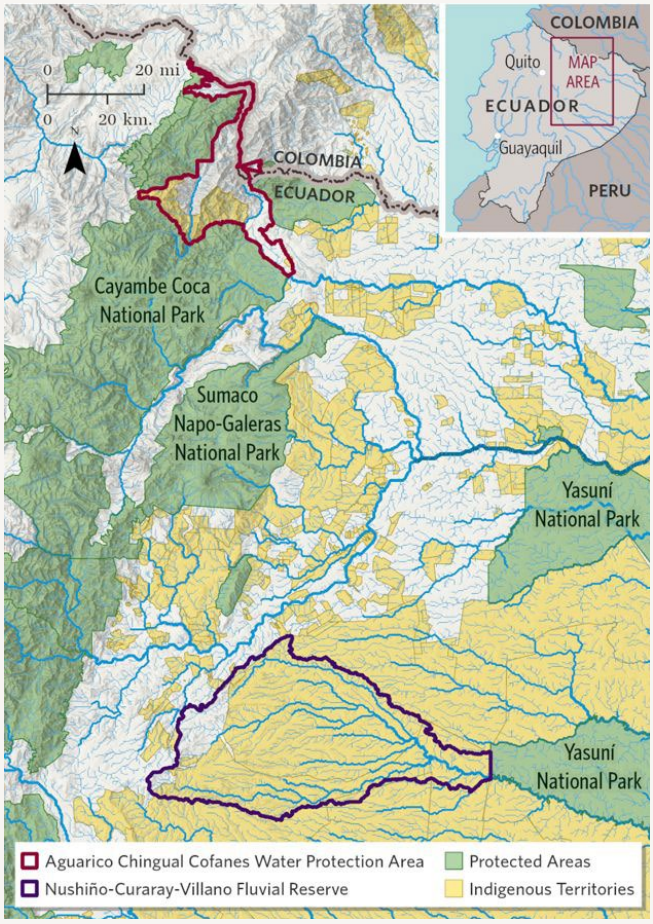
Workshop with PAKKIRU community leaders to discuss the potential community-led conservation area © Gabriela Celi/The Nature Conservancy

The Nushiño, Curaray and Villano rivers are rich in biodiversity and significant for the Kichwa (PAKKIRU) and Waorani (NAWE) Indigenous peoples. Together, the rivers support more than 200 species of fish, supply the primary protein source for local communities and span portions of the recognised territories of both nations. Mining, deforestation and pollution (from oil development) were threatening the region, prompting both Indigenous nations and The Nature Conservancy (TNC) to become interested in scoping the concept of a community fluvial reserve as a means of conserving the area. The representatives of the Indigenous nations asked TNC to facilitate a Free, Prior and Informed Consent (FPIC) process with the communities living in the fluvial-scape. FPIC was conducted with all 80 Waorani and Kichwa communities to designate the Nushiño-Curaray-Villano Community Fluvial Reserve initiative as a 'Community Conservation and Management Use Area' (ACUS, acronym in Spanish) protecting the right of Indigenous peoples to self-determination and guaranteeing the freedom to make decisions without pressure.

Following the processes in the *FPIC Guide* of the Pastaza Local Government and TNC's *Human Rights Guide*, an FPIC Guide and Report was created for the fluvial reserve. This included five annexes with information about the Indigenous communities, the conservation initiative, and the discussion and decision-making process, including final consent.

In order to carry out the FPIC process, direct communication channels were established and a workplan generated to interact with each community through its representatives. Subsequently, participatory community workshops were held where participants' concerns and comments were addressed, and the importance of the project, the potential benefits for each community, and the community strategies necessary for its implementation were reaffirmed. Important elements of the workplan included:

- Facilitators from each nation, Waorani and Kichwa, were present at each dialogue and workshop.
- Conversations were facilitated using simultaneous translation into the native languages (Wao Terero and Kichwa).
- All communication materials were translated, contributing to cultural relevance and effective understanding of the information by the communities.
- Commitment to use of direct, clear and agile communication strategies adapted to the communities in each territory helped to familiarise people with the initiative. This included understanding the key actors, the next steps, the importance of community participation and leadership in the reserve's development and execution.



The result of the FPIC process could vary for each of the 80 communities, from affirmative, affirmative with conditions, negative but open to future discussions, or negative. The initial results of the FPIC process were: 76 of the 80 communities responded 'affirmative', 2 'affirmative, with conditions', 1 'negative, but with a desire to continue analysing it' and 1 'negative'. Dialogue continued with the community that expressed 'negative, but a desire to keep analysing'. As of 2024, all 80 communities have given consent to declare the fluvial system as a community-led conservation area, protecting 371,380 ha. This area includes 1,860 km of rivers, 26,000 ha of wetlands and benefits 4,300 people. The communities are also leading development of the governance structure, management plan and community monitoring plan, with TNC's support.

Please see Section 5.5.3 for additional details on the protection designation and co-management approach of the Nushiño-Curaray-Villano Community Fluvial Reserve.

Figure 3.1 The Nushiño-Curaray-Villano Fluvial Reserve and Aguarico Chingual Cofanes Water Protection Area (Case 29 in Ecuador. Data sources: TNC, GloRiC, RAISG, GADM, Natural Earth, Esri. © Chris Bruce/The Nature Conservancy



The winding Nushiño river within the recently recognized community fluvial reserve, Ecuador. © The Nature Conservancy

3.2 Particular characteristics of inland waters to consider relative to human rights, equity and inclusion

As described in Chapter 2, inland waters have characteristics that require special consideration in order to achieve effective conservation. Here, we outline **four important characteristics of inland waters from the perspectives of equity, inclusion and human rights**. These are critical issues to consider in siting, designing and implementing effective, long-lasting area-based conservation.

- **Non-substitutable, essential and finite:** There is no substitute for fresh water – it is necessary for all human, plant and animal life. This is the reasoning behind the recognition of the human right to water. Given its status as a basic human right, many countries do not allow for private ownership of water, but only for the granting of other tenure rights (see next section on rights).
- **Non-excludable and rival:** Multiple users can rely on the 'same' water, but not without affecting or even preventing use by others: for instance, upstream users might alter downstream flow and water quality; and downstream users might block upriver migration routes for fisheries or impede passage critical for boats. Generally, being located upstream provides certain advantages, and power imbalances act to either counter or reinforce these dynamics.
- **Mobility and variability:** Inland waters are fluid, creating high variability in availability across space and time. It can be expensive to make water and aquatic species available when and where people need them, so decision-makers must ensure that development projects account for the interests and needs of marginalised groups, including those within PCAs.
- **Observational challenges:** Inland waters and aquatic species are often difficult to observe and monitor (e.g. peak river flows, groundwater status, migratory fish stocks), which poses challenges to understanding the resources, establishing boundaries, and providing the feedback users require to manage them. Research should be undertaken in collaboration with IP&LCs, who often hold valuable biodiversity knowledge, such as an on-the-ground understanding of the impacts of climate change and flow variability on fishing stocks and behaviour.

Accounting for these characteristics and ensuring a PCA follows an equitable and human rights-based approach requires the explicit consideration of water rights and of connected uses that depend on water availability and ecosystem health, such as subsistence agriculture, fisheries, aquaculture and tourism. **Water rights** are defined as individual or collective claims to use or control water and may derive from statutory law and customary or religious entitlements. Water rights are rarely one-dimensional. In some countries, water resources may be privately owned, or water rights might be tied to rights to land. More often, water resources are accessible through permits. Here, it is important to know who holds different (often overlapping) *bundles of rights*, including use rights and control rights. **Use rights** cover the ability to access and withdraw or otherwise utilise water (e.g. for irrigation, fishing, navigation, recreation). **Control rights** increase the holder's prerogatives to participate in management and rule-making decisions. Other rights, such as FPIC and the right to recourse, are important when considering IP&LC resource rights.[150]

When developing PCAs, it is important to take both the full picture of IP&LC resources rights into consideration as well as power dynamics, because imbalances can prevent certain groups from asserting their rights. Relatedly, it is worth considering not just established water rights under formal legal systems, but also the water and connected rights that communities hold under Indigenous or traditional law, which often extend beyond the water itself to encompass cultural, religious and subsistence dimensions. Decisions and activities linked to PCAs should thus be based on people's full **relationship** to inland waters (including relationships to water itself, to inland water ecosystems and to their resident species), not just to the resource itself. Practitioners could focus on the following:[151]

- Completeness: whether the various rights are held by one water user group or distributed among different stakeholders.
- Robustness: whether the relationships and responsibilities are known by the holders, accepted by other water users and stakeholder groups, and enforceable at reasonable cost in the face of challenges.
- Duration: whether the rights are long-term to allow capturing the benefits of conservation, and whether they change by season or between regular and drought years.

Both the particular characteristics of inland waters and the understanding that rights to water resources are complex, evolving and cross-cutting, and thus require tailored considerations compared to land rights, underscore the importance of understanding and realising them fully when designing and developing PCAs.[152] **It is important to note that conservation entities should uphold equity, inclusion and human rights independent of the legal and regulatory framework in a given country. If a country does not have a favourable legal framework to uphold human rights, it is the moral and ethical duty of conservation entities to adhere to a higher standard.**

A handful of guidance documents has been developed to help analyse water rights and incorporate equity, inclusion and human rights measures into governance for inland waters (Box 3.1). Box 3.2 below presents a summary checklist on incorporating water rights, equity, inclusion and human rights when planning and implementing area-based conservation for inland waters. Field study 6, Gayini wetlands, offers an example of protecting inland water ecosystems through the lens of water rights and IP&LC leadership.

Box 3.1

Inland water-specific guidance on human rights, equity and inclusion

Analysing Freshwater Resource Rights in the Context of Indigenous Peoples and Local Communities: A Guidance Document for Consultants and Practitioners. How to analyse freshwater resource rights, as relevant to IP&LCs, in a given country.[153]

Community-Based Conservation of Freshwater Resources: Learning from a Critical Review of the Literature and Case Studies. A framework for creating enabling conditions for community-led conservation in the inland water context, supporting cultural connections, equity and justice.[154]

Participatory skills: Establishing and strengthening local communities' and Indigenous people's participation in the management of wetlands. An accessible reference on implementation of participatory approaches to establish or strengthen IP&LC participation in wetland management.[155]

Box 3.2

Summary checklist of human rights, equity and inclusion considerations

- ✔ **Develop, review and maintain information on the state of water resources and ecosystems within the territories and areas conserved by IP&LCs, in cooperation with the populations concerned,** including data available through the ICCA Registry.
- ✔ **Evaluate the adequacy of existing national and subnational legislation and policies** for water resources; protected areas; biodiversity; sectoral laws; gender; IP&LCs; recognition of Indigenous and traditional territories; integrating freshwater considerations (e.g. water tenure in relation to agriculture, inland fisheries co-management; access to water and sanitation). This includes identifying relevant treaties to which the country is a party.
- ✔ **Map local customary rules on water and inland fisheries tenure and on freshwater uses, protection and management**; and formally integrate local rules into national decision-making on development projects that might affect individual ICCAs or communities in PCAs.
- ✔ **Identify and recognise rights and permit holders in the areas concerned**, including relevant owners or resource users of lands, waters, fisheries and territories (including non-title holders with traditional rights, as some rights may not yet be recognised under national law).
- ✔ **Define the FPIC process to be implemented**, in relation to both Indigenous peoples and local communities, building on national legislation, traditional laws, and international good practice and guidance.
- ✔ **Incorporate power, equity and inclusion considerations into consultation processes and decision-making,** with a special focus on water tenure and water-dependent livelihoods, and conduct power analysis, on the basis of existing templates and guidance.
- ✔ **Design an environmental and social safeguards process,** screen project plan through a safeguards screening tool to ensure the team is taking into consideration both environmental and human benefits and risks, and mitigating the risks accordingly.

Chapter 4

Expanding and strengthening the protected and conserved area network to support inland water biodiversity and ecosystems



The threatened humpback chub (*Gila cypha*) evolved around 3.5 million years ago and is endemic to the canyons of the Colorado River basin. © David Herasimtschuk / Freshwaters Illustrated

Key messages:

- Inland waters can and should be integrated into large-scale planning processes, to create more efficient and effective solutions for area-based protections.
- Seven principles guide the integration of inland waters into a PCA network: 1) Plan for effective, inclusive and sustained implementation; 2) Define clear conservation objectives and targets; 3) Assemble information to represent habitats, biodiversity and ecosystem services; 4) Evaluate condition and threats; 5) Review existing conservation areas and identify options for expansion; 6) Refine site-specific design, actions and mechanisms; and 7) Develop and implement a monitoring system and adaptive management plan.
- Specific design principles may apply to new PCAs, such as ensuring sufficient size and configurations to account for connectivity and basin influences, including full water bodies where possible, and including riparian and floodplain buffers. Using rivers as PCA boundaries should be strongly avoided.
- Environmental standards – defined ranges or thresholds for environmental parameters – should be defined during a scoping and planning process if possible. These standards would then be incorporated into the legal instrument of the protected area designation.

This chapter provides key considerations and a synthesis of good practices for expanding and strengthening the global PCA network in a way that both supports the unique needs of inland water ecosystems and, building from Chapter 3, respects the critical human dependencies, rights and community knowledge related to inland waters. The focus is on information and resources to support stakeholders in identifying **where** to prioritise PCA investments and **how** to design them, in order to bend the curve for biodiversity as well as to support ecosystem functions and services.

4.1 Guidance for representing inland water biodiversity and ecosystems in conservation area network planning

As shared in Section 1.3, for the first time in the history of the CBD, there is a baseline status of inland water coverage by PCAs and progress towards 2030 global targets will be tracked separately from terrestrial areas. The next several years provide an opportunity to design expanded and strengthened PCA networks in ways that improve inland water biodiversity and ecosystem representation, effectiveness and connectivity and also diversifies governance (Table 4.1).

Given the dependence of inland water ecosystems on landscape context and connectivity, the question of 'where' requires understanding of the coverage and configuration of the existing PCA network and alternatives for expansion. **Successful conservation cannot be achieved on a case-by-case basis but requires planning at the scale of regions, and in the case of inland waters, by basins.** This requires integrating the connected nature of rivers, lakes and other wetlands in conservation planning processes, which have until recently mostly overlooked inland water systems or assumed their conservation needs would be met by terrestrial conservation planning frameworks.[156,157,158] To achieve the global goal of halting and reversing biodiversity and nature loss by 2030, inland waters, and their unique needs, must be incorporated into PCA network planning.

Table 4.1. Summary of KM-GBF policy language as it applies to conservation planning

Key components of policy commitments to guide national and transboundary conservation planning	
Target 1	✔ All areas are under participatory, integrated and biodiversity inclusive spatial planning and/or effective management ✔ Aim to bring the loss of areas of high biodiversity importance, including ecosystems with high ecological integrity, close to zero by 2030
Target 2	✔ Effective restoration of degraded inland waters ✔ Aim to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity
Target 3	✔ Areas of particular importance for biodiversity and ecosystem functions and services ✔ Effectively conserved and managed ✔ Ecologically representative ✔ Well-connected ✔ Equitably governed ✔ Recognising and respecting Indigenous peoples, local communities and their traditional territories and customary uses

4.1.1 The case for integrated planning – terrestrial, inland water, coastal and marine

Research shows that a focus on large, well-connected areas, large-scale ecological processes, and integrated prioritisation and planning will be required to meet biodiversity and ecosystem services objectives.[159] Yet, many regional and national PCA networks have been designated opportunistically, using *ad hoc* decisions rather than being planned at regional or national scales.[160] Planning has often been siloed by agency and ministry remits, which tend to mirror realms (marine, terrestrial, inland water). This has resulted in lack of consideration of large-scale ecosystem processes required to achieve conservation objectives.[161] **Addressing this gap requires building from existing, often isolated and realm-specific area designations, to develop integrated PCA networks that preserve physical and process-based connections between and among terrestrial, inland water, coastal and marine environments – now and through a changing climate.**

Planning across ecosystems and realms has been shown to increase benefits. Furthermore, this increase in benefits can be achieved at little or no additional opportunity cost. In an Amazon Basin research study, planning based on terrestrial conservation targets yielded less than 25 per cent of the benefits achieved from planning based on freshwater conservation targets. When using integrated planning across both terrestrial and freshwater realms, the inland water benefits increased by up to 600 per cent with a negligible (< 1 per cent) loss of terrestrial benefit as compared to if planning had been based on terrestrial biodiversity targets alone. [162] Importantly, this study also demonstrated that where inland water biodiversity data were unavailable but aquatic connectivity was incorporated into planning as a proxy, inland water benefits could still be doubled for a negligible loss in terrestrial coverage, as compared to terrestrially-focused planning. Additional research has shown that integrated planning across realms can not only improve the adequacy of conservation for species that rely on multiple realms, but that these benefits can be achieved at no significant additional area selection.[163]

As described in Chapter 1, integration here should also include coordinating to find efficiencies across existing and planned investments for related global treaties and commitments (e.g. Ramsar, Sustainable Development Goals (SDGs), UN Framework Convention on Climate Change (UNFCC), Convention on Migratory Species (CMS), UN Convention to Combat Desertification (UNCCD) Land Degradation Neutrality target, among others), to deliver, where possible on two or more commitments through a single investment. For example, the conservation of peatland areas can support delivery of commitments towards both the KM-GBF Target 3 and UNFCC natural climate solutions.



Brooks River, Katmai National Park, USA. © Jennifer Webber/ TNC Photo Contest 2022

4.1.2 Expanding PCA networks to be resilient and representative of inland water biodiversity, ecosystems and services

From the Open Standards for the Practice of Conservation[164] to systematic conservation planning, many valuable and flexible tools exist to support governments in scoping, planning and expanding the PCA network. This section summarises seven common principles and highlights inland water-specific tools and resources for each step.

The development and management of PCAs have predominantly followed an opportunistic approach centred around terrestrial habitats, processes and fauna.[165] When PCAs encompass inland waters they can provide some degree of conservation to those ecosystems and species through the abatement of threats and the creation of localised habitat refugia.[166] However, this is often insufficient for conserving the full spectrum of KEAs necessary to achieve ecological integrity.[167,168] Management objectives of PCAs frequently lack explicit inland water targets or indicators (see Chapter 6 for more on management). Furthermore, terrestrially-focused protected areas may allow activities harmful to inland water biodiversity that would not be tolerated for terrestrial biodiversity, for example, opening sensitive sites to unregulated fishing, untreated sewage disposal or fragmentation by dams, or allowing industrial-scale water withdrawals.[169]

As introduced in Chapter 2, the lack of explicit consideration of inland waters in PCAs is, in part, due to the unique characteristics of these systems, making their direct translation into conventional PA network design challenging.[170] One such aspect is the multi-directional connectivity of inland water ecosystems across space and time,[171] which is crucial for sustaining processes such as the movement of water, sediment, biota, and natural fluxes of energy and large and fine particulate organic matter.[172] Moreover, inland water systems are strongly influenced by activities within their basins, including operating as socio-ecological systems.[173] The connected nature implies the propagation of threats and disturbances along these connections, particularly for rivers. Effective planning for inland water conservation necessitates the incorporation of these unique considerations.[174]

Seven foundational principles for integrating inland waters in PCA network expansion and management

Below we focus on principles to integrate inland waters into PCA network design and expansion, drawing on multiple sources.[175,176,177,178] These principles are intended to guide the effective inclusion of inland water ecosystems within conservation planning efforts. However, their implementation may vary in complexity and scale of precision across use case scenarios and will often be driven by the decision context and complexity and resource availability. The principles are supported by Table 4.2 which outlines key components, examples and technical resources, and Field Study 2, which steps through an example in Nepal.

1: Plan for effective, inclusive and sustained implementation

- ✔ **Rapid assessment of the social, economic and policy landscape** – when considering how best to achieve inland water conservation objectives through area-based protections and, where necessary, additional complementary interventions, first understand the institutional, legal and policy landscape for inland water conservation and available protection mechanisms. This should critically include and inform national commitments and activities under the UN CBD, like National Biodiversity Strategies and Action Plans (NBSAPs) and National Biodiversity Finance Plans, as well as implementing plans for the Convention on Wetlands. Chapter 1 details a list of global conventions and Sustainable Development Goals that may be considered when assessing the legal and policy landscape. Due to water being considered as both a resource for human use and an ecosystem, regulations and protection mechanisms are often seeded across laws governing water use, allocation, customary water rights, wetland management, fisheries management, and species-specific protections, whereas protected area laws or regulations may overlook inland waters.
- ✔ **Identify and engage stakeholders, partners and relevant agencies** – this step also requires identification of key interests, stakeholders and partners for engagement, ideally through an engagement plan or committee. For example, stakeholders might include key actors that are endowed with legal or customary rights with respect to lands, waters and other natural resources, fishing communities, hoteliers, ecotourism operators, downstream water users including municipalities, or farmers using irrigation water.
- ✔ **Using a participatory process, draft a common long-term vision** – Often overlooked, the most pivotal step in any planning effort is to develop an understanding of common purpose related to the resources being discussed and decided upon.

This first step results in what is sometimes called a situation analysis and vision statement.

2: Define clear conservation objectives and targets

- ✔ **Identify objectives** – Objectives provide a framework to focus conservation efforts (e.g. effectively conserve critical habitat types), while targets refer to specific actions with quantifiable milestones, which contribute to the broader objectives (e.g. protect a specific length of free-flowing river). Together, these help to identify priority sites and actions and provide a roadmap to monitor and evaluate the conservation plan. Their selection is guided by the enabling conditions (e.g. baseline context summarised in step 1), stakeholder-informed values, and other national priorities to help align inland water outcomes with other ecological and societal needs.
- ✔ **Quantify conservation targets** – Targets should be quantitative and are typically defined for species (particularly keystone, indicator, imperilled, endemic and range-restricted species), human communities (e.g. flood-risk reduction, inland fisheries security), ecosystems (particularly threatened or under-represented inland water ecosystems, such as peatlands or floodplains), and/or ecosystem functions or services (such as water-provisioning services).

The identification of objectives and targets requires an understanding of the broader social-ecological system and can be identified at a range of suitable scales and levels of biological organisation.[179] In the context of the KM-GBF, the Convention on Wetlands (2024) recently published technical guidance for including inland waters, objectives and targets in NBSAPS.[180]

3: Assemble information to represent inland water habitats, biodiversity and ecosystem services

✔ **Delineate inland water ecosystems with meaningful planning units using basin boundaries.** Spatial data identifying and delineating inland water ecosystems (river networks and sub-basins, wetlands, peatlands, cave and karst ecosystems, lakes, bogs, etc.) with their applicable spatial, bio-physical and socio-economic attributes are essential for developing a spatial conservation plan.[181,182] Data can come from expert and community workshops, traditional ecological knowledge, citizen science, data inventories, rapid assessments, spatial models and/or remote sensing.

At a minimum, information on the coverage and ecological representation of inland waters within the existing PCA network should be included. Spatial data should also be organised in a framework that represents the river and its hydrological network.

✔ **Compile best available information to represent inland water biodiversity** – Equally important are spatially explicit data on the status and distribution of inland water biota. This can range from observational information to systematic species inventories or distribution models. Several key global data sources and databases exist, including the IUCN Red List of Threatened Species, IUCN Red List of Ecosystems, and World Database of Key Biodiversity Areas, each with inland water datasets. IUCN has a global freshwater fish assessment plus species distributions for crabs, crayfishes and shrimps, molluscs, dragonflies and damselflies, and aquatic plants, plus assessments for specific regions or basins. There are almost 4,000 freshwater KBAs in the World Database of KBAs, although some may be recognised due to the presence of non-freshwater species, and the database is not globally comprehensive. IUCN's Global Invasive Species Database has information on the distribution, ecology and effects of invasive species globally. Species information is constrained by survey data and sampling bias, so ecosystems and species data play complementary roles.

✔ **Compile best available information to represent ecosystem services** – Information on inland water-related services, such as flood-risk reduction, nutrient abatement, drinking water regulation and food provision are often best informed at the local level and through government consultation, although some tools exist to generally model ecosystem services.[183,184] This information should be developed in conjunction with Indigenous or traditional knowledge and expert-based assessments.

4: Evaluate present condition, existing threats and future threats

✔ **An evaluation of current conditions** and anticipated future threats to inland water ecosystems is needed, including the vulnerability of current management efforts to climate change.[185] The ecological integrity or condition of inland waters is best represented by the five KEAs (see Section 2.2.1).

✔ **An exploration of future threats or stressors**, particularly to individual KEAs, involves forecasting the challenges anticipated from growing human populations, urbanisation, energy use, infrastructure developments, land and water use change, climate change, and other stressors (Chapter 2). This requires consideration of the propagation of threats along connectivity pathways, especially river networks.[186,187] Evaluating these can inform the development of proactive measures to improve resilience and mitigate against future threats. This could include, for example, preferentially selecting sites on the basis of their likely resilience to climate change, such as north–south aligned rivers and highly connected inland water networks.[188, 189]

5: Review existing conservation areas and identify options for expansion of conservation area network (terrestrial, inland water and/or marine).

This phase involves the design of an integrated PCA area network spanning inland water, terrestrial, and where relevant, coastal and marine ecosystems.

- ✔ **Evaluate existing protection status and gaps** – The process begins by assessing the current baseline of area-based protections, including their effectiveness. Typically conducted through a representation gap analysis,[190] the PCA network is assessed for representation of biological values and habitat types, as a proportion of their national or regional distribution.
- ✔ **Identify scenarios that address gaps and meet targets** – The efficacy of the existing PCA network in conserving the inland water values captured within it should also be assessed, based on configuration, location, connectivity, size, condition and external threats – attributes that cannot be addressed solely through management improvements. The guiding principles of systematic planning, also known as the **CARE** principles, can be used to inform decision-making including: **C**onnectivity (within and among inland water ecosystems as well as within and across realms), **A**dequacy (of habitat type and species), **R**epresentation (encompassing the diversity of habitat types and species) and **E**ffectiveness (to minimise costs and adverse impacts on stakeholders).[191]
- ✔ **Review and adapt scenarios based on stakeholder feedback and national priorities** – Similarly, several approaches can be used to inform PCAs including participatory expert and community workshops that are informed by some combination of scoring and ranking, multi-criteria decision analysis, optimisation analysis, or planning tools such as Marxan or Zonation.[192,193] The output – an integrated, well-connected and ecologically representative PCA network – should be developed with wide stakeholder participation to incorporate diverse perspectives such as local knowledge and preferences, key socio-economic factors and national priorities. PCA design is a balance between what is ideal from a conservation perspective and what is acceptable for local stakeholders.

  The results of the analysis can help to refine quantitative targets and identify alternatives for new or expanded PCAs, ecological corridors, and buffer areas to fill representation gaps and address deficiencies. They should result in an integrated network across terrestrial, inland water and marine realms, where the combined impact surpasses that of individual areas.

6: Refine site-specific design, conservation actions and mechanisms.

- ✔ **Confirm site design is appropriate to achieve inland water objectives** – Assessing the adequacy of the identified priority conservation sites is an important next step, including considerations such as size, boundaries (avoiding using rivers as boundaries wherever possible), cohesiveness, and position in the landscape (Chapters 2 and 3).
- ✔ **Maintain active participatory process** – This step in the process should continue to be informed by extensive stakeholder engagement to ensure the incorporation of diverse perspectives and local knowledge, which in turn helps the successful adoption and implementation of the conservation plan and can help to identify opportunities for community-led or co-management.
- ✔ **Confirm protection mechanisms are appropriate to abate threats** – Furthermore, protection mechanisms (see Chapter 5) and management strategies (Chapter 6) should be identified for each site to mitigate threats and achieve conservation objectives. These strategies serve as the actionable components of the conservation plan, encompassing a spectrum of initiatives such as habitat restoration, species or habitat protection, and/or the implementation of sustainable use practices.

7: Develop and implement a monitoring system and an adaptive management plan.

This phase is designed to continually assess and adapt to new information, evolving conditions, and the effectiveness of implemented conservation strategies. Mechanisms for monitoring and adaptive management are crucial components, ensuring that the conservation efforts remain effective over time. This step requires engagement with local communities, scientists, project managers and relevant stakeholders to incorporate their insights and realise anticipated outcomes. Further details regarding the development of a monitoring and adaptive management plan are elaborated in Chapter 6.

Table 4.2. Seven foundational principles and key components to integrate inland waters into regional and national spatial planning

✔	Principles and Key Components	Supporting Data and Resources
1.	**Plan for effective, inclusive and sustained implementation**	
	Conduct an assessment of the social and institutional/ policy landscape for inland water conservation and management at the national scale or region of analysis to identify protection mechanisms and gaps.	• Open Standards for the Practice of Conservation V 4.0[194] • Conservation Coaches Network Situation Analysis Training[195] • Example assessment of policy landscape for river conservation in Europe[196] • For engagement and consultation plans, please see resources in Chapters 3 and 6
	Identify stakeholders, partners and relevant agencies and co-develop an engagement and consultation plan for the full process.	
	Draft a long-term vision for inland waters based on a participatory process.	
2.	**Define objectives and targets**	
	Identify a set of objectives explicit for inland waters, and consistent with national commitments and policies.	• Recipes for Conservation: A Conservation Standards Toolkit[197] • Convention on Wetlands NBSAP Guidance, Appendix 1, Guidance on target setting for inland waters in the KM-GBF[198]
	Quantify conservation targets for inland water ecosystems, species, communities, and/or ecosystem processes aligned with KM-GBF targets.	
3.	**Assemble a data system to represent inland water habitats, biodiversity and ecosystem services, focusing on basins as an organising unit**	
	Delineate inland water ecosystems with meaningful planning units, at a minimum using nested basin boundaries.	• HydroATLAS [data][199] • Global Lakes and Wetlands Database (GLWD) V2 [data] [200] • Global River Classification (GloRIC)[data] [201] • Global Freshwater Ecoregions of the World[202] • IUCN Global Ecosystem Typology[203]
	Compile spatial data for inland water biodiversity and ecosystems.	• IUCN Red List of Threatened Species [data][204]; IUCN Red List of Ecosystems [data][205] • World Database of Key Biodiversity Areas [data][206] • Wetlands of International Importance [data][207] • Important Bird Biodiversity Areas [data][208] • Global Biodiversity Information Facility [data][209] • Regional examples: Amazon River Basin fish biodiversity database[210], Europe Freshwater Information Platform[211] and Natura 2000[212]
	Compile spatial data and information for inland water ecosystem services.	• ValuES Methods Navigator and Database[213] • Regional example: European Catalogue of Mapping and Assessment of Ecosystem Services [data] [214]

✔	Principles and Key Components	Supporting Data and Resources
4. Evaluate present condition and future threats		
	Assess existing condition and threats using best available data.	• Threats and Actions Classification[215] • Connectivity Status Index [data][216] and training materials[217] • Current and future dams [data][218] • Contaminant fate model for global river systems [model] [219] • Attributes for upstream basin land use, protection status and other impacts[220] • Threats of global warming to the world's freshwater fishes [data][221] Example applications for: • Large-scale condition assessment in freshwater conservation planning[222] • Integrating climate change scenarios in freshwater conservation planning[223] • Mapping current and projected threats to rivers[224] • Integrating human impacts and ecological integrity for conservation planning[225]
	Evaluate anticipated future threats using best available information.	
5. Design an integrated national conservation area network (terrestrial, inland water and marine)		
	Evaluate existing protections status and assess protection and information gaps.	• World Databases on Protected Areas (WDPA) and OECMs (WD-OECM) [data][226] • IUCN Green List of Protected and Conserved Areas [data][227] Example applications for: • Data-scarce region, using an iterative, manual process to select portfolio areas[228] • Integration of freshwater and terrestrial priorities in conservation planning[229] • Using an optimisation software[230] • Conservation planning prioritisation with public participation[231] • Co-developed area-based conservation scenarios with FPIC (see Field Study 1)
	Identify scenarios of spatially efficient conservation portfolios that meet targets.	
	Review and adapt the scenarios based on stakeholder feedback and national priorities.	
6. Refine site-specific design, conservation actions and mechanisms		
	Confirm site design is appropriate to achieve inland water conservation objectives and targets.	Please see Chapter 2 and Section 4.2.1 Metric for spatially explicit contributions to science-based species targets[232]
	For each area, confirm policy mechanisms are appropriate to abate threats and achieve the conservation objective, and adapt as necessary.	Please see Section 4.2, Chapter 5, and Appendix 1 Case Study Compendium, for examples of policy mechanisms for different basin contexts, Key Ecological Attributes, and threats
7. Develop and implement adaptive management plan		
	Regional or site-specific PCA management plan including conservation objectives, priority activities, monitoring and evaluation.	Please see resources in Chapter 6



Data can come in different forms, shapes and sizes. In June 2022, a 300 kg giant freshwater stingray accidentally caught by a fisherman in the Mekong River in Koh Preah village, Cambodia was confirmed as the world's largest freshwater fish by Guinness World Records. The record-breaking ray, which is an endangered species was named Boramy ("full moon" in the Khmer language), by the Wonders of the Mekong team before releasing her back to the Mekong River. Boramy the super-sized stingray has reignited national pride in the region's exraordinary wildlife and the vital need for conservation.
© Chhut Chheana / Wonders of the Mekong.

Field study 2
National spatial planning to identify High Conservation Value rivers (HCVR), Nepal

This study highlights application of several of the key principles above in a national assessment.

Nepal is a country with remarkable rivers that support rich aquatic and terrestrial biodiversity. It features thousands of lakes, including ten internationally recognised important wetlands under the Convention on Wetlands. The inland water ecosystems provide ecosystem services such as groundwater recharge, flood abatement and livelihood opportunities. There is a framework pending approval by the Parliament, known as the River Basin Strategy, that would require the maintenance of at least one high conservation value river (HCVR) as free flowing in each of the major basins in Nepal. The Ministry of Forest and Environment, a federal agency, is responsible for managing the strategy.

Effective implementation. To support this effort, a study led by WWF-Nepal identified HCVRs[233] to inform the priorities under the River Basin Strategy. An HCVR was defined through two in-person workshops which involved participation from the Government of Nepal, NGOs and academia. Through these workshops, an HCVR was defined as *"a clean, highly connected or free-flowing river or stretch that acts as a lifeline, maintaining ecosystem services for present and future generations, providing refuge and habitat for high levels of aquatic biodiversity, and supporting important socio-economic and cultural values."*

Evaluate condition and threats. There is an increasing risk of losing the benefits from Nepal's vast rivers, particularly due to the planned and ongoing dam and hydropower development. Freshwater status or condition was represented by two categories:

- River connectivity: Six proxy indicators were used – river fragmentation, river regulation, water use, sediment trapping, road construction and urban development.
- Water quality: Two proxy indicators were used – land use and population density.

Inland water values or objectives were selected by the stakeholder group and split into four broad categories:

- Biodiversity: Seven values were included to represent aquatic biodiversity, split into two categories (fish and flagship species). For fish, fish richness, threat, endemism, and migratory status were included. For flagship species, dolphin, gharial, and mahseer were included. Floodplain biodiversity was represented by five values including tiger, rhino, wetland birds, otters, and critical corridors.
- Recreational values: Four values were included – angling, rafting, trekking, and protected areas.
- Livelihood values: Two values were included – commercial and food value of fisheries and water provision (drinking water and indigenous irrigation).
- Social and cultural values: Religious and symbolic sites were included.



Two workshops were held, including participation from the Government of Nepal, academia, NGOs and other civil society members, to guide the development of inland water objectives, prioritization and action mapping. © Michele Thieme/WWF

The **data to represent these values** were collected from various sources including published data sources (local and global), IUCN Nepal, official government data, national studies and surveys, non-profit organisations and books. After values were selected through stakeholder consultation, literature review and data collection, they were mapped to the river network used for the freshwater status assessment. Next, the values were standardised and weighted, and finally combined to categorise into HCVR categories.

Refine site specific design and conservation actions. The HCVR ranking scheme allowed for targeted management decisions on a national scale, especially when considering competing interests and limited resources. All HCVRs have at least one conservation value within them. HCV type 1 rivers are those that also have both high water quality and high levels of river connectivity and it is recommended that their status be maintained. HCV type 2 rivers have high water quality but have lost connectivity or are fragmented. Recommended management activities would increase connectivity, for example by removing dysfunctional or unused barriers, by implementing environmental flows, or by improving passage through bypass reaches or fish ladders. HCV type 3 rivers maintain high levels of river connectivity but have degraded water quality. Management recommendations focus on improving water quality through agricultural best management practices, riparian buffers, wastewater management and other measures. HCV type 4 rivers have compromised river connectivity and water quality such that management interventions need to address both aspects of river health.

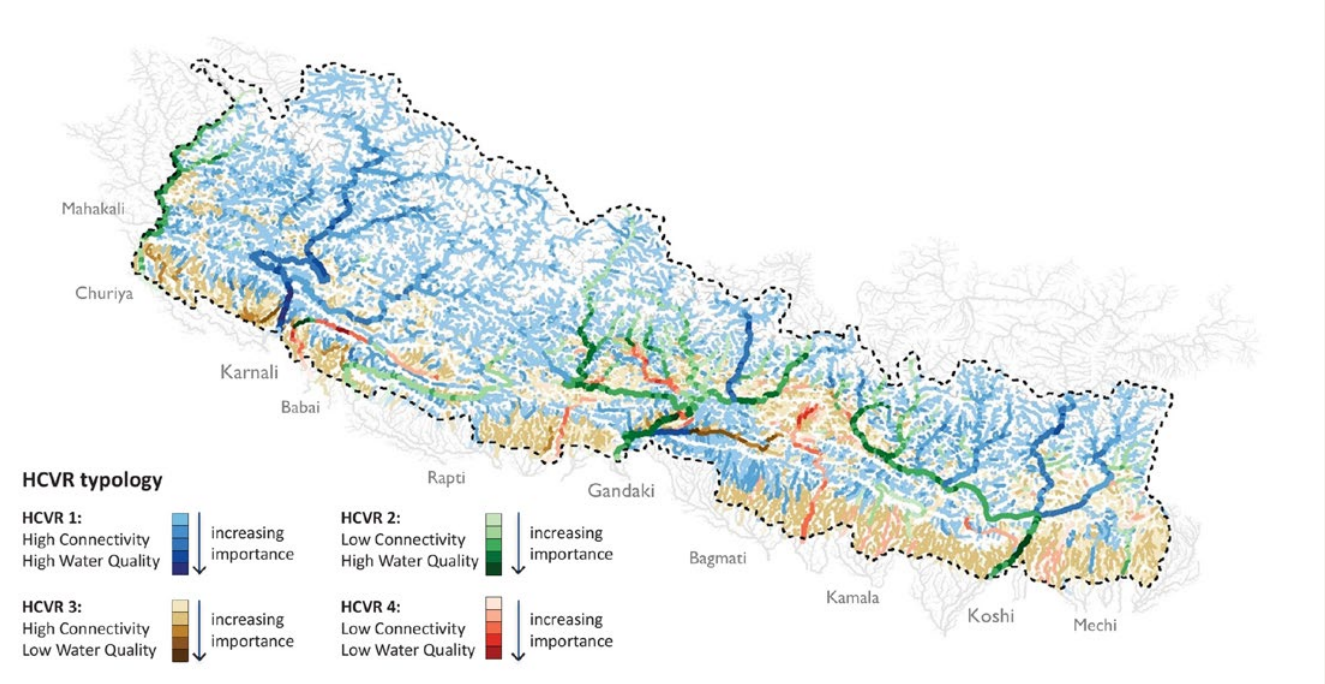


Figure 4.2 High Conservation Value Assessment results for the rivers of Nepal. Out of the rivers assessed, 62 per cent were classified as having high river connectivity and high water quality (i.e. HCVR type 1). The Karnali River Basin stood out as the basin with the highest number of HCVR type 1, followed by the Gandaki, Koshi and Mahakali, and the West Rapti river basins. Therefore, these river systems were recommended to be protected. Other categories of river (i.e. HCVR types 2, 3 and 4) were recommended for other types of management or restoration. The higher the number of values in any particular river stretch, the greater the saturation of the colour in the map such that darker river stretches include higher numbers of biodiversity, recreational, livelihood and social and cultural values.



A stream cascades below AmaDablam, one of the most prominent peaks in Nepal. © Matt Meisenheimer/TNC Photo Contest 2019

4.2 Delineating geographic and ecological boundaries to inform site-specific design and designation

The previous section highlighted considerations for identifying where in the landscape PCAs could be sited or modified to improve the representation, connectivity and effectiveness of the PCA network. Equally important to the PCA location, in this section we introduce some considerations for their site-specific design, including **geographic boundaries** as applied to inland waters. Geographic boundaries are the standard for a protected or conserved area in terms of defining the two-dimensional 'area' that will be conserved and managed. However, inland waters also need clearly defined ecological boundaries to recognise that their ecosystem integrity relies on several attributes in addition to the conventional protection of land. Therefore, this section also reviews the concept and use of **environmental standards** to define conditions within a PCA that can be enforced and managed for, with a focus on environmental flows, connectivity and water quality standards.

4.2.1 Geographic boundaries

Aligned with the IUCN definitions, it is necessary to develop and maintain clear geographically defined boundaries for each PCA. Defining geographic boundaries to support inland water ecosystems requires consideration of their basin context, unique characteristics (Chapter 2) and governance context including rights and traditional uses by IP&LCs (Chapter 3). Building from the foundation of these characteristics, the following guidance can support the development of geographic PCA boundaries for rivers, lakes and other wetlands. It is noted that this guidance is shared holistically for supporting the integrity of focal inland water areas, and that in practice, boundaries will be informed by the conservation objectives for the area and local circumstances.

✔ **Sufficient size and configuration** – A protected and conserved area should be of sufficient size and configuration to include key elements of the inland water ecosystem of focus.[234, 235, 236]

- This should include consideration of basin context, including being well-connected, through terrestrial and aquatic corridors, to other PCAs as illustrated in Figure 2.1. In considering basin context, inland water focal areas, as described in Chapter 1 can be combined with tailored management and threat mitigation in linked critical management zones and catchment (basin) management zones across the broader basin, to achieve conservation effectiveness.
- Inland water focal areas could also be designated/recognised within larger PCAs (e.g. designated wild rivers within nature reserves), such that a tailored legal and management regime is applied to the inland water focal area, as appropriate.
- Finally, rivers can serve as effective connectors between PCAs (e.g. conserved riverine corridors) and designating rivers as ecological corridors should be considered in PCA network alternatives.[237]

✔ **Include the banks, bed and surface/ground water body in the defined area** – the geographic area should include banks and shorelines, bed (and substrate) and water body, including connected aquifers.

- For rivers, this should include the full width of the river, rather than only one bank or the river centre-line.
- For lakes and other wetlands, the full extent of the water body and shores should be included.
- Recognising this may not always be possible, if only a portion of a water body is included, prioritise ecologically meaningful units. An example would be protecting fish breeding areas along the shores of a large lake.

✔ **Include riparian and floodplain buffers.** River, lake and wetland edges should ideally *not* be used to define PCA boundaries, because this omits important and connected habitats such as riparian wetlands and neglects the ecological value of longitudinal, lateral and vertical connectivity. For example, floodplain areas provide critical groundwater recharge zones that temporarily store floodwaters and sustain river flows during dry seasons and periods. Instead consider the following:

Box 4.1

Moving away from using rivers as PCA geographic boundaries.

Using rivers as boundaries means in practice that often only one bank is included in protection, thus exposing the river to the risk of interference, fragmentation and pollution, and omitting protection of important connected habitats such as migratory corridors and riparian wetlands and floodplains. Nonetheless, the practice of using rivers as PCA boundaries is widespread. For example, a study demonstrated that in Brazil, rivers form nearly half of all protected area boundaries, totalling nearly 80,000 km.[238] The study illustrates one example of Iguaçu National Park in southern Brazil. The red rectangle on the right highlights the Goncalves Dias River, which is the eastern park boundary. This corresponds to the photo in the lower right side of the frame. This illustrates that rivers that serve as protected area boundaries can have very different land uses on the side of the river that is not protected.



- In addition to the water body itself, boundaries should consider incorporating riparian zones. Within these zones, only uses consistent with maintaining habitat quality should be permitted.
- Buffers can be defined using several methods, including a fixed width approach (e.g. X m from the bank); using widths appropriate for the landscape position, gradient and type of inland water feature; or using more advanced and site-specific tools like the Active River Area tool[239] that customises the buffer based on local topography and inundation potential. The latter approach was used in Mongolia (Case Study 30) to develop a national-scale delineation of the geographic boundaries of riparian zones in order to facilitate implementation of a law to designate priority runoff areas as legally protected from mining and industrial activities.[240]
- Ideally a protected or conserved area designed to deliver inland water objectives would include an entire floodplain, but understanding that may not be feasible, including the floodplain area in a sustainable use management zone may be another alternative.
- For existing PCAs that are delimited by the edges of a water body, the water body and its riparian area/floodplain should be integrated into the overall management plan for the PCA. This can often be integrated into the protected and conserved area's buffer zone management regime.

4.2.2 Defining site-specific environmental standards

In addition to having a'clear definition of the geographical space, inland water ecosystems within protected area boundaries also need clear ecological boundaries to define the conditions necessary to maintain their ecological integrity. Therefore, this section outlines examples for defining **environmental standards, with a focus on environmental flows, water quality and connectivity.**

Environmental standards are not only critical for guiding and adapting allowable uses and management activities within the PCA, but equally for informing policies and activities outside of the PCA (in adjacent areas and within the larger basin) with the potential to impact the resources and values meriting protection (Okefenokee National Wildlife Refuge, Case Study 24 and Vjosa Wild River National Park, Case Study 2).

Ideally, the **development of environmental standards should occur during the PCA scoping and planning process in order to be incorporated into the legal instrument of the PCA designation and to benefit from the feedback and input of a participatory planning process** (see Chapter 5).



Sarus Crane (*Antigone antigone*) family feeding in North Queensland, Australia. © Brian Callaghan/TNC Photo Contest 2021

Understanding that the timeline may not allow definition of site-specific environmental standards for the area before designation and establishment, Table 4.3 outlines a step-wise approach, starting with articulating a narrative standard, which can be relatively low cost and accomplished in a short amount of time (months) with targeted consultations, all the way to site-specific standards which can be costly and require years to complete. These approaches can be applied in sequence to build from one another as appropriate for the local timeline, resources and context. A narrative or presumptive standard could readily be incorporated into the PCA delimitation, design, preliminary zoning and designation, and a prescriptive, site-specific standard could be developed to inform long-term management.

Example application: Okefenokee National Wildlife Refuge (Case Study 24) is a federally protected and globally significant wetland located in Georgia, USA. A recent application for a mining permit and related water withdrawal permit near the border of the refuge prompted the US Fish and Wildlife Service (the refuge manager) to clarify the dependence of the wetland on surface and groundwater flows, assert the federal reserved water rights to maintain ecological flow needs, and serve a notice to the mining company for the potential violation of those thresholds based on the ground and surface water use plan in the proposed mining lease.

Box 4.2

Environmental standards for protected areas

Defined ranges or thresholds for environmental parameters to guide regulations (including designation), policies and management regarding activities within the PCA as well as decisions outside of the PCA with the potential to affect the ecological condition within the PCA.

Here we focus on standards for environmental parameters specific to inland waters (water quality, environmental flows, connectivity), but the concept also applies more generally (e.g. light pollution and air quality).

- **Narrative standards** – statements that clearly describe the desired goal for the environmental parameter.
- **Presumptive standards** – define quantitative limits, ranges or thresholds developed to be universally applicable in the absence of site-specific information.

Table 4.3. Example approaches to include environmental standards in PCA design and designation. The approaches range in levels of effort and time required, increasing from left to right. Please see Table 6.2 for a list of management interventions that can be used to support achievement of standards.

	Example narrative policy standards	Example presumptive policy standards	Resources for site-specific policy standards and management tools
Environmental flows	Ex. 1. **Specific to inland water ecosystems:** Waterbodies and their riparian areas and floodplains within the PCA shall be protected and maintained, including through legislation and management plans providing for environmental flows/water reserves, aquatic connectivity, and water quality to support aquatic life and ecosystem services. Ex. 2. **General, but inclusive of inland water ecosystems:** An area having permanent protection from habitat conversion and managed to maintain a state within which natural ecological processes are allowed to proceed with minimal interference and sustain functional ecosystems, while safeguarding traditional and Indigenous practices and rights (e.g. VT Act 59)	• Limit of 10% maximum change (withdrawal or discharge) from baseline daily flows to maintain ecosystem structure and function.[241] • Water reserve for 90% of natural flows	• A scenario-based holistic approach to environmental flows assessments for rivers.[242] • A practical guide to environmental flows for policy and planning.[243] • A three-level framework for assessing and implementing environmental flows[244]
Connectivity		• PCAs shall be maintained free from aquatic barriers • For rivers, maintain vertical, longitudinal and lateral connectivity measured by a Connectivity Status Index (CSI) of >=95% (*note this may also require restoration and working with stakeholders upstream or downstream of the PCA*).[245]	• Datasets to understand baseline connectivity within a current or potential PCA.[246] • Training materials and example of applying CSI.[247] • Fish passage performance standards can be developed for barriers/ dams and incorporate site-specific hydraulics (water velocity, depth) and species-specific swimming abilities. The standard is often expressed as percentage efficiency (successful passage #/total population #) and managed through best technologies and environmental flow releases.[248,249]
Water quality		Water quality baselines are dependent on local condition, however, standards should consider a seasonal timestep and maximum and minimum thresholds for constituents including dissolved oxygen, temperature, turbidity, salinity, nutrients and pH.	• Consult with national water use and quality authority and use national standards as available for example: • Aquatic Life Criteria Standards; • Australia and New Zealand Guidelines for Marine and Freshwater Quality

Chapter 5

Designation and governance mechanisms



Vjosa Wild River National Park was declared by the Government of Albania in 2023 and is the first wild river National Park in Europe (Case Study 2). © Ulrika Åberg

Key messages:

- Long-term and effective inland water conservation will depend on a multi-layered approach with complementary legal and non-legal mechanisms, at nested scales, to support the integrity of the ecosystem and meet conservation objectives.
- Examples exist of protected areas across all six IUCN management categories that are contributing to inland water conservation outcomes.
- The opportunity afforded by OECMs to bring in a wider set of mechanisms for protection is critically important for conservation of inland water systems, given both the nature of communities dependent upon inland water systems and the particular challenges these ecosystems face. Seven general questions can help guide the application of the OECM framework and site-level tool for inland waters.
- Emerging protection mechanisms are being used to meet the specific conservation needs of inland water areas. These mechanisms include: rights of nature, sacred and cultural areas, riverine-focused protections, groundwater-supported system protections, geographically defined environmental flow protections, nature-based solutions for water and climate, community fish reserves, and transboundary inland water conservation mechanisms.
- National protected and conserved area laws, recognitions, governance and management will determine whether a given designation is considered a protected area, OECM, or neither for inland water ecosystems in any given country.
- Area-based inland water conservation can be achieved through any governance type: governance by government, shared governance, private governance, and governance by Indigenous peoples and local communities.

In the following sections, we describe a number of area-based designation and governance approaches that can support the conservation of biodiversity and ecosystem services in inland waters. While attention to PCAs has often focused on designation and management of either terrestrial or marine protected areas, there are many sites that protect inland water ecosystems and dependent biodiversity. We include guidance on where these are likely to fall along the spectrum of protected and conserved areas as defined by IUCN and CBD. Ultimately, the label applied to them is less important than how effective they are in achieving conservation.

Area-based conservation is defined by three criteria: how sites are *designated*, *managed* and *governed*. Designation ranges from informal approaches, such as local community decisions, to national and international mechanisms; several can apply to any site. Here we look particularly at *protected areas* and *other effective area-based conservation measures* (OECMs), referred to together as protected and conserved areas, or PCAs. Management approaches across PCAs vary, depending on circumstances. Just as important are the variety of ways in which areas are governed. This is perhaps where attitudes are changing fastest, with top-down, state-controlled areas gradually being replaced by a wider variety of areas governed by Indigenous peoples, local communities, private individuals or various trusts and companies, or through shared governance.

5.1 Area-based conservation in inland waters

Conservation draws on a range of different approaches, for instance:

Laws and policies that seek to impose changes at a national or regional level, such as blanket protection of particular rare species such as the sturgeon, closed fishing seasons to protect breeding fish or waterbirds, or application of the Water Directive in the European Union.

Area-based conservation measures that are applied within agreed geographic boundaries, such as freshwater nature reserves, EU nitrate exclusion zones, etc. Some but not all of these may be recognised as protected areas or other effective area-based conservation measures.

Management actions, including restoration, applied site-by-site, often on a voluntary basis. Voluntary fishing agreements on a single river, coastal mangrove restoration and dam removal are all part of these management approaches.

The current report is aimed primarily at explaining many aspects of the second approach.

Area-based conservation approaches have some obvious strengths, namely the ability, at least in theory, to control what happens within a discrete parcel of land or water and to aim management primarily towards the conservation of biodiversity and other ecosystem services. Such areas are not ever completely isolated from the rest of the world and are affected by what happens beyond their boundaries. This is particularly true in many inland waters in relation to terrestrial and airborne pollution, dams and weirs, runoff of fine sediments, solid waste/plastic, deforestation, land use change, water abstraction (e.g. from upstream aquifers), culverts, channelisation, embankments, etc.[250] And it is doubly so when an area-based approach is part of a wider ecosystem, such as a portion of a lake or estuary, or a section of a river where actions in the rest of the basin – particularly upstream, including subterranean aquifers connected to downstream rivers and lakes – can be a dominant factor in success or failure.

As introduced in Chapters 1 to 4, no area-based approaches can or should exist in isolation, so planning for inland water conservation needs to take a broad perspective, drawing on landscape and aquascape approaches. This means working with multiple stakeholders, trading off different needs and wants, operating with at least a measure of consensus, and layering conservation and management interventions. The whole system sits in the context of a policy and legal environment that largely defines what is possible. Area-based approaches have moved a long way from early, often local, nature reserves where an individual pond or small lake was set aside for nature without much consideration of what was happening beyond the area's border.

To illustrate the diversity of mechanisms and approaches that are being employed around the world, we provide more than forty cases throughout the report and in Appendix 1. The case studies are representative of different:

- Geographies: Including dozens of countries across six continents.
- Designation and management focus: Even if inland waters occur in protected areas they have often not been well considered in design or planning and not prioritised in management. A survey of PA managers in a well-resourced area, the Tennessee-Cumberland Basin in the USA, found that most PAs have fewer resources dedicated to freshwater conservation and management than to other activities, and some completely lacked resources for freshwater management.[251] Opportunities for management and restoration depend partly on whether the whole or most of the focal habitat is within the PCA.
- Scales: Range from transboundary protections like the 5-country Mura-Drava-Danube Rivers biosphere reserve and whole-lake ecosystems, to small, individual wetlands protected to conserve critical stopover habitat for bird migration, to river reaches to conserve discrete habitats for highly range-limited species.
- Governance types: Range from national and state governments to various forms of shared governance, private governance and governance by Indigenous peoples and local communities.

- Mechanisms: Include well-established protected area types like national parks and emerging mechanisms like riverine reserves and rights-of-rivers, in addition to potential OECMs, including some Ramsar sites.
- Inland water ecosystem types: Include lakes, pools, springs, wetlands, peatlands, fresh, brackish, headwaters to large rivers, including groundwater-dependent ecosystems.
- Biodiversity conservation objectives: Range from whole ecosystems and swimways to species at risk and dependent on inland water ecosystems, from megafauna like hippos, crocodiles, pink river dolphins and giant otters, to migratory and wading birds, aquatic macro-invertebrates including freshwater mussels, endemic lake fishes, migratory fishes and freshwater turtles.
- Ecosystem services: Include carbon sequestration, water provisioning, community fisheries, drought and flood-risk reduction and related climate mitigation and adaptation, cultural and spiritual services.

Cases for area-based conservation initiatives are referenced throughout the text in green boxes and included in Appendix 1 including a look-up table and compendium. A brief summary table is included below for quick reference (Table 5.1).

Table 5.1. Summary table of case studies of area-based conservation mechanisms embedded in the text and further in Appendix 1

Management objectives	Designation type or management mechanisms	Examples
Areas that meet the IUCN/CBD definitions of protected areas		
Conservation	IUCN Category Ia protected areas	Prek Toal Core Area, strictly protected part of Tonle Sap Biosphere Reserve (Cambodia)
	IUCN Category Ib protected areas	Fossil Springs Wilderness (USA)
	IUCN Category II protected areas	Vjosa River National Park (Albania)
	IUCN Category III protected areas	Gachedili Canyon Natural Monument (Georgia)
	IUCN Category IV protected areas	Laguna Torca (Chile)
	IUCN Category V protected areas	Zones humides de 'I'Onilahy (Madagascar)
	IUCN Category VI protected areas	Pacaya-Samiria (Peru)
	Indigenous Protected Areas (not an official IUCN definition)	Paraku (Lake Gregory, WA, Australia), Toogimbie (NSW, Australia)
Areas designated under international conventions		
Conservation	UNESCO natural World Heritage sites	Ivindo River World Heritage Site (Gabon), Rio Abiseo National Park (Peru), Okavango Delta (Botswana)
	UNESCO Biosphere reserve	Mura River Biosphere Reserve (Slovenia)
	Ramsar sites	Bita River (Colombia)
Other area-based approaches		
Conservation	Species-specific reserves	Upper Yangtse Fish Reserve (China)
	River reserves	Sarapiquí River (Costa Rica), Riverine Reserves (Spain)
	Seasonal wetland and floodplain reserve	Kadwa Kosi Floodplains (India)
	Rights of Nature/ Rights of Rivers	Rio Atrato (Colombia)
	Water reserve	San Pedro Mezquital Environmental Water Reserve, Mexico

Management objectives	Designation type or management mechanisms	Examples
IP&LC territories	ICCAs – territories and areas conserved by Indigenous peoples and local communities	Fish River (Australia)
	General IP&LC lands, waters and territories	Great Bear Rainforest (Canada)
Provisioning/ regulating services	Source water protection areas	Rwenzori Mountains National Park (Uganda); Water Protection Areas (Ecuador)
	Carbon capture areas, biodiversity offset, e.g. peatland	Mawas Peatlands (Indonesia)
	Aquifer recharge area	Susupe Wetland (Northern Mariana Islands); San Pedro River (USA)
	Fisheries reserves	Mae Ngao River Community Reserves (Thailand); Lake Tanganyika (Africa),
	Riparian protection areas (water quality)	Mongolia Active River Areas Riparian zones
	Coastal marshland as storm protection	Biloxi Marsh, Louisiana (United States)
	Protected floodplains	Dyfi Valley Biosphere Reserve (Wales, UK)
	Area-based pollution control (e.g. nitrate exclusion zones)	Rio Muelas River Reserve (Spain)
Cultural services	Cultural heritage areas	Krupa River (Croatia)
	Sacred lakes, pools, springs and wells	Mai Pokhari (Nepal)
	Sacred rivers	River Ganges, India
Connectivity	Migratory swimways	Pärnu River (Estonia)
	Free-flowing rivers or river stretches	Upper Delaware River (United States)
	Climate corridors	Wild and Scenic Rivers, Oregon (United States)
	‘Stepping stones’ (stopover sites) for migratory birds	Laguna Mar Chiquita (Argentina) freshwater part of WHSRN
Recreation	Recreational fishing rivers	Onon River (Mongolia)
	Wetland/game hunting reserve	Parker River (United States)
	Artificial recreational lakes	North Creek Wetland, Colonel Samuel Smith Park (Canada)
	Natural recreational lakes	Isojärvi National Park (Finland)
Military/Defence	Military buffer zones	Hero River, reflooded wetlands, north of Kyiv (Ukraine)

5.2 IUCN protected areas

Protected areas – variously called national parks, nature reserves, wildlife reserves, wilderness areas and other terms – are a conservation approach with defined priorities and restrictions in terms of management objectives, but within these boundaries there is a great deal of flexibility regarding how these objectives are achieved. There are, confusingly, two internationally recognised definitions of a protected area:

The Conventional on Biological Diversity definition of a protected area: "*a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives*."

The IUCN definition of a protected area: "*A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.*"

In practice, the CBD takes into consideration much of the additional detail contained within the IUCN definition. Each word and phrase in the IUCN definition has been carefully explained.[252] Of relevance in an inland water context:

- A protected area is *area-based*, with clear geographic boundaries, but sometimes these boundaries may shift through natural processes. For instance, if a protected area is protecting a river system or, less ideally, has a river as a boundary, the precise position of the banks may alter considerably over time. Kaziranga National Park in Assam, India, is bounded by the Brahmaputra River, which can shift its banks by up to a mile or more, but the bank is always the boundary. As already discussed, this guidance strongly recommends moving away from the practice of using rivers as boundaries.
- Protected areas do not have to be defined under law, although most are. Those under private or community management can be listed on the World Database on Protected Areas as long as the government reports them and the objectives, management and governance are strong enough to meet the protected area definition. Community freshwater reserves and sacred lakes and springs are some inland water examples.
- *Nature* is listed as the main aim rather than *biodiversity*. This is deliberate, to include geodiversity and in reflection of the fact that within many Indigenous territories and community conservation areas, the understanding of nature is more holistic than the technical definition of biodiversity as composed of ecosystems, species and intra-species genetic variation.

Both the CBD and IUCN definitions specify the primary objective of nature conservation. IUCN goes further, with an accompanying principle: "*For IUCN, only those areas where the main objective is conserving nature can be considered protected areas; this can include many areas with other goals as well, at the same level, but in the case of conflict, nature conservation will be the priority.*"[253] But there are a range of different ways in which this objective can be achieved, summarised in the management categories, which are recognised by both the CBD and IUCN.

Table 5.2. Examples of inland water protected areas in different IUCN management categories

Category		Description
No.	**Name**	
Ia	Strict nature reserve	Strictly protected for biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values. (Prek Toal Core Area, Tonle Sap Biosphere Reserve)
Ib	Wilderness area	Usually, large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition (Fossil Springs Wilderness, Case Study 1)
II	National park	Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which can also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities. (Vjosa Wild River National Park, Case Study 2)
III	Natural monument or feature	Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove (Gachedili Canyon Natural Monument, Case Study 3)
IV	Habitat/species management area	Areas to protect particular species or habitats, where management reflects this priority. This could include designated critical habitat areas under the jurisdiction of an endangered species act. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category (Laguna Torca, Case Study 4)
V	Protected landscape or seascape	Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values. (Zones humides de l'Onilahy, Case Study 5)
VI	Protected areas with sustainable use of natural resources	Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims. (Pacaya-Samiria, Case Study 6)

Note that the names are indicative only and often confusing; for instance, 'national parks' exist in every category and indeed some are not protected areas at all in a global sense; for instance, the Mall in Washington DC is managed by the US National Park Service.

To aid in categorisation, assignment guidelines have been developed,[254] along with guidance and best practice for privately protected areas.[255] [256] The system of IUCN categories is explained, defended and promoted through instruments like the CBD. IUCN WCPA supports governments with application of the definition and categories. The categories determine the way countries designate and manage huge areas critical to global conservation efforts.

IUCN applies the definition and categories alongside a series of principles, approved by the IUCN World Conservation Congress in 2012. **While all management categories make a contribution to conservation, not all categories are equally useful in every situation and management must be tailored to the individual situation**. A diversity of management approaches is desirable and should be encouraged, as it reflects the many ways in which communities around the world have expressed the universal value of the protected area concept. And importantly, the definition and categories of protected areas should not be used as an excuse for dispossessing people of their lands, waters or dependent rights.[257]

Of particular relevance, and widely misunderstood, is **the 75 per cent rule**.[258] This advises that up to a quarter of a protected area can be used for purposes other than conservation **as long as this doesn't interfere with conservation objectives**. Introduced originally to avoid the relocation of existing settlements in large protected areas, or tourist infrastructure within national parks, this also has relevance, for instance, for existing aquaculture projects, fishery operations, tourist use, and lakeside settlement in protected areas. A quarter is a maximum, and this applies predominantly to existing activities rather than new ones. It is not an open invitation to develop a quarter of any protected area, and in most cases less area would be used. Further, some uses, regardless of their direct development footprint, could have far reaching impacts that would inherently interfere with inland water conservation objectives, especially those that impact connectivity, water quality or environmental flows.



Smallmouth buffalo. © David Herasimtschuk / Freshwaters Illustrated

These 'rules' are all voluntary; the Convention on Biological Diversity is not legally binding and IUCN has no legal power over governments. However, those governments that sign up to the CBD and are members of IUCN are generally expected to follow these agreements.

5.3 Other effective area-based conservation measures

Other effective area-based conservation measures (OECMs) recognise area-based interventions that provide effective conservation of biodiversity outside of protected areas. They are defined by the CBD in Decision 14/8 as:[259]

> *"A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity with associated ecosystem functions and services and where applicable, cultural, spiritual, socio-economic, and other locally relevant values."*

Under the KM-GBF, parties reaffirmed the role of OECMs as a mechanism to complement the use of protected areas in achieving Target 3.[260] They include sites without a particular focus on biodiversity conservation but where management nevertheless supports biodiversity. OECMs must demonstrate that they are delivering long-term conservation of important biodiversity and are achieving the same level of in situ or whole ecosystem biodiversity conservation as protected areas. Identification, reporting, monitoring and strengthening of OECMs can be conducted by governments, organisations, Indigenous peoples, local communities or other actors. OECMs provide an opportunity to increase recognition and support for *de facto* long-term conservation that takes place outside of traditional protected areas.[261]

In this section, we present current thinking on how and where OECMs may apply within the context of conserving inland water ecosystems and biodiversity. There are several potential types of OECMs that offer protection to inland waters but have not yet been recognised in official national documentation of protected area systems. Recognition as an OECM may allow for an area to receive resources for long-term maintenance and also provide additional security against management changes or degradation. Experience with OECMs remains limited.

Box 5.1

Key resources on OECMs

- IUCN OECM good practice guidance (2024): https://iucn.org/our-union/commissions/world-commission-protected-areas/our-work/wcpa-publications/iucn-wcpa-good
- IUCN OECM site-level identification tool (2023): https://www.iucn.org/story/202308/site-level-tool-identifying-other-effective-area-based-conservation-measures-oecms
  Criterion 1: The site is not a protected area
  Criterion 2: There is a reasonable likelihood that the site supports important biodiversity values
  Criterion 3: The site is a geographically defined area
  Criterion 4: The site is confirmed to support important biodiversity values
  Criterion 5: Institutions or mechanisms exist to govern the site
  Criterion 6: Governance and management of the site achieve or are expected to achieve in situ conservation of important biodiversity values
  Criterion 7: In situ conservation of important biodiversity values is expected to be long-term
  Criterion 8: Governance and management arrangements address equity considerations
- CBD 2018 decision on OECMs: https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-08-en.pdf [262]
- FAO OECM marine fisheries guidance (inland water guidance in development): https://www.fao.org/3/cc3307en/cc3307en.pdf
- World Database on OECMs: https://www.protectedplanet.net/en/thematic-areas/oecms?tab=OECMs

5.3.1 Considerations in applying the OECM framework to inland waters

The opportunity afforded by OECMs to bring in a wider set of mechanisms for protection is critically important for conservation of inland water systems, given both the nature of communities dependent upon inland water systems and the particular challenges these ecosystems face.[263] Recognising those areas that are delivering inland water biodiversity outcomes as OECMs also offers potential to deliver resources and credibility to management interventions that:

- complement conventional PAs, which we know are inadequate on their own for conserving inland water ecosystems
- are equivalent in conservation outcomes to protected areas
- are focused in areas of importance to biodiversity
- can fill management gaps within basins, since protection of whole basins outright is rarely practical or achievable (see Chapter 2)
- in many cases the management approach of OECMs aligns more closely with how inland water ecosystems are effectively managed in many parts of the world, from the ground up.

While the understanding and implementation of OECMs are still evolving, there are several resources that can be useful in identifying inland water-related OECMs (Box 5.1). Importantly these include an OECM site-level identification tool with a three-step screening approach (screening, consent, and full assessment),[264] and the IUCN OECM Good Practice guidance.[265]

Here we share seven general questions to guide the application of the OECM framework and site-level tool for inland waters, referencing the eight criteria (Box 5.1):

1. **Does the site make a significant contribution to the conservation of inland water biodiversity?** All inland waters support biodiversity, but not all areas will be equally important. A critical step in determining whether the area should be recognised as an OECM is assessing **the significance of its contribution to the conservation of biodiversity**.[266] This can include importance at the global, national or sub-national levels.[267] All sites being considered should be reviewed. For more guidance, criteria 2 and 4 in the site-level identification tool[268] and Chapter 3 of this report outline additional considerations and data sources to identify areas of particular importance. It will be important, when evaluating areas as potential OECMs, to assess and understand and record **what biodiversity value is being conserved and how that outcome is being measured/**

evaluated. Areas can be managed for water-related services, like source water protection, but may not deliver long-term in situ inland water biodiversity conservation, as required to be recognised as an OECM.[269] In principle, an area of land being managed to produce water-related services could qualify as an OECM based on terrestrial biodiversity outcomes but not inland water biodiversity outcomes. For OECMs to reach their potential for delivering inland water conservation, we need to ensure that meaningful and measurable biodiversity outcomes are being generated.

2. **With the basin context in mind, is the management approach likely to deliver effective conservation of biodiversity over the long term?** As described in Chapter 2, the conservation of inland water biodiversity is often more complex than that found in other realms. The health of a river, lake or other wetland depends in part on the condition of upstream lands and waters, as well as on upstream and downstream aquatic connectivity.
3. **The condition and threats should be reviewed to understand the extent that the management approach can deliver effective conservation** of the inland water's biodiversity value over the long term. Criterion 6 of the site-level identification tool and Chapter 4 serve as references for data sources to characterise basin condition and threats. The connected nature of inland water ecosystems inevitably limits OECMs – and PAs – from preventing *all* threats to biodiversity. Because OECMs are evaluated on their outcomes (a higher bar than is applied to PAs, which are classified based on intent rather than outcome), the conservation community will need to come to consensus about how to apply criteria around management and conservation effectiveness (see Chapter 6).
4. **Have the governing bodies, Indigenous peoples and local communities, and as applicable, stakeholders and rightsholders, given consent and do the arrangements address equity considerations?** For areas that include inland water resources, Chapter 3 outlines the questions, considerations and outreach that should be included to ensure full consideration of the linkages between the site being assessed, the management approach, and the relationship to water-related rights and resources. Further, **OECMs hold real potential for conserving inland water ecosystems – or at least some elements of them – via local governance and stewardship**.
5. **If the OECM is focused on terrestrial or marine biodiversity values, does the management approach also provide a net gain for inland waters?** For areas that contribute to terrestrial or marine biodiversity conservation, management approaches within these areas should be comprehensively evaluated to assess their impacts (positive or negative) on inland water biodiversity, including downstream. An area that is managed in a way that benefits one set of biodiversity values and ecosystems, to the severe detriment of another set, is unlikely to qualify as an OECM.[270] Biodiversity values of a site should be assessed comprehensively rather than opportunistically.
6. **When do managed inland water areas qualify as OECMs?** In general, areas managed for extractive or industrial exploitation of natural resources are unlikely to meet the criteria for OECMs. Depending on their management, these areas may support delivery of other aspects of the CBD KM-GBF, often referred to as 'the other 70 per cent' (e.g. Target 10). Sites where development or management activities are low impact and non-extractive *may* qualify as an OECM, for example community fish reserves [Field Study 3 Mae Ngao Community Fish Reserve], so long as the management of the site is maintaining important biodiversity values, can address reasonably foreseeable threats, and meets the site-level criteria.[271]
7. **Are sites listed under the Convention on Wetlands (Ramsar sites) considered protected areas in your geography?** While many Ramsar sites will meet the OECM site-level identification criteria to qualify as OECMs, there will be exceptions. Exceptions could include countries where local legislation recognises Ramsar sites as protected areas, as PAs do not qualify as OECMs (criterion 1 in the site-level identification tool). Additional exceptions include sites without a clearly defined geographical area and areas where governance and/or management are not maintaining important biodiversity values.[272] Given potential complexities, it is recommended that the national legal framework (laws and regulations) is assessed to determine whether Ramsar sites are recognised as protected areas. If they are not, assess sites either individually, or in aggregate, using the steps and criteria in the OECM site-level identification tool (see Section 5.4.1). For example, Colombia went through a national OECM process and reclassified their Ramsar sites as a "complementary conservation strategy" (CCS), which is equivalent to an OECM. In 2018, a tributary of the Orinoco River, the Bita River, in Colombia, was designated as a Ramsar site and is now recognised as an OECM (Field Study 4).

Field study 3

An illustrative application of the site-level tool for identifying OECMs,

Mae Ngao Community Fish Reserve, Thailand

Background. Over the last three decades, Indigenous P'ganaw (Karen) communities along the Mae Ngao River have established a network of more than 50 no-take community fish reserves ranging between 0.2 and 2 km in length. The communities were unified in their opposition to a national park designation, clear that their primary goal is the maintenance and augmentation of subsistence fisheries, with conservation a secondary goal. Communities delineate the boundaries of the no-take zones, develop and enforce penalties for non-compliance and in some cases sell licences for catch and release recreational angling. Relative to sites outside of the reserves, the managed areas contain 27 per cent more fish species, 124 per cent higher density and more than 2,000 per cent greater fish biomass (see Appendix 1, Case 35, for full study and references).

Illustrative application of the site-level tool for OECMs. As an illustrative desktop example, this site has the *potential* to qualify as an OECM based on the information available. It is outside a recognised protected area (criterion 1); shows reasonable likelihood of supporting biodiversity values, in particular for species spawning and breeding aggregations and for ecological connectivity as part of a network of sites (criterion 2); the reserves have clear boundaries (criterion 3); peer-reviewed scientific studies confirm that they support important biodiversity values (criterion 4); mechanisms exist to govern and manage the site (criterion 5); and there is potential that the management arrangements address equity with the role of Indigenous-led governance and management.

Critically, the site *does not yet* meet the required step of consent for full assessment. Understanding that the communities did not support a national park, they may also not see value or be interested in giving consent for an OECM full assessment. In addition, the fisheries reserve management may not prevent foreseeable threats to the site, like upstream hydropower dams, that would impact the ability to achieve in situ conservation of important biodiversity values (criterion 7). As noted above, an inability to protect against all external threats may be an unrealistic bar for potential inland water OECMs, though the likelihood of threats to impair long-term biodiversity conservation should be evaluated and weighed. Interestingly, recognition as an OECM could potentially support the rationale for avoidance and/or mitigation of future upstream development proposals.

This example is shared for illustrative purposes only and is not intended to represent an actual assessment or its results, in part or in full.



Community fish reserves across rivers in the Salween River basin , including the Mae Ngao River, in Thailand have demostrated clear benefits for fish biodiversity and abundance. © Aaron Koning

5.3.2 Potential types of inland water-related OECMs

Assessments of potential OECMs should be undertaken on a case-by-case basis, with assistance of the OECM site-level identification tool and good practice guidance.[273] Below is a list of designations or management mechanisms that could be OECMs and relevant to inland water conservation.[274] **Whether or not a site will qualify as an OECM will be determined in part by whether there are important biodiversity values associated with the site, and the effectiveness of the management approach in maintaining those values**.[275] Most of the examples outlined below could be OECMs, could sometimes be protected areas and might in other circumstances be neither.

- Areas designated under international conventions or programmes and which are not also deemed to be protected areas (such as UNESCO Biosphere reserve buffers or transition zones, or some Ramsar sites). For instance, in the WDPA, South Africa has reported Marico Biosphere Reserve as an OECM. Similarly, Morocco has reported as an OECM Oued Cheibeka, a Ramsar site and biological and ecological interest site, which is managed by the national government.
- Area-based conservation approaches such as river reserves, seasonal wetland and floodplain reserves, and rights of nature/rivers areas, where these are not designated as protected areas (for more information, see Section 5.5).
- Indigenous peoples and local communities' territories such as Indigenous and Community Conserved areas. While some of these are considered by the people concerned as full protected areas, OECMs offer a separate option if this is undesirable (for instance, some national legislation insists no settlements within protected areas). Indigenous territories were expected to be the largest 'type' of OECM, although in practice this has not been the case so far.
- Provisioning, regulating or supporting area-based approaches such as source water protection areas, government-mandated riparian strips, water reserves, carbon capture areas, aquifer recharge areas, fisheries reserves, coastal marshlands as stormwater protection areas, protected floodplains, and area-based pollution controls (e.g. some nitrate exclusion zones), if there are biodiversity conservation outcomes (for more information, see Section 5.5). Many permanent fisheries reserves are likely to qualify as OECMs, while a small proportion may be PAs.
- Cultural or faith-based areas such as sacred rivers, lakes, pools, springs and wells, and important cultural sites in rivers.
- Connectivity area-based approaches such as migratory swimways, designated river corridors, free-flowing rivers or river stretches, climate corridors, and stopover sites for migratory species.
- Recreational sites such as natural lakes and rivers with recreational fishing and boating, and wetland/game hunting reserves.
- Military areas and buffer zones that have co-benefits for inland water biodiversity conservation.

5.4 International designations

5.4.1 Wetlands of International Importance (Ramsar sites)

The Convention on Wetlands, formally called the *Convention on Wetlands of International Importance Especially as Waterfowl Habitat*, was signed in Ramsar, Iran in 1971, the first modern intergovernmental treaty focused on the conservation and sustainable use of natural resources. The Convention on Wetlands was not adopted under the United Nations, but as an independent agreement among governments. There are currently 172 Contracting Parties to the Convention. The Conference of the Contracting Parties (COP), the decision-making body of the Convention, meets every three years. The Convention Secretariat is based at the headquarters of the International Union for Conservation of Nature (IUCN) in Gland, Switzerland.

While development of the Convention was strongly driven by an interest in and concern for waterfowl, the wider importance and benefits of wetlands are clearly stated already in the short preamble of the convention text. The Convention's mission is "*the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.*" The Convention has three main pillars: the designation and management of wetlands of international importance, supplemented by the establishment of wetlands nature reserves; the wise (sustainable) use of all wetlands; and an international cooperation requirement, especially in the case of a wetland or water system extending over the territories of more than one party.

Article 1(1) of the Convention on Wetlands defines wetlands broadly: "*areas of marsh, fen, peat, and or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.*" The Convention's classification system of wetland types encompasses marine and coastal, inland, and human-made wetlands, further subdivided into 42 wetland types.

Under Article 3(3) of the Convention, Parties commit to pursuing *wise use* of wetlands throughout their territory. 'Wise use' is defined as "*the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development.*"

The Convention produces large amounts of guidance relating to conservation and sustainable management of wetlands, along with assessment of the status of wetlands and their biodiversity, and policy recommendations.

Per Article 2(1), each Party must designate suitable wetlands for inclusion in the Convention's List of "Wetlands of International Importance," also referred to as Ramsar sites.[276] Each Contracting Party needs to propose at least one Ramsar site when joining the Convention and most list more; there are currently over 2,500, covering more than 2.5 million km^2, an area larger than Mexico. Listed sites may incorporate riparian and coastal zones adjacent to wetlands – so Ramsar sites can include free-flowing rivers *and their floodplains*, or lakes and springs and surrounding vegetation. Ramsar sites are selected on the basis of one or more of nine criteria, all of which refer to their ecological importance. Article 3(1), moreover, **requires Parties to formulate and implement their planning so as to promote the conservation of Ramsar sites.**

Box 5.2

Relationship between the CBD and the Convention on Wetlands

The CBD and the Convention on Wetlands have been collaborating since 1998. They have entered into five joint work plans and a draft of the sixth iteration for 2024–2030 has been prepared to support the KM-GBF and all Ramsar resolutions, recognising the Convention on Wetland's broad definition of wetlands. The plan foresees activities for Parties to each Convention (e.g. establishment and maintenance of well-connected ecologically representative systems of protected wetland ecosystems, considering the wider catchment scale; as well as consideration of sacred and IP&LCs' lands and waters in environmental impact assessments); for the two Conventions' bodies (e.g. design of guidance and tools to improve representativeness and extent of wetland protected areas and wetlands of international importance); and for the two Secretariats (e.g. mapping goals and targets of the two Conventions in national reporting templates).

The Convention has devised processes for managing changes – good or bad – in ecological character, which may include monitoring missions. **Sites may be added to the Montreux Record, a list of Ramsar sites at risk from technological developments, pollution or other human interference**, such that changes in their ecological character can be seen or are expected.

In addition, Ramsar **sites may be deleted from the List or have their boundaries changed** on the basis of "urgent national interests" (Article 2(5)). The Party in question *must* inform the Secretariat and "*should as far as possible compensate for any loss of wetland resources, in particular by creating additional nature reserves for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat*" (Article 4(2)). The expression 'should' weakens this compensatory approach, which then becomes a soft recommendation rather than a strict requirement.[277]

Deletion and boundary variation prerogatives mean that Parties may exclude areas from protection coverage under the Convention, even if those areas have high conservation value.[278,279] This becomes significant under climate change when some countries face reduced flows. The degree of formal protection given to Ramsar sites is left up to the government concerned. Moreover, despite the requirement for Ramsar sites to be precisely described, their boundaries are often poorly defined, although this is currently being addressed.

Article 5 of the Convention requires Parties to consult with each other on implementation. This is particularly important for shared water systems and wetlands extending over the territories of more than one state.

There has long been a debate about whether Ramsar listing automatically means that a site is a protected area in the sense recognised by the CBD and IUCN. The priority of "wise use" as a management objective is markedly different from IUCN's prioritisation of nature conservation. However, a commitment to maintain ecological character (and because selection is predominantly based on ecological importance) suggests that the area embodies a strong commitment to conservation. Many Ramsar sites are located within or overlap with formally protected areas. In recent years, the Ramsar Secretariat and its scientific committee have argued for the equivalence of Ramsar sites with protected areas, although some state parties disagree. The emergence of OECMs has altered the debate and the Secretariat is investigating whether some Ramsar sites fit better as OECMs. Colombia is already recognising its Ramsar sites as OECMs. **Ultimately, Contracting Parties are sovereign to decide how they will report Ramsar sites under KM-GBF Target 3.**

Central to this discussion is whether there is an effective management plan being applied to the site. In this respect, "Participatory Environmental Management (PEM)" (*Ramsar Convention, Recommendation VIII, 36*) is an important tool for management and wise use of wetlands.[280] PEM can help local communities contribute their knowledge of life and conditions in the areas under consideration and help shape the management plan and its implementation. The development of the Nosivolo River in Madagascar as a Ramsar site (and, subsequently, a protected area) was strongly based on the principle of complete engagement of the local communities, and this proved very successful (Luciano Andriamaro, pers. comm.).

Box 5.3

Enforcement of Ramsar site obligations through adjudication

In the San Juan River Cases (Costa Rica v. Nicaragua), both parties invoked the Convention on Wetlands, in alleging harm to Ramsar sites; and, in issuing its decisions, the International Court of Justice (ICJ) explicitly relied on the Ramsar status of the two wetlands at stake, underscoring and unpacking Convention obligations. These decisions highlight the duty to cooperate in Article 5 of the Convention, as well as the role of the Secretariat in the monitoring of the affected areas. The evidence presented and considered in this case included a 2010 Mission Report by the Ramsar Secretariat. The Court also authorised Costa Rica to adopt measures aimed at avoiding irreparable harm to a designated wetland; and required that country, in so doing, to consult with the Ramsar Secretariat and "use its best endeavours to find common solutions with Nicaragua".[281] The Court also stated: "The presence of Ramsar protected sites heightens the risk of significant damage because it denotes that the receiving environment is particularly sensitive".

This case study illustrates how Ramsar state obligations might be enforced at the international level, but the same precedent is also an indication that Convention effectiveness might be pursued by interested actors in domestic courts – for example, to hold states accountable to a general obligation to protect a healthy environment (see Chapter 3 on equity, inclusion and human rights); or, where international treaties have national legislation, to enforce compliance with Article 3(1).

Field study 4
A basin-scale Ramsar site and OECM
Bita River, Colombia

As a tributary of the Orinoco River originating in Colombia's Llanos high plains, the Bita River meanders for 510 km within a basin of 825,000 ha.[282] The Bita River basin is recognised as a high priority area for conservation due to its rich biodiversity and relatively good conservation condition.

In 2014, the Alliance for the Protection of the Bita River was formed by government entities and civil society with a mission to develop a strategy to protect the river. The Alliance drew on systems thinking and a decision-making framework developed by communities, local entities and government. It serves as a model in its engagement of fishers, farmers, companies, scientists and citizens to collaboratively identify priorities, understand relationships and implement conservation actions.

Analyses funded through the Tropical Forest Conservation Act identified the Bita River to be important for conservation. Conservation values include biodiversity, forest and wetland habitat, culture, community livelihoods reliant on tourism, and recreational activities, like bird watching and fishing. Connectivity is critical to the movement of the Bita River's species such as migratory fish, turtles, crocodiles, river dolphins, jaguars, tapirs and otters, among many others.

An assessment of the costs and benefits of alternative river protection mechanisms was conducted using biological surveys, gap analysis, as well as participatory system dynamics modelling and scenario building.[283,284] Analyses led to recommendations for a Ramsar designation, a tiered conservation approach (i.e. conservation, restoration, production zones), and development of management plans, conservation agreements and private reserves to balance conservation with sustainable use.

As a result, the Bita River Basin Wetlands Complex was added to the Ramsar List of Wetlands of International Importance in 2018. It is the largest Ramsar site in Colombia, and globally one of the first to protect an entire free-flowing river, including the mainstem and contributing basins. Along with protection of the riverine system, the site aims to maintain its free-flowing status and preserve biodiversity and ecosystem services. Biodiversity is threatened by land use conversion, ranching, agricultural runoff, over-harvested fisheries/forests, infrastructure development, tourism and climate change.

The government of Colombia considers the Bita River Ramsar site one of its "Complementary Conservation Strategies" (CCSs), which are an OECM equivalent. Colombian CCSs aim to deliver on biodiversity conservation objectives by contributing to the connectivity of the National System of Protected Areas (SINAP), and in allowing for diverse local and regional governance systems across the country.

After designation, a 228,000-ha ecological corridor was created within the Ramsar site to connect stretches of the river supporting wildlife movement and migration. By expanding its national system of protected and conservation areas, including the Bita Ramsar site, Colombia announced it has achieved its goal to protect and conserve 30 per cent of its lands and waters to curb biodiversity loss.



Thanks to the highly connected network of river habitats for feeding and reproduction, the Bita has one of the best populations of river dolphins (*Inia geoffrensis*). © Adriano Gambarini/WWF



The giant river otter (*Pteronura brasiliensis*) is endemic to South America and present in the Bita River ecosystem. As the world's largest otter, an adult can reach 1.8 m in length and requires habitats with high fish densities. © R.Isotti, A.Cambone / Homo Ambiens / WWF

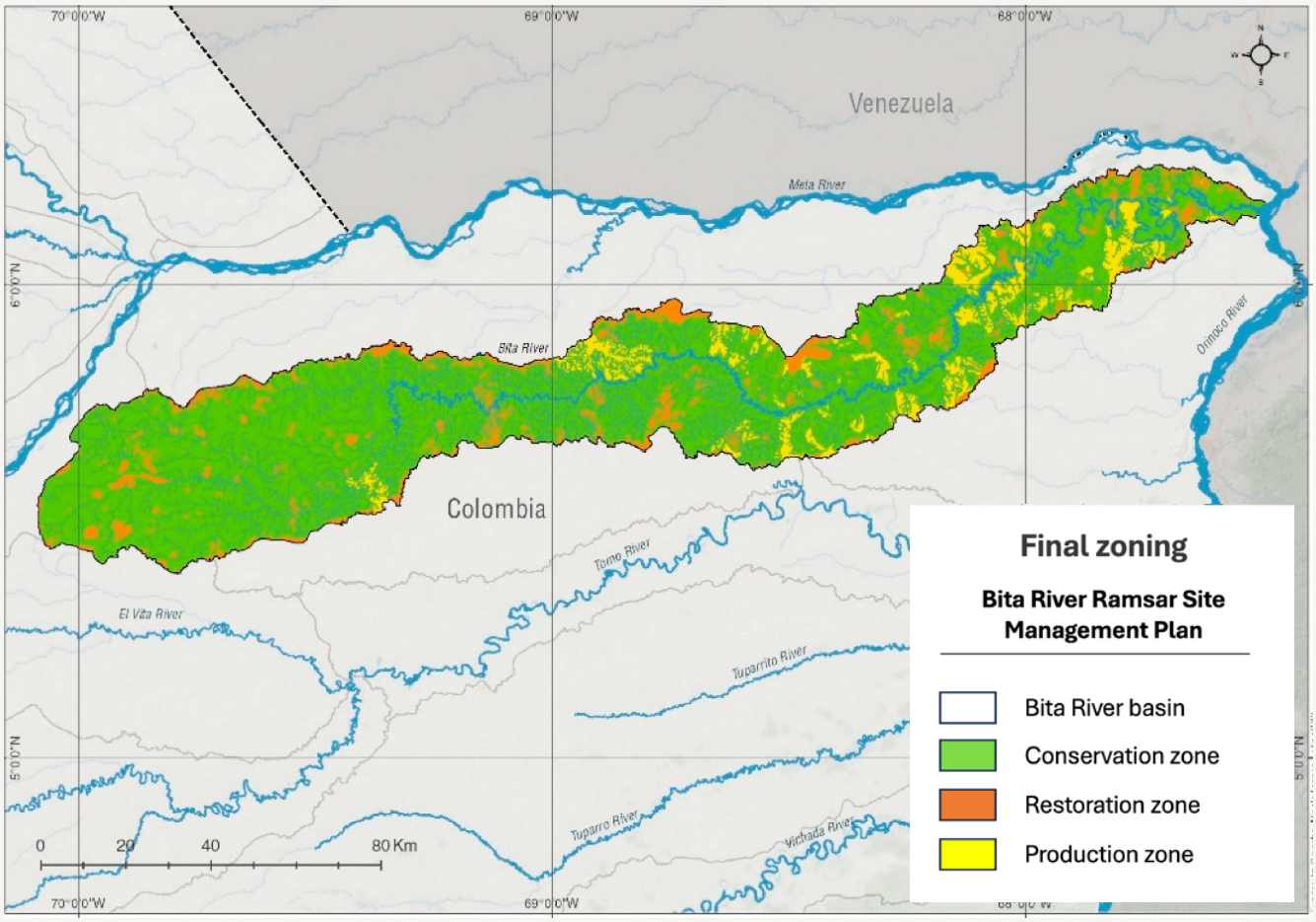


Figure 5.1. Bita River Management Plan Conservation Zoning Map for conservation (green), restoration (orange) and production (yellow). [285]

The effectiveness of established Ramsar sites varies significantly. Reports from Ramsar Contracting Parties suggest both that the average ecological condition of wetlands continues to deteriorate and that the same trend occurs in many Ramsar sites as well, particularly in Africa and Latin America and the Caribbean.[286] Mauerhofer et al.[287] examined examples of the implementation of the Convention and noted some general conditions for success, including cumulative implementation benefits where there are overlapping governance efforts linked to multiple regional and international biodiversity efforts. Similarly, institutional and organisational complexity can, perhaps surprisingly, provide opportunities for local actors to drive implementation through a mix of processes of coordination and across contentious politics.

Despite the above challenges, Ramsar sites are an important and widespread area-based conservation approach for inland waters, **representing almost 5 per cent of the total global inland water coverage by protected and conserved areas**. They are likely to become more important as the conservation and policy community look at broader options for achieving conservation of inland water ecosystems under frameworks of mixed management or multi-zonal use. **But, if their full potential is to be realised, this will require greater commitments from contracting governments in terms of implementing policies and providing resources to ensure that sites maintain ecological functioning and contribute to biodiversity conservation goals.**

5.4.2 UNESCO Biosphere Reserves

Biosphere Reserves (BRs) are an international model of natural resources management and in situ nature conservation and use, created to enhance human development in harmony with the environment (see Case Study 8, Mura-Drava-Danube Biosphere Reserve). In view of their clear delimitation, durability goals, public profile and high international visibility, changes to BRs are unlikely to go unnoticed.

Unlike traditional PAs, BRs do not centre on biodiversity as a primary management objective over their whole area, but rather on sustainable development, balancing socio-economic and biodiversity goals. The legal basis for BRs is not a treaty. Instead, states voluntarily submit sites for inclusion in the Biosphere Reserves World Network, under UNESCO's *Man and the Biosphere Programme* (MAB). The Programme is governed by its Statutory Framework,[288] which, problematically for inland waters, defines BRs as "areas of *terrestrial and coastal/marine* ecosystems, or a combination thereof."

Despite the Programme's voluntary nature, states may enact supplementary domestic legislation, as is the case with Brazil, affording legal binding force to the Programme's zoning approaches. Under Brazil's legal regime, an institutional governance and management structure is created for each Reserve, including to elaborate action plans, which may contain recommendations on specific thematic areas, inland waters being one, presumably; propose pilot projects in strategic areas within the site; and implement the basic zoning principles under the Programme (Law 9985/2000 and Decree 4340/2002).

These zoning principles are the core characteristic of BRs, which must comprise: (i) legally constituted and appropriately sized *core area[s]*, devoted to long-term protection, according to the BR's conservation objectives (and which will usually be protected areas in the sense recognised by IUCN and the CBD); (ii) *buffer zone[s]*, clearly identified and surrounding or contiguous to the core area[s], where human use and activities must be compatible with the preset conservation objectives for the core area and mechanisms for the management of those activities must be adopted (which might be OECMs); and (iii) *outer transition area*, wherein sustainable resource management practices are promoted and developed.

The zoning is designed so that BRs can perform three interrelated, mutually reinforcing, and equally important functions: (i) *conservation*: of landscapes, ecosystems, species and genetic variation; (ii) *development*: socio-culturally and ecologically sustainable economic and human development; and (iii) *logistic support*: for demonstration projects, environmental education and training, research, and monitoring.

In support of the above structure and objectives, BRs must have in place: (i) a designated governance and implementation body; (ii) stakeholder participation mechanisms; (iii) a management policy or plan; and (iv) research, monitoring, education and training programmes.

The criteria for a site to receive international recognition as a BR are as follows: (i) be structured as "a mosaic of ecological systems representative of major biogeographic regions"; (ii) have significance for biodiversity; (ii) be able to serve as a testing and demonstration ground for sustainable development approaches on a regional scale, along with scientific research and education; and (iv) have an appropriate size to perform the foregoing functions (Statutory Framework, Art.4).

Once a site is designated, it is expected to undergo reviews every ten years, based on the reporting provided, with the involvement of local populations and following a predefined process. If, after review, a BR fails to meet the criteria in Art.4 of the Framework, the MAB International Coordinating Council may issue the appropriate recommendations to address the barrier preventing the site from meeting those criteria. In the case the site continues to fail to meet the criteria within a reasonable period, it may lose its BR status. States may also notify the Secretariat of their decision to remove a BR from the Network.

5.4.3 World Heritage Convention

The UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC) was concluded in 1972 and has been in force since 1975. It has 195 state parties. There are 1,099 listed properties, of which 933 are cultural, 227 are natural and 39 are mixed sites, across the territories of 168 Parties (see Case Study 7, Ivindo River World Heritage Site). Almost 100 World Heritage wetlands overlap wholly or partially with over 150 Ramsar sites. Other relevant statistics include: (i) total number of assessed species and percentage of species in World Heritage Sites (WHS): freshwater fishes – 12,256 / WHS 40 per cent; (ii) number of species in WHS: waterbirds (321); frogs (2,412); salamanders (181); crocodiles (20); freshwater fishes (4,937); (iii) percentage of species in WHS that are globally threatened: freshwater fishes (23 per cent); amphibians (19 per cent); and (iv) estimated number of threatened species in UNESCO World Heritage Sites: freshwater fishes (615); amphibians (471).

The WHC's implementation centres on listing and monitoring of universally outstanding or endangered areas. Among these areas, *natural* heritage includes three criteria, all of which should be of "outstanding universal value": (i) *natural features*: "physical and biological formations or groups of such formations"; (ii) *geological and physiographical formations and precisely delineated areas*, "which constitute the habitat of threatened species of animals and plants"; and (iii) *natural sites or precisely delineated natural areas* (Art.2).

The Convention thus affirms a *collective duty of cooperation* towards *international heritage protection* – among all parties and other international actors and across all heritage sites. In this context, parties undertake to cooperate in safeguarding *listed* heritage, upon request by the interested state; and agree to avoid causing direct or indirect transboundary harm through unilateral measures to heritage within the territory of another party.

Each party identifies and delineates areas suitable for potential designation, with appropriate measures (legal, scientific, technical, administrative and financial) to protect, conserve, present, restore and transmit to future generations heritage sites within their respective territories. In particular, states commit to: (i) adopt a heritage policy and incorporate heritage protection into comprehensive planning programmes; (ii) establish services for heritage management; and (iii) advance relevant training, research, education and awareness-raising. This legal regime is detailed in periodically revised *Operational Implementation Guidelines*, which define precise criteria and processes for property nomination, listing and protection and for the provision of assistance.

The Convention's institutional governance is formed by: (i) the General Assembly of States Parties; (ii) the Intergovernmental Committee for the Protection of the Cultural and Natural Heritage of Outstanding Universal Value (WH Committee), which guides the listing process; coordinates international cooperation and assistance and publishes the *World Heritage List* and the *List of World Heritage in Danger*; and (iii) the Secretariat.

The WH Committee receives and studies requests for support from parties, with reference to both listed sites and those suitable for being listed as World Heritage or World Heritage in Danger. Assistance may take the form of studies and trainings; provisions of experts, technicians and skilled labour; supply of equipment; low-interest or interest-free loans; and non-repayable subsidies.

Financial assistance is provided through the World Heritage Fund, administered by the WH Committee. This body decides on use of the Fund's resources, seeks ways to increase those resources and organises fundraising campaigns. All parties are required to make regular contributions to the Fund.

The WH Committee has identified activities deemed to be incompatible with World Heritage status, including mining, oil and gas developments and dams with large reservoirs. Accordingly, some companies (public and privately-owned, and across sectors, like extractives) and financial and insurance institutions have assumed a commitment to preserve heritage sites and surrounding areas (buffer zones or broader setting) as no-go areas, including the International Hydropower Association. As of November 2022, more than 50 World Heritage 'no-go' commitments and other Heritage safeguard policies had been endorsed by the corporate sector. On hydropower, in particular, Decision 40 COM 7 (2016) under the Convention notes that an increasing number of properties face threats from major dam projects that are incompatible with their status and urges parties to ensure that the impacts from dams that could affect properties upstream or downstream within the river basin are rigorously assessed. There are precedents of projects being withdrawn.

UNESCO has published guidance on the assessment of impacts from planned measures focusing specifically on the world heritage context, including hydropower.[289] Guidance refers to the need to consider hydrological connectivity, changes in flows, and blockage of migration routes, and it recognises that, for a project capable of affecting water levels in a river, the area of influence might extend to the entire basin.



Boats used by the local shrimp cooperative of Salto de Agua lay at rest in La Encrucijada Biosphere Reserve and Ramsar site, Mexico. © Mark Godfrey/TNC

5.5 Emerging mechanisms and concepts for conserving inland waters

As outlined in the introduction, effective conservation of inland water ecosystems often requires several designation types or mechanisms to safeguard critical facets of physical habitat, ecological flows, water quality, connectivity, and/or biotic interactions that underpin the conservation objectives. Most often, long-term and effective conservation will depend on a multi-layered approach with a set of complementary legal and non-legal mechanisms, at nested scales, to support the integrity of the ecosystem and meet conservation objectives.[290]

Building from the discussion of protected areas, OECMs and international designations, this section outlines a selection of emerging mechanisms that have been used to meet specific conservation needs of inland water areas including: rights of nature; sacred and cultural areas; riverine-focused protections; groundwater-supported system protections; geographically defined environmental flow protections; nature-based solutions for water and climate; community fish reserves; and transboundary inland water conservation mechanisms.

Whether or not each of the following mechanisms is considered a protected area, OECM or neither, will depend on integration with national protected and conserved area laws, recognitions, governance and management.

5.5.1 Rights of nature

The concept of the 'Rights of Nature' recognises that natural phenomena "*have an independent and inalienable right to exist and flourish*."[291,292] There has been growing action on Rights of Nature, partly in response to the failure of environmental law to protect natural ecosystems, with participation of diverse groups, especially Indigenous peoples, civil society, legal experts and youth. Because natural systems cannot represent themselves in court, the Rights of Nature approach assigns people in the role of guardians.

The first application of Rights of Nature to rivers was in 2011, by Ecuador for the Vilcabamba River, and the approach has advanced since then. In New Zealand, the Te Awa Tupua (Whanganui River Claims Settlement) Act of 2017 is based on recognition by the Māori that the Whanganui River is a living being, which has "*all the rights, powers, duties, and liabilities*" of a legal person.[293] The Ganges and Yamuna rivers have sacred importance and are personified as goddesses in Hinduism, and the two rivers were judicially recognised in 2017 as "*legal and living entities having the status of a legal person with all corresponding rights, duties and liabilities*" and were assigned state government officials as legal custodians.[294] Also in 2017, a petition was made to protect the Himalayan ecosystem of glaciers, streams and forests. But both cases were stayed by a decision of the Indian Supreme Court, showing that granting of legal rights of a river may not guarantee protection.[295]

In Colombia, the Atrato River has acted as a model for other cases (Case Study 14, Rio Atrato, Rights of Rivers). The river's biodiversity has been threatened by pollution from mining. A case for stopping mining was brought to the Constitutional Court by local NGOs in 2017 and accepted because the pollution threatened rights to "*water, food security, the healthy environment, and the culture and the territory of the ethnic communities that inhabit the Atrato River basin.*"[296] However, a criticism of some of these cases is that they focus on actions to support human communities rather than in support of the ecosystems themselves.[297]

Recognition of the rights of rivers led to *The Universal Declaration of the Rights of Rivers*,[298] developed and launched in 2020 by a coalition of NGOs, scientists, Indigenous leaders, Earth jurists, and others. Widening the scope of attention, Davies et al. (2021) proposed a Universal Declaration of the Rights of Wetlands,[299] applying this to wetlands as defined by the Convention on Wetlands, which includes peatlands, artificial wetlands and coastal ecosystems. The relationship between these and other rights-based approaches (e.g. a proposed one for peatlands) is still being discussed.

It is still unclear whether the recognition of Rights of Rivers, and Rights of Wetlands, as stated in the Declarations, define a river or other wetland as being protected and contributing towards national or global conservation targets. In some cases, inland waters granted legal personhood include sections within protected areas or OECMs. For example, in 2019 the Yurok tribe established a Resolution granting legal personhood to the Klamath River in Oregon, USA.[300] Part of the Klamath River is already designated a Wild and Scenic River and listed in the World Database on Protected Areas under IUCN Management Category V. However, where rivers and wetlands have been given rights and legal standing but are not otherwise PCAs, the argument

is less clear. Rivers and wetlands accredited with personhood rights can be represented in court to appeal for their conservation, but ultimately the court decides whether to uphold the rights.[301]

It might be argued that granting a river or wetland legal rights establishes them as an OECM. A question for the recognition of rights of rivers and wetlands as OECMs is whether they are "*governed and managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity.*" Governance and management are still defined by the landowners and water rightsholders; the power of the guardians only extends as far as being able to take legal action in cases where the river's rights are seen to have been ignored.

5.5.2 Sacred and cultural species and areas

Inland water ecosystems and biodiversity hold many religious, spiritual and cultural values. This includes sacred pilgrimages and experiences, traditional customs and rituals found in various cultures around the world, particularly among Indigenous peoples.

For example, in New Zealand, *repo* (wetlands) are reservoirs of *mātauranga Māori* (Māori knowledge systems), especially important for the Māori tradition of *mahinga kai* (to work the food).[302] *Mahinga kai* is associated with the gathering of *kai* species, but also with the health of their ecosystems. It includes intergenerational practices and *tikanga* (customs) to protect, harvest and prepare the food and so plays an important role in knowledge transmission.[303] Pollution of Māori waterways has rendered many *kai* species toxic or diseased and colonisation and confiscation of land has made continuing the practice challenging. This has direct consequences for the *mana* of the Māori, their sense of pride and empowerment, and their capacity to contribute *manaakitanga* – caring for communities and environment.

More examples include the Papua New Guinean Sepik River Clans honouring their sacred crocodile through an annual festival;[304] the cultural identity of Amazonian people resting on several species of *Arapaima* (large freshwater fish) and *Podocnemis* (freshwater turtles);[305] and freshwater fishes that are culturally significant to many Indigenous peoples from all over the world.[306]

Inland water areas serve as sources of learning, inspiration, tourism and recreation.[307] Many communities have a deep emotional bond to these ecosystems and local people and religions are often responsible for their long-term conservation. Mai Pokhari sacred lake (and Ramsar site) (Case Study 15), in Nepal is believed to have been created when nine goddesses descended to Earth and inhabited the nine corners of the lake. Local Nepalese people protect it from activities that might create negative ecological impacts, believing these bring bad luck. It is one of innumerable sacred natural sites linked to inland waters, typically lakes, springs or rivers. Faith-based values can support conservation and many such sites are suitable as locally-managed nature reserves, maintaining both spiritual and ecological values. But inland waters can be culturally and aesthetically significant in ways that are not necessarily religious or traditional. In Croatia, the Krupa River (Case Study 16) was designated as protected for its cultural heritage by the Ministry of Culture after lobbying from local communities who felt connected to the river.

Fresh water occupies a place in many cultures for its elemental role in healing and transformation.[308] People travel long distances to access thermal waters and springs that are believed to have therapeutic properties. A good example of work focusing on promoting the physical, mental and spiritual health benefits of protected areas is the Healthy Parks Healthy People movement.[309]

Inland waters and particularly rivers also feature as important motifs in the major organised religions. For example, the Jordan River Valley basin is shared by three countries: Israel, Jordan and Palestine, and the river is considered holy by the faiths of the region.[310] The transboundary Jordan River Valley ecosystem restoration project, launched by the regional NGO EcoPeace with support from national governments and religious authorities, is an example of faith-based advocacy in promoting cooperation across political divides in the rehabilitation and preservation of a shared natural and spiritual heritage.[311]

The governance of cultural and spiritually conserved areas will often depend on the scale of values. For example, if the values are localised, such as Mai Pokhari, it is likely that the area will be managed and governed by local bodies such as a community-based organisation. A culturally important river stretching across a number of communities, such as the Krupa, might be managed and governed at the district or even national level.

5.5.3 Riverine-focused protections

Healthy and connected rivers provide a multitude of services and host a large proportion of freshwater biodiversity. Natural patterns of river flows shape aquatic and riparian habitats, provide cues for species migration and spawning, distribute sediments, nutrients and seeds and enable rivers, lakes, wetlands and estuaries to function properly.[312,313] The river channel along with riparian and floodplain zones provide key habitat and migration pathways for both aquatic and terrestrial animals across basins and landscapes.[314] Rivers, however, do not easily lend themselves to conventional protected area measures, given that their functionality and health is dependent on land use in the surrounding basin and instream activities up- and downstream from any particular river stretch.[315,316] Nevertheless, conceptual frameworks of how to provide basin and river reach protection[317] and a range of mechanisms to achieve river reach protection and beyond have been developed and implemented.[318] Three riverine-focused protection methods are featured here: fluvial reserves, wild and scenic river designations, and migratory swimways. Each of these mechanisms highlights foundational elements for effective river protection, including the explicit protection of the river and its riparian or floodplain area, as well as its connectivity and environmental flows. This includes the prohibition and/or regulation of development activities that would impact those attributes.

1. Fluvial reserves

One river-focused conservation area designation that has taken multiple forms across the world is the *fluvial reserve*. Fluvial reserves are based on the foundational concept of explicitly conserving the flow, connectivity and ecological integrity of designated rivers or river segments within geographically defined boundaries that include the river, full riverbed and a defined portion of the riparian area and/or floodplain.

In 2022, Argentina's Ministry of Environment and Climate Change of the province of Jujuy issued a Ministerial Resolution in the form of a declaration of interest towards legal recognition of the São Francisco River in Argentina, as a protected area. The river is the first in Argentina to be legally recognised under the national protected areas system as a *Paisaje Protegido Fluvial*, or fluvial protected landscape (Case study 17). The designation includes 130 km of river and more than 19,000 ha total area, including riparian corridors, under a category of protected area that includes co-management (public–private) between the Ministry of the Environment and private landowners.

The proposal was stewarded by the local NGO ProYungas, which played a critical role in providing information to support the declaration and working with vested parties including Indigenous communities to get feedback on and refine the proposal. ProYungas was supported by the secretariat of Indigenous peoples of the province, mayors of the riverside municipalities, private owners and the general public.

It is important to note that the implementing decree (Decree No. 2187-PMA-08) of Argentina's National Law 26331, defines riparian corridors as "**riparian forest and other environments directly affected by river dynamics (floods and channel migrations) and wet areas of the non-flooded forests**." It goes on to note that they, "*are important movement areas for medium and large mammals, serve as channel protection zones in the face of extraordinary flooding events and channel migration. In general, these environments are marginal to the productive system due to their flooding conditions…and have a high intrinsic conservation value due to the biodiversity they harbour*." The width of the riparian corridors is geographically defined, based on river size, with **a 500-m buffer for secondary rivers, and a 1,000-m buffer for primary tributaries** including the São Fransisco.

This case is a good example of a protected or conserved area with layered conservation designations, where a focused freshwater protection mechanism was added to a landscape with established areas designated and managed for native, high conservation value (HCV) forests. The riverine protected landscape was designated with the aim of "conserving the quality and use of the water, the hydrological functioning of the river and its biodiversity," and is aligned with IUCN Category V protected landscape or seascape, with conservation objectives that include protecting biotic and abiotic elements as a site of natural and environmental values, including the ecological, socio-cultural and community values.

Discussed in detail in Chapter 2 as a model for Indigenous and community co-created conservation areas, we mention the Nushiño-Curaray-Villano Fluvial Reserve (Community Fluvial Reserve) (Case Study 18), as an alternative type of designation to Argentina's national protected area model. Specifically, in 2016, the Ministry of Environment, Water and Ecological Transition created a category of "Conservation and Sustainable Management Areas" (ACUS),

which **allows decentralised autonomous governments, communities or private owners to create Areas of Conservation and Sustainable Use where the purpose is the conservation of biodiversity and sustainable development, while maintaining ecosystem services**. The Nushiño-Curaray-Villano Fluvial Reserve applied the ACUS category in the designation process. The Pastaza local government is creating an ordinance to include the Community Fluvial Reserve in local planning and territorial decision-making. The local government is a key partner that can provide support with technical and financial resources for implementation of the conservation, livelihoods and governance strategies. Management implementation is being led by the two Indigenous nations, while The Nature Conservancy is working with the communities to develop a participatory management plan, including a community-based monitoring system.

2. Wild and scenic rivers

Established in 1968, the US Wild and Scenic Rivers Act is one of the longest-standing area-based conservation designations focused on rivers. The Act (Public Law 90-542), recognising the gap in protections for rivers afforded by public lands laws at the time, declared a national policy to recognise, **"certain selected rivers of the Nation, which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."** To implement this policy, the Act instituted the National Wild and Scenic Rivers System recognising the gap in protections for



A section of the 644 km Snake River headwaters Wild & Scenic River area. © Matt Meisenheimer/TNC Photo Contest 2019

rivers afforded by public lands laws at the time (e.g. National Parks, National Forests, National Wildlife Refuges). This includes defining the Outstandingly Remarkable Values (ORVs) for which the area (defined by the river corridor) is designated (e.g. scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar river-related values), the terms of designation, eligibility criteria, methods by which new rivers can be added to the system, and responsible administrative bodies.

Rivers or segments of rivers designated under the National Wild and Scenic Rivers System can be classified as one of three categories (Public Law 90-542; 2(b)):

- **Wild River Areas:** those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with basins or shorelines essentially primitive and waters unpolluted.
- **Scenic River Areas:** those rivers or sections of rivers that are free of impoundments, with shorelines or basins still largely primitive and shorelines largely undeveloped but accessible in places by roads.
- **Recreational River Areas:** those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

The classification category is determined by a feasibility study and the level of development and accessibility within the river corridor at the time of designation. Once designated, each river in the National System must be managed to maintain the level of development at the time of designation in addition to protecting and enhancing its free-flowing condition, water quality and ORVs (collectively referred to as "river values").

In particular, the Act and National System are notable in the intention to create a national policy that balances the safeguarding of rivers for future generations with development of water infrastructure appropriate to meet food, water and energy needs. Desired conditions for river values, stewardship approaches and monitoring strategies for most wild and scenic rivers are identified in a river management plan developed in consultation with Tribal, State and local governments, and with civil society. A federal agency is responsible for administering each designation, though these are not limited to river areas flowing through federal lands. Governmental and non-governmental partnerships and other collaborative efforts are important components of managing each designation consistent with the Wild and Scenic Rivers Act.

Wild and Scenic Rivers Act: Conserving native fish and providing world class recreation across the basin in the Snake River headwaters: *Location: Wyoming, USA, encompassing parts of and connecting Yellowstone and Grand Teton National Parks and adjacent US National Forests.* Designation of the Snake River headwaters (Case Study 19) marked the first time the Wild and Scenic Rivers Act was used at the basin scale, designating sections of 13 streams and 644 km of river. This included refuge for native fish by protecting the mainstem river and primary tributaries through a combination of wild, scenic and recreational classifications.[319] The area supports abundant populations of two endemic, possible subspecies of trout, the Yellowstone cutthroat trout and the Snake River fine-spotted cutthroat trout. It includes a Comprehensive River Management Plan (2014) and is managed jointly by the US federal government (US Forest Service, US Fish and Wildlife Service and National Park Service), as well as state fish and wildlife agencies. Collectively, the agencies manage land and water use including recreational boating and fishing.

3. Migratory swimways

Building from the framework of conservation areas to support migratory flyways for birds is the emerging concept of migratory swimways for freshwater-dependent fish migrations (hereafter referred to as freshwater fish and including diadromous species that migrate between marine and freshwater systems).[320] Migrations of freshwater fish are distinctive in that they often have limited pathways. The lack of options to complete their life cycle means that they are particularly vulnerable to activities that block or fragment riverine connectivity. Examples of such activities include dams that fragment longitudinal connectivity, weirs or channelisation structures that disconnect floodplain habitats from the main channel (lateral connectivity), and large volumes of water abstraction that change the natural flow regime (temporal and vertical connectivity).[321]

The latest Living Planet Index for migratory freshwater fish reports that populations of this group of species have declined on average by 81 per cent since 1970, demonstrating how urgent the need is for conservation action.[322] There have been some efforts to protect rivers targeting the migration pathways or 'swimways' of freshwater migratory fish. For example, the Vjosa River in

Albania was declared Europe's first wild river national park in 2023 (Case Study 2).[323] Several fish species native to the Vjosa depend on river connectivity for short- and long-distance migrations to complete their life cycles, including the endangered European eel (*Anguilla anguilla*), European sea sturgeon (*Acipenser sturio*) and Adriatic sturgeon (*Acipenser naccarii*). The Vjosa River National Park is an IUCN Category II protected area and prohibits the building of dams and gravel mining, which would negatively affect the fish.

In some cases, concerted action is needed to first restore and then maintain particular swimways. For example, for areas with heavily developed rivers, like in the US and Europe, there is an ongoing movement towards dam removal, often targeting those dams blocking fish migration pathways.[324,325] These actions are often triggered by underlying national or regional laws protecting the species or fisheries and/or upholding related treaty rights. For example, the Estonian government established a condition in their national Water Act that protects historic migration corridors of salmon by requiring effective fish passage at all barriers. Several dams with ineffective fish passage impeded the migratory swimways on the Pärnu River (Case Study 21), the second largest river in Estonia. After a multi-year consultation process led by Estonia's Environment Agency, it was decided that the most cost-effective alternative was removal of the Sindi Dam as well as other smaller dams upstream. This gave migratory fish access to over 3,300 km of river, with salmon and other fish able to resume their natural migratory routes within the swimway.

Another exemplary case of restoring and protecting migratory swimways is the Penobscot River, USA (Case Study 22). A series of hydropower dams constructed in the 20th century led to the significant decline of culturally and economically important migratory fish populations. A coalition including the Penobscot Indian Nation, government agencies, NGOs and the power company agreed an approach to improve access to more than 3,200 km of riverine migratory habitat while maintaining power production by removing two mainstem dams and adding additional power capacity and a river bypass for fish passage to an upstream dam.[326] In an important precedent, the removal of the two lower dams was followed by designating the re-connected lower Penobscot river as 'free-flowing', under the state's Clean Water Act Designated Uses, in support of migratory habitat for Atlantic and shortnose sturgeon, Atlantic salmon and striped bass.

Once rare, the use of dam removal as a conservation tool to restore fish, fisheries and ways of life is growing, from Olympic National Park (Elwha River, US) to Kruger National Park (South Africa). After decades of negotiation, a series of dams on the Klamath River in the US is being dismantled in the world's largest dam removal project to date, to restore migratory runs of Klamath River salmon and steelhead trout to the Klamath River Tribes and recreational users. Restoration of water quality and riparian areas, as well as removal of other types of barriers (e.g. culverts and levees) are also often a needed intervention to restore habitats for migratory fish.

5.5.4 Groundwater-supported ecosystem protections

Subterranean biomes represent at least 19 per cent of the world's terrestrial surface,[327] and these include saturated alluvial soils and aquatic ecosystems such as subterranean springs and hypogenic cave systems with pools and underground rivers. These are poorly studied and protected compared to other inland waters but are essential sources of clean water for downstream ecosystems and for people.[328,329] About 95 per cent of the world's available liquid freshwater supply is groundwater, with over 25 per cent of the human population completely or partially dependent on it.[330]

While the biodiversity of subterranean springs and cave systems is generally not well described, they are known to usually have a large proportion of highly restricted, endemic species, living in small subterranean systems. Many of those species are highly specialised and unique from an evolutionary perspective.[331,332] Rate of discovery of new species in subterranean systems is relatively high; for instance, the rate of discovery of cave fishes between 1980 and 2005 quadrupled compared to the previous 60 years.[333]

Groundwater ecosystems represented by saturated alluvial soils may be rich in microfauna. The bacteria and invertebrates are critical for maintaining clean water. Water flows through gravel-bed river floodplains in mountain landscapes can extend hundreds of metres or several kilometres away from the river channel, maintaining critical ecosystem functions, supporting riparian plant communities, small crustaceans and large aquatic insects.[334,335] These alluvial groundwater systems are rarely considered in conservation planning, and further highlights that the boundaries of protection for inland water systems must also account for the extensive alluvial riparian areas that border the surface water itself.

Ignoring groundwater flow when planning for and managing protected areas can create serious problems.[336] Linke et al.[337] considered multiple groundwater systems (e.g. karst, fractured rock and alluvium), modelling the costs and benefits of integrating groundwater systems into conservation planning for rivers and wetlands in the Hunter Valley, NSW, Australia. They found that if groundwater protection is included at planning stage, then there is only a marginal increase in overall land needed and the efficiency of conservation is not compromised. By contrast, if groundwater is only included after riverine and wetland planning, then there is a loss of efficiency, sometimes almost doubling the conservation cost, and perhaps requiring a 30 per cent increase in the surface area needing protection. Huggins et al. (2023)[338] suggest several mechanisms that can increase groundwatershed protection, including source water protection, groundwater regulation, sustainable water policies, Indigenous-led land and water management and monitoring, and regenerative agriculture.

Groundwater-supported ecosystems are often highly threatened by human actions (e.g. pollution and water abstraction) and environmental fluctuations that affect water levels and temperature.[339] They are generally omitted from global policies for the protection and management of ecosystems and their biodiversity.[340] Overall, protected areas only encompass 52 per cent of their own groundwatersheds by area, and groundwatersheds may not be better protected in wealthier countries or in countries with greater protected area coverage. Particular areas with high human modification to unprotected groundwatersheds include the Midwest to east coast of the USA, Europe, Western Africa, Northern India, Pakistan and the east coast of Brazil.[341] These highlight the serious challenge of conserving protected area ecosystems above and below ground without consideration of groundwater flow.

Despite overall lack of adequate protection, there are some flagship examples of protection of groundwater-supported ecosystems. For example, in Santa Monica in the US, residents can bring legal actions to protect groundwater aquifers and native species within the boundaries of the city.[342] Among the most famous examples of a groundwater-driven protection is that of Devils Hole within Death Valley National Monument, also in the US. The entire wild population of the Critically Endangered Devils Hole pupfish, *Cyprinodon diabolis*, lives in a single, deep pool (Devils Hole) filling an underground limestone fissure at a desert site at Ash Meadows in Nevada, USA (Case Study 25).[343,344] A series of legal decisions, including the affirmation of



Endangered Florida manatee at the Three Sisters Spring wintering site in Crystal River, Florida. © Carol Grant/TNC Photo Contest 2009

federal groundwater rights associated with Devils Hole, addressed the threat of groundwater overuse in the area known as Ash Meadows, which was purchased by The Nature Conservancy and ultimately incorporated into Death Valley National Park. Today, public access to Devils Hole is not permitted, and the pupfish population is actively managed. In spring 2024 the numbers rose to an all-time high for the last 25 years, with 191 individuals.[345] Nevertheless, there remains a growing concern that a climate change induced increase in water temperature may be lethal for the eggs of the fish.

A similar example is the Critically Endangered golden cave catfish, *Clarias cavernicola*, with a global population of about 120 individuals and a known geographic range of less than 4 km^2, restricted to underground pools in the: Aigamas Cave system in Namibia.[346] The pools are threatened by water abstraction and pollution. The cave system is privately owned[347] and not part of a protected area but may qualify as an OECM.

5.5.5 Geographically-defined environmental flow protections

Around the world there have been concerted efforts to restore or maintain environmental flows (e-flows) – that is, the hydrological regime required to sustain freshwater and estuarine ecosystems and associated human livelihoods and well-being, often in response to current or planned alterations in the flow regime due to dam operation or water abstraction.[348,349] Environmental flows or 'water reserves' can also be allocated to protect human and environmental water needs prior to alterations to the flow regime.[350]

As an example, the environmental water reserve for the San Pedro Mezquital (Case Study 26) (decreed in Mexico in 2014) has contributed to efforts to prevent the Las Cruces hydropower dam from being built. Part of the argument is that the dam would affect flows designated in the Environmental Water Reserve, including those that feed mangroves downstream in the Marismas Nacionales Ramsar site and those required for livelihood resources for Indigenous peoples.[351,352] Mexico has shown leadership in putting in place water reserves before over-allocation occurred. Other nations are following suit, including Peru, Bolivia and most recently, Chile.

In Chile, the Patagonia Sin Represas Campaign set an important precedent for the rivers of Chilean Patagonia. Following a campaign to avoid new hydropower dams, in 2016, the hydroelectric company relinquished its water rights and abandoned several projects, including on the Puelo and Futaleufú Rivers. Once dam proposals were cancelled, parties were interested



A water flow reserve adds protection to the Puelo River in Chile (Case Study 27)
© Guy Wenborne

in securing the durability of the area and developing assurance of long-term river protection for these emblematic rivers.

Over the next few years, each community launched grassroot campaigns aimed at protecting their rivers using the Chilean Water Code, which was reformed in 2022 to include ecosystem preservation as a justification for water flow reserves. The campaigns to protect the Puelo (www.pueloreservadeagua.cl) and Futaleufú (www.porlasaguasdelfutaleufu.cl) Rivers have been community-driven and actively supported by respective mayors and regional authorities, receiving technical support from civil society and a wide range of NGOs and research centres.

In 2023, under the Chilean Water Code, the Ministry of Public Works and the National Water Authority signed two decrees Creating water flow reserves to preserve the Puelo and Futaleufú Rivers (Case Study 27) for the flora, fauna and community value of each of the rivers, including ecotourism. While parts of the rivers overlap with biosphere reserves, national reserves and other designations, **the decreed water flow reserves are the first in Chile explicitly to protect the quantity of water flowing for ecological and social purposes.** The decrees are under final revision by Chile's Comptroller General. At a national level, these efforts are being replicated through the national Protected Rivers Coalition (www.riosprotegidos.clwww.riosprotegidos.cl).

The cases in Mexico and Chile demonstrate examples of using water flow reserves as an effective legal mechanism for protecting geographically-defined inland water ecosystems from conversion by major water diversions or dams. Dams and major water diversions continue to be one of the dominant threats to rivers and freshwater biodiversity around the globe.[353,354]

5.5.6 Nature-based solutions for water and climate

Nature-based solutions are defined as "*actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits.*"[355] Here we discuss the use of area-based protections to address societal challenges at the intersection of inland water ecosystems and water supply provisioning, climate mitigation and climate adaptation.

Source water protection areas. Source water protection areas are established principally to provide reliable supplies of clean water (surface or ground) for human consumption and use. Multiple co-benefits, including biodiversity conservation as well as climate change adaptation and mitigation, can be generated.[356] Source water protection can encompass a suite of nature-based solutions, such as land and wetland protection, restoration, and/or best management practices. The establishment and long-term maintenance of source water protection areas is often financed by payments for ecosystem services schemes. Designated source water protection areas can be part of national protected area networks and managed intentionally to produce inland water biodiversity benefits alongside water security. An example includes Ecuador's newly established Water Protection Areas (Case Study 29), made possible by the country's 2008 constitution and its 2014 water law. Specifically, Article 64 of the Organic Law on Water Resources, Uses and Exploitation establishes that nature has the right to conservation of water and its properties, ensuring the protection of water sources, maintenance of ecological flow, preservation of the hydrological cycle, protection of watershed and ecosystems, as well as the restoration of ecosystems affected by pollution and soil erosion. Additionally, Article 65 of the same law stipulates that water resources must be managed in an integrated and comprehensive manner, with an ecosystem-based approach that ensures biodiversity, sustainability and preservation by the regulations of the law. In 2022 and 2023, five water protection areas, encompassing 2,300 km of rivers and 2,800 ha of wetlands, were established with the primary aim of protecting essential water sources for almost 174,000 people and supporting the sustainable development of local communities. These water protection areas will be incorporated into Ecuador's system of national protected areas.

Climate change mitigation. As the reality of climate change impacts become ever more visible, there is strong evidence and rising interest in using ecosystem management and nature-based solutions to mitigate and adapt to a changing climate; actions are often referred to as *natural climate solutions* (or NCS) when they relate specifically to mitigation. ***Climate change mitigation*** is defined as avoiding and reducing emissions of heat-trapping greenhouse gases into the atmosphere to prevent the planet from extreme warming.[357] Inland water bodies can function as carbon 'sinks' for dissolved and particulate organic and inorganic carbon.[358,359] They also play a critical role in the global carbon cycle, controlling long-term sequestration of atmospheric CO_2 and transporting inorganic carbon from the land to coastal and marine carbon sinks.[360]



Montpelier, Vermont during 2023 flood. (Case Study 31) © Jack Markoski/TNC

Research shows that NCS can deliver over one-third of the cost-effective climate mitigation needed between now and 2030 to hold the global average temperature to below 2°C.[361] Protection NCS (avoided conversion of natural ecosystems such as peatlands) are considered first in the 'NCS hierarchy' as they offer a high per-hectare mitigation potential over a short time horizon and at a comparatively low per unit cost, typically with many co-benefits.[362]

Mitigation NCS strategies often focus on wetlands conservation and especially peatlands. Healthy peatlands form immense carbon stores, but once drained and degraded they are significant sources of greenhouse gases, including through increased fire risk. Maintaining carbon stores is a critical reason to prevent peatlands' conversion. Restoration through the rewetting of drained peatlands and wetlands is identified as a major priority by the Intergovernmental Panel on Climate Change[363] and is underway in many countries. As an example, the 309,000 ha Mawas peatlands project in Central Kalimantan (Case Study 34), is being managed through the Borneo Orangutan Survival Foundation's Mawas Conservation Program to restore environmental flows and native vegetation to an area previously drained and cultivated as a rice paddy. This project is registered under REDD+ and is expected to prevent the emissions of over 125 million tCO_2 equivalent over its 20-year term. The area is not designated as a protected area but could be assessed for recognition as an OECM.

Climate change adaptation. Simply put, climate change manifests as water change. Climate change has and will continue to increase the incidence and severity of flooding and droughts. Solutions to adapt to these changes can also be found in the conservation of inland water ecosystems. Ecosystem-based adaptation strategies and nature-based solutions can include measures to reduce flood risk, such as conserving and restoring functioning floodplains and river courses. These solutions have benefits for biodiversity and a range of other ecosystem services. In theory, many such sites would be suitable as either protected areas or, probably more likely, OECMs. Conversely, some adaptation strategies could further damage inland water systems if poorly planned or implemented, such as building artificial water storage (affecting instream water quantity), constructing higher levees (disconnecting rivers from their floodplains) or undertaking large-scale reforestation (reducing downstream water availability).[364]

In the US, following devastating flooding in 2023, the state of Vermont passed the Flood Safety Act (Act 121) (Case Study 31). This takes a basin approach to mitigating flood-related impacts and grants state agencies jurisdiction to meet the intent of the Act. It has been demonstrated

that 80 per cent of flood-related damages in the state occur within the riparian corridor meandering area. The Act's provisions include limiting future development in an estimated 5,500 miles of river corridors (accounting for roughly 67,000 hectares) to reduce flood impacts and costs for residents. The Act established a 2:1 wetland net-gain policy to reverse historic wetland loss, meaning that for each hectare of wetlands impacted in the future, two must be restored and conserved in the same basin to offset the loss.

5.5.7 Community fisheries reserves for rivers, lakes and wetlands

Inland fisheries supply significant benefits to individuals, society and the environment.[365] They provide food security, economic security and empowerment and are the primary source of protein for a billion people worldwide.[366] Inland fisheries also provide cultural and recreational services, human health, well-being and knowledge. It is estimated that recreational fisheries have a combined value of more than US$ 100 billion.

Inland fisheries face threats such as overfishing, illegal or harmful fishing gear, pollution and dams. Community-based inland fishery reserves, a form of area-based conservation, can maintain or increase fish populations that people rely on. A recent literature review of the impacts of community-based inland fishery reserves showed that the majority had positive impacts on the fishery.[367] A few examples with evidence of increased fish populations or size of fish include community-established fish conservation zones in Laos, the Sikunga Fisheries Reserve in Namibia, and fish reserves along the Salween River in Thailand.[368] In the case of the Salween, 23 communities in Thailand along the (Case Study 35) Salween River established voluntary fish reserves to improve and conserve fisheries that thousands of people depend on. Based on the data collected from these fishery reserves, markedly increased fish richness, density and biomass was documented relative to adjacent areas and three indicators predicted increased fish diversity – reserve size, enforcement and connectivity.[369] Another emerging example of a community fisheries reserve on Lake Tanganyika is summarised in detail in Field Study 5.

5.5.8 Transboundary inland water mechanisms

Many transboundary basins are already covered by agreements. Additionally, two global treaties outline principles, rules and procedures governing the cooperative use, management and protection of transboundary basins. The UN Convention on the Law of the Non-Navigational Uses of International Watercourses (UNWC) entered into force in August 2014, and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) entered into force in 1996, initially for members of the UN Economic Commission for Europe but later opened for global accession. These conventions inform interstate arrangements for the designation and effective management of PCAs in transboundary basins. The UNWC codifies a *general obligation to cooperate* on protection of an international watercourse. Parties to the Water Convention must "*take all appropriate measures … to ensure conservation and, where necessary, restoration of ecosystems*" (Art.2(1)(d)).

Both Conventions require states to take appropriate measures to prevent transboundary impact when utilising a watercourse and to address transboundary pollution, with requirements for information exchange. The UNWC contains provisions dealing with water management and regulation; invasive alien species; freshwater-coastal-marine linkages; and harmful conditions and emergencies. The Water Convention governs joint monitoring and assessment, research, warning and alarm systems and mutual assistance, and public access to information. Both contain provisions balancing development and conservation. This could lead, in a specific case, to a requirement for a state to assess and maintain environmental flows.[370,371] This requirement would be even stronger if the aquatic ecosystem in question were located within a PCA.

Environmental cooperation

In order for support between co-riparian states to flourish, ways of mutually beneficial cooperation are needed, rather than harm prevention on a case-by-case and often confrontational basis. There are now conceptual and methodological frameworks to facilitate the equitable allocation of not only the water itself, but also of the resulting benefits, including environmental benefits. Interstate cooperation may take the form of payments for ecosystem services (PES) in a transboundary context. If a country decides to relinquish its right to build a dam, for instance, to safeguard a protected river, other states could allocate the costs necessary for compensation.[372]

Field study 5
Community-managed fisheries reserves
Lake Tanganyika

Lake Tanganyika - one of the African Great Lakes - is one of the largest lakes in the world by volume (17 per cent of world's surface freshwater) and depth (1.47 km). The lake spans four countries, primarily bordered by Tanzania and the Democratic Republic of Congo, with a smaller shoreline in Zambia and Burundi. It is a globally significant area for biodiversity, hosting hundreds of endemic species, nearly 250 of which are endemic cichlid fish. The health of Lake Tanganyika is critically tied to the health of the communities that surround it. For example, riparian and shallow water areas on Lake Tanganyika and its tributaries harbour important medicinal plants. In addition, hundreds of thousands of people depend on the lake for water, transportation, cultural rituals, and as a source of food. The fish from the lake provide more than 40 per cent of the total animal protein consumed by lakeside communities, and fisheries are one of the top two sources of income for communities living adjacent to the lake.

Growing populations, lack of sustainable alternative livelihoods, unsustainable fishing practices, pollution and sedimentation have pushed Lake Tanganyika to the brink. Climate change compounds these challenges by warming waters which have reduced ecosystem productivity. This consequently results in decreased fish yields, diminished fisheries and freshwater biodiversity, and heightened economic vulnerability for local communities. Further, illegal, unreported, and unregulated fishing practices, such as use of fine mesh (e.g. mosquito nets), continue to devastate fish populations and degrade important habitats.

Riparian countries and the transboundary Lake Tanganyika Authority have begun to rise to these challenges. For example, Tanzania's 2003 Fisheries Act (Section 18) and implementing regulations that went into effect in 2009, empower the government to designate and gazette areas identified as critical habitats (e.g., fish breeding areas, nesting, resting habitats and swimways/pathways) and define area-based management regimes including prohibitions or restricted uses (e.g. seasonal closures, equipment restrictions). In addition, the Act and associated policy empower communities to establish Beach Management Units (BMUs).

BMUs are community-led institutions with jurisdiction over defined areas and provide a mechanism for community-led protection and management of fisheries and aquatic biodiversity conservation. For more than a decade, communities in Tanzania, with the support of The Nature Conservancy, government, and other and partners, have formed BMUs to develop fisheries management plans, collect and report on catch data, engage in monitoring, and develop by-laws to guide use of the fishery. Management plans informed and adopted by BMUs generally delimit zones where fishing activities are controlled, as well as protected fish breeding grounds that are off-limits to extractive activities.

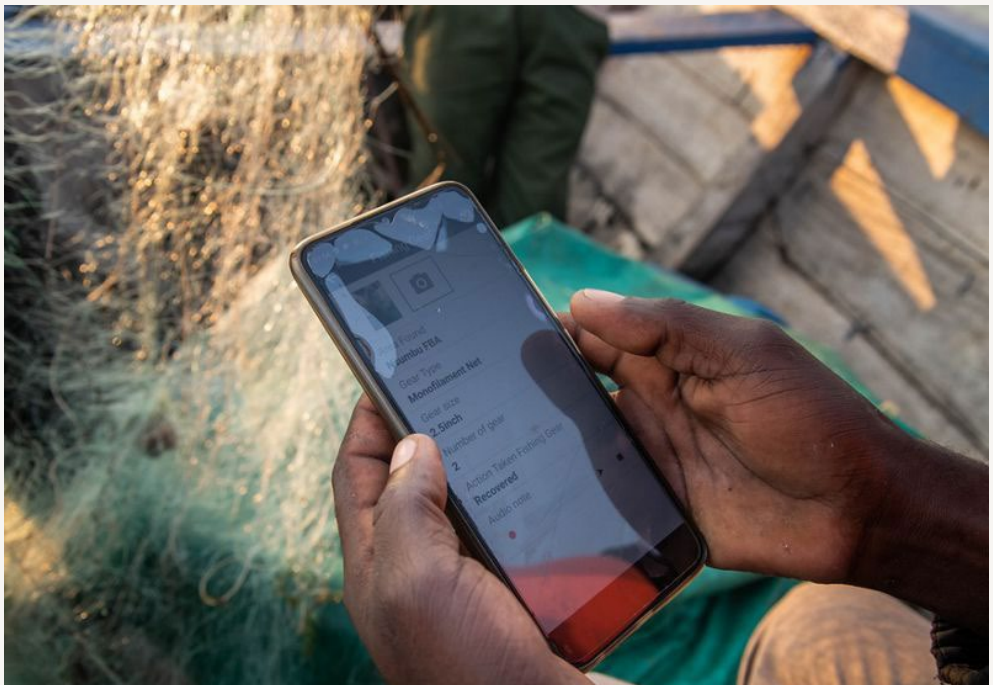
To date, 42 BMUs have been established across 85 coastal villages in Tanzania, covering 670 hectares under community-led protection. The establishment of BMUs has been facilitated



Tatu Habibu lays dagaa, a kind of sardine popular in the Lake Tanganyika region, on drying racks owned by the Buhingu Beach Management Unit (BMU) on the shores of Lake Tanganyika, Tanzania. © Ami Vitale

through involvement with the local government from the beginning, persistently raising awareness, and developing a programme based on support from the Fisheries Act and its regulations. Moving forward, building and keeping capacity remains an issue, due to new leadership being elected every 3 years. In addition, to maintain their long-term establishment, sustainable funding (building from current local and international funding), must be identified for the BMUs. Zambia and the Democratic Republic of Congo are similarly empowering community co-management through area-based conservation governed by Fisheries Managment Committees and Beach Management Committees, respectively. Across all countries, this area-based approach is still relatively early in implementation and metrics for effectiveness are still being collected. Data will be used to inform whether and how management techniques can be adapted to lead to healthier fisheries and improved biodiversity outcomes.





Above: Fishermen returning to shore with their catch to sell to the local market in the village of Katumbi on Lake Tanganyika in Tanzania. © Ami Vitale

Left: A Spatial Monitoring and Reporting Tool (SMART) app is used by a Fisheries Management Committee to monitor and record data on illegal fishing practices in the Zambian portion of Lake Tanganyika. © Roshni Lodhia

Transboundary cooperation and human rights

One of the Framework Principles on Human Rights and the Environment deals with interstate cooperation on transboundary or global spillovers that threaten human rights. Well-designed and implemented treaties provide a useful tool. A focus on expanding inland water conservation presents opportunities to reshape transboundary basin agreements to advance environmental protection and human rights goals within PCAs, with a special focus on border communities and their shared waters and biodiversity. The UNWC determines that, if conflict between water uses occurs, special regard be given to *vital human needs*. The Water Convention aims to protect human health and well-being, including through control of pollution.

International law considers cross-border cooperation between IP&LCs. Under Article 32 of the International Labour Organisation Convention, governments are required to "*facilitate contacts and cooperation between indigenous and tribal peoples across borders, including activities in the economic, social, cultural, spiritual, and environmental fields.*" The UNDRIP affirms the right of Indigenous peoples divided by international borders to maintain and develop contacts, relations and cooperation. Transboundary protected areas, through the concept of Peace Parks, have long been forerunners in promoting such contacts.

Historically, riparian states have entered into numerous joint schemes to allocate benefits accruing from hydropower and other river development measures. However, transboundary water management deals targeting environmental benefits remain scarce.[373] The international community can promote and facilitate cooperation between co-riparian states on the designation and management of PCAs. The two global water Conventions are binding among parties and may guide other states in their relevant interactions.

5.6 Governance

Governance, in this context, refers to who is in charge of, or able to influence the management of, a particular area of land and water. A more formal definition is: "*The interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken and how citizens or other stakeholders have their say.*"[374] Governance is a critical element of management and one in which there are sharply divergent and sometimes polarised positions about the value of different approaches. The IUCN World Commission on Protected Areas has identified several governance decisions that are critical to protected areas:

- Agreeing that a territory or marine area will be designated as a protected area and clarifying its boundaries and extent.
- Drawing up and agreeing on a long-term goal (vision) for the area, the main management objective(s) – and thus the IUCN management category – and how these relate to local livelihoods and development.
- Setting up a zoning system for the area if this is needed, possibly including different governance and management rules in different parts of the area.
- Developing a management plan and/or rules, deciding who will carry these out and ensuring that there are enough human and financial resources to achieve the plan and enforce rules.
- Establishing how to monitor, evaluate and adjust the management plan and implementation process in light of results (adaptive management).
- Establishing how the rule of law and broader global legislation, including human rights, are to be respected and enforced in and around the protected area.[375]

Most protected areas around the world are on state-owned land and are managed by the state, but this situation is changing. IUCN and the CBD recognise four different governance 'types', each of which has several subdivisions, illustrated in Table 5.3.

Table 5.3. Governance types in protected areas[376]

Type	Name	Description
A	Governance by government	Federal or national ministry/agency in charge Sub-national ministry/agency in charge Government-delegated management (e.g. to NGO)
B	Shared governance	Collaborative management (various degrees of influence) Joint management (pluralist management board) Transboundary management (various levels over frontiers)
C	Private governance	By individual owner By non-profit organisations (NGOs, universities, cooperatives) By for-profit organisations (individuals or corporate)
D	Governance by Indigenous peoples and local communities	Indigenous peoples' conserved areas and territories Community conserved areas – declared and run by local communities

A wide variety of actors can be involved. State management includes national and local governments; additionally, some governments contract management out to NGOs. Privately protected areas are managed by individuals, non-profit trusts, religious bodies, co-operatives and companies. Of increasing importance is governance by Indigenous peoples and local communities, where a collective decision is made to prioritise nature conservation on land and water under communal control. And finally, but importantly, there are various forms of shared governance, ranging from collaborative management, where different groups have varying influence on decisions, to truly joint management with a pluralist management board. Shared governance includes transboundary management between states, particularly important in the case of large water bodies. Examples of governance for inland water protected areas include:

- **Lake Malawi National Park**, in Malawi, covers part of the vast lake and protects many unique fish species; it is managed by the government protected area agency.
- **Ynys-hir Nature Reserve**, in the Dyfi Valley, Wales, is an area of saltmarsh, wetland and woods and is owned and managed by the Royal Society for the Protection of Birds, a charity.
- The **Transboundary Biosphere Reserve of the Senegal River** covers a large area of wetland and coast in West Africa, with a core zone including Djoudj National Bird Sanctuary in Senegal, Diawling National Park in Mauritania and four other protected areas.[377] An approach for joint governance and management is an ongoing challenge that is actively being addressed through a Global Environment Facility (GEF) project.
- A number of **sacred lakes** in the Himalayan region of Nepal are managed by communities as sacred natural sites, both for religious purposes and to protect the ecosystems.[378]
- **Gayini wetlands**, in Australia, under the ownership and stewardship of its Traditional Custodians (see Field Study 6).

All these types of governance are possible within OECMs as well; military training grounds managed by the state, communally-managed fishing grounds and multiple ownership of extensive wetlands might all, in some circumstances, qualify as OECMs.

Governance is seldom straightforward and may change over time. If local people feel alienated from the process of managing a state or privately protected area, they can and often do take matters into their own hands and intervene in ways not laid out in the management plan; governance in practice (*de facto*) may be very different from governance under the law (*de jure*). Recognition of this means that many protected areas are changing their governance approaches, bringing more people into discussions about management and/or directly into the decision-making process. At the other end of the spectrum, locally managed or Indigenous-managed reserves that have worked well for a long time can see a collapse of management as generations change or different people assume influence within the group.

Governance is therefore both important and inherently fragile; long-term success depends on careful monitoring and the willingness to take action if things start to go wrong. It is becoming increasingly clear that getting the governance system right is often the most critical element in managing a protected area or an OECM.

Field study 6
Returning legal rights to First Nations, Gayini, Australia

The Lowbidgee has been home to more than 40 First Nations over tens of thousands of years and is the largest remaining area of wetlands in the Murrumbidgee Valley.

Since the late 1800s, surface water extraction and periods of drought have significantly impacted the area. In 2011–2012, the Gayini Nimmie-Caira water-recovery project was initiated when the New South Wales government purchased 84,417 ha of wetlands and their associated water rights over 19 properties across the Lowbidgee floodplain, later transferring the water rights to a government-owned watering agency and then first leasing and later transferring (returning) title to the Nari Nari Tribal Council (NNTC).

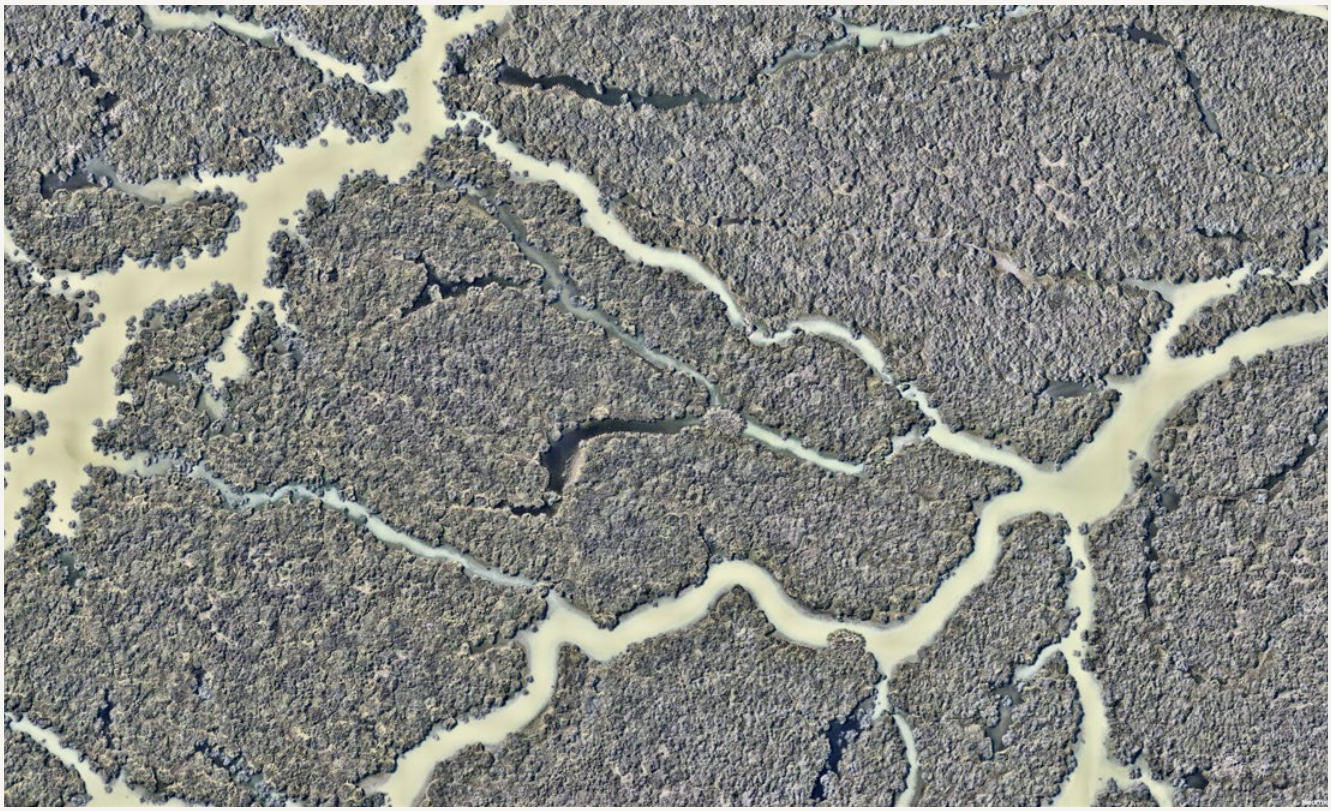
A consortium of First Nations, environmental non-governmental organisations, and scientific organisations successfully tendered for the long-term management of the 88,000 ha property. In February 2023, the NNTC and the New South Wales Biodiversity Conservation Trust signed an historic agreement, securing the permanent protection and sustainable management of more than 55,000 ha of the Gayini wetlands, under the ownership and stewardship of its Traditional Custodians, to protect the biodiversity and cultural values of the property. Today, after 150 years of dispossession, the Nari Nari people legally own Gayini, as they have spiritually for more than 50,000 years.

The NNTC now manages these lands and waters, leading and receiving support from a number of consortium partners, including the University of New South Wales, The Nature Conservancy and the Murray Darling Wetlands Working Group. A number of protection mechanisms are in place, including a Land and Water Management Plan, easements for water flow, and a conservation covenant. Gayini is the Nari Nari word for water, and their primary aim is to restore the water table and enhance delivery of water to culturally significant and ecologically valuable areas in the Lowbidgee under an environmental water plan.

Gayini is now one of the largest wetland restoration projects in Australia and is leading the way for Australia's First Nations' land and water management, featuring a mix of environmental and Indigenous conservation and sustainable farming. This has already begun to pay off with improved water quality and an increased number of breeding waterbird colonies.



Nari Nari Elders Mabel Fitzpatrick (left) and Kerrie Parker, at Gayini © Annette Ruzicka.
We acknowledge the Nari Nari people, the Traditional Custodians of the lands and waters at Gayini, and pay our respects to their Elders past, present and emerging. We celebrate the stories, culture and traditions of Aboriginal and Torres Strait Islander peoples and recognise their continuing cultural connection and importance in caring for Country.



Through a partnership with Nearmap, high resolution aerial imagery combined with advanced AI-detection technology are being used to monitor environmental flow releases moving through Gayini. © Nearmap US., LLC; EPSG 3857, September 27, 2024, Lat34.544966/Lon144.201733, Mpp0.149

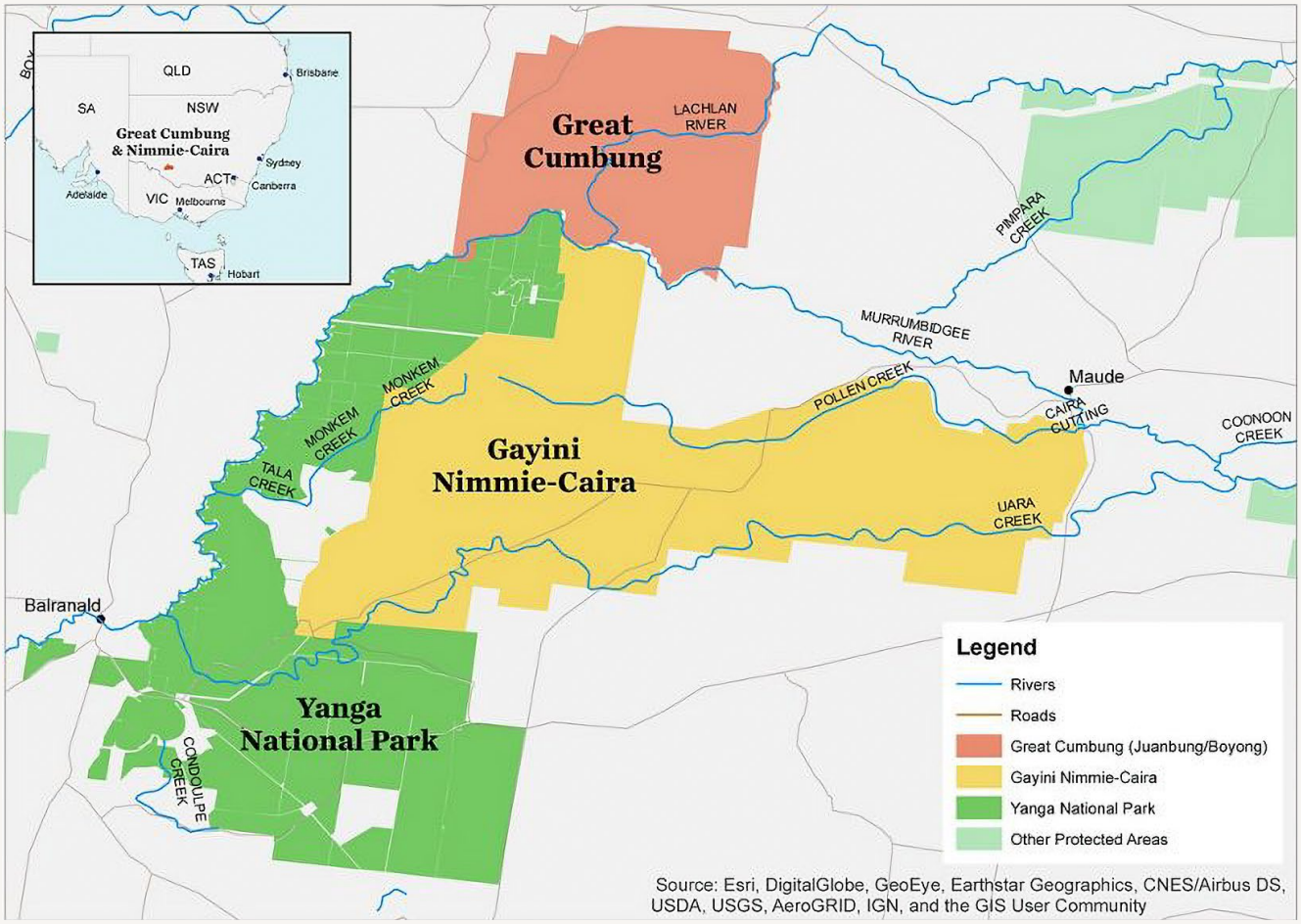


Figure 5.2. Map of Gayini (formerly Nimmie-Caira) and the Great Cumbung in relation to Yanga National Park

5.6.1 Privately protected inland waters

Privately protected areas (PPAs) are defined as being under private governance, that is, by individuals and groups of individuals; non-governmental organisations (NGOs); corporations – both existing commercial companies and sometimes companies set up by groups of private owners; for-profit owners; research entities (e.g. universities, field stations); or religious entities.[379] PPAs are often owned but also sometimes leased by the managing body. Most, but not all, PPAs are open to the public and may charge a visiting fee. Companies managing PPAs include those that do so as part of an ecotourism operation, but also private companies with holdings that include areas set aside for conservation because they are rich in biodiversity or simply not needed for commercial operations. Although there are exceptions, PPAs tend to be fairly small; the average size of privately protected areas reported to the World Database on Protected Areas is 10.26 km^2.[380]

An important subset of PPAs is those created by covenants, where owners agree to set aside land and water from development in perpetuity whilst still retaining ownership. Covenants are often linked to financial incentives such as tax breaks or access to carbon trading schemes. For example, in New Zealand, landholders with covenants on their land can in some basins benefit from nutrient-trading schemes to protect water quality of lakes and rivers.[381]

In the inland water realm, the most common PPAs are probably small and discrete wetland areas, such as pools, small lakes, mires or peatlands, often protected primarily for their bird life. As such, they can face problems from genetic isolation and impacts from surrounding land use, such as eutrophication due to fertiliser seepage in agricultural areas. But PPAs also provide habitat for aquatic species in areas where wetlands have otherwise declined and where they can serve as stepping stones for migratory waterfowl.

In parts of the world where there has been extensive drainage of natural wetlands, a proportion of inland water PPAs are the result of human activities, such as abandoned gravel pits and other quarries, peat cutting, and old reservoirs. Restoration can be an important part of their mandate. PPAs that include floodplain restoration can also play an important role in downstream flood mitigation. Entire rivers are less often PPAs due to their length and likelihood of multiple ownership. Those managed for sport fishing can, however, often have high ecological values, particularly if only native species are fished, and may be suitable as OECMs.

PPAs are currently most common in western Europe, North America, Australia and New Zealand, but are emerging everywhere, often linked to ecotourism. For example, there are several wetland PPAs in China, South Korea, Chile, Brazil and South Africa. [382] An important part of planning for inland water conservation is to ensure that scattered private initiatives are integrated with state or community conservation exercises to multiply the net benefits.

5.6.2 ICCAs and IPAs

Over the past twenty years, there has been increasing recognition of the role of both Indigenous peoples and other local community groups in managing land and water to benefit conservation.[383] This includes both traditional management, sometimes centuries old, and emerging initiatives. Such sites became known collectively as Indigenous and Community Conserved Areas or ICCAs. Today the ICCA Consortium, a global NGO that represents many such groups, keeps the term ICCA but uses it as an abbreviation for "*territories and areas conserved by Indigenous peoples and local communities*" or simply "*territories of life.*"[384]

ICCAs have been defined as: "*natural and/or modified ecosystems, containing significant biodiversity values, ecological benefits and cultural values, voluntarily conserved by Indigenous peoples and local communities, both sedentary and mobile, through customary laws or other effective means.*"[385] The ICCA Consortium today prefers to define ICCAs by three main characteristics:[386]

- There is a close and deep connection between a territory or area and an Indigenous people or local community, generally embedded in history, social and cultural identity, spirituality and/or people's reliance on the territory for their material and non-material well-being.
- The custodian people or community makes and enforces decisions and rules (e.g. access and use) about the territory, area or species' habitat through a functioning governance institution.
- The governance decisions and management efforts of the concerned people or community contribute to the conservation of nature (ecosystems, habitats, species, natural resources), as well as to community well-being.

Defined ICCAs fulfil all three characteristics; *disrupted ICCAs* are places that are known to have fulfilled these characteristics in the past but fail to meet one or more today due to reversible factors; and *desired ICCAs* are "under development" and have the potential and community willingness to fulfil the three factors in the future. ICCAs, like OECMs, are defined partly by their effectiveness in conserving biodiversity; in theory, if they cease to protect biodiversity effectively, they cease to be ICCAs.

In part because they include both Indigenous territories and other types of local community, ICCAs vary enormously in size, type and function. Many are protected areas, others are potential or in a few cases already recognised OECMs, and some are neither.[387] Similarly, many ICCAs are under traditional governance arrangements and not formally recognised by governments. The fact that with the right conditions and incentives local and Indigenous peoples' communities can and do protect ecosystems is more important than the label applied.

Names and classifications remain under debate. Some Indigenous peoples' groups are reluctant to have their areas treated together with those of other communities, and there is an IUCN World Conservation Congress resolution to investigate having a separate category for Indigenous Protected Areas. There are also complications in the ways governments define and recognise Indigenous peoples; groups that in one country would be recognised as Indigenous may not have the same recognition over a national border.

Notwithstanding, some countries have already developed legally recognised Indigenous Protected Areas (IPAs), most notably in Australia where over 80 self-declared IPAs now cover 87 million hectares. Here the IPA Program has been supporting First Nations communities to voluntarily dedicate and manage their land as protected areas since 1997. In addition to environmental and cultural heritage protection, IPA participants report benefits of empowerment, cultural connection and well-being. IPAs now make up over 50 per cent of Australia's National Reserve System.[388] Most are managed under IUCN categories V and VI and a number contain important wetlands.[389,390]

Indigenous peoples and other communities protect wetlands as sacred natural sites, to maintain important ecosystem functions like fish spawning or fish migration pathways,[391] to protect sustainable artisanal fisheries,[392] and for cultural reasons. Development of Indigenous led and controlled ecotourism activities is also a growing phenomenon, sometimes located adjacent to existing protected areas but with more freedom to bring people into the territory through, for instance, river and lake trips and cultural tourism.

Local communities also protect wetlands, ranging from village ponds to larger areas; in countries where commons still exist these often provide an obvious vehicle for community protection.[393] Many of these sites are quite similar to PPAs, described earlier, but here management is by a collective rather than an individual, company or organised group. Community approaches have proved effective in many situations, although this is not inevitably the case.[394] Groups often need resources, sometimes training and support in withstanding outside pressures on their inland water resources, along with internal measures to organise and resolve disputes.[395]

Chapter 6

Managing for inland water ecosystem integrity in protected and conserved areas



Giant salamanders (*Cryptobranchidae*) native to China, Japan and the eastern US, include some of the earth's largest amphibians, with some species growing to more than 1 meter in length. They are fully aquatic, using their wavy skin to breathe and therefore require freshwater habitats with good water quality. © David Herasimtschuk / Freshwaters Illustrated

Key messages:

- Upgrading the management plans of existing protected and conserved areas to include inland water objectives can make a meaningful difference, especially if current management activities are inconsistent with inland water conservation.
- The stakeholder groups involved in developing management plans should include users of the inland water resources as well as those whose operations or actions outside the area could affect the health of inland waters inside the PCA.
- Key ecological attributes should guide the development of a monitoring plan, and specifically its outcome indicators.
- A number of tools exist for assessing site-level management effectiveness. The R-METT has been developed for use in Ramsar sites, and some others have been applied to a limited extent to inland waters.

Many if not most of the world's 'terrestrial' PCAs contain inland water ecosystems, yet the existence of inland water management objectives for those PCAs is far less common. Inland water values are often overlooked, resource constraints might be a concern, or managers may simply lack the knowledge to manage the systems.[396,397]

The same management activities that might be prescribed within those PCAs dedicated to inland water conservation – for instance, inland Ramsar sites and PCAs designated to conserve lakes or wetlands – can be tailored to existing and new PCAs that have a terrestrial orientation. Integrating inland water values more fully into PCA management plans and implementation can provide measurable benefits to freshwater biodiversity and often provide additional support to terrestrial and/or marine life as well. Even minor adjustments can pay dividends.[398]

At the other extreme, management actions can unintentionally damage inland water biodiversity, such as through the introduction of non-native fish for recreational angling, releasing pollution from tourist infrastructure or road maintenance, allowing excessive water removal for tourist accommodation, creating artificial water bodies for wildlife viewing, or permitting boating or water sports at harmful levels. Conversely, even a limited consideration of inland water issues can result in major conservation gains through securing vulnerable fish species, waterbirds or flora.

The following section looks at how to include inland waters in PCA management planning and then gives an annotated checklist of issues to be considered. It draws on concepts of *durable freshwater protection* and use of freshwater *KEAs* – **hydrologic regime, connectivity, water quality, habitat** and **biotic composition**, see earlier chapters for further details.

6.1 Updating and developing management plans

All protected areas should have management plans, and the managers of some OECMs will require or want plans as well. In the following sections we focus on PAs although the advice can apply to OECMs.

Before starting or revising a management plan it is important to ensure that inland water considerations are included in: (i) goals, objectives and targets, (ii) analysis of threats or pressures, and (iii) allocation of technical and financial resources. This is particularly important in sites containing a large proportion of a basin, or rare or endemic aquatic species.[399] Additionally, three broad issues need to be addressed:

What is the plan for?
Every protected area should have a plan but the length, aim and content of plans vary depending on circumstances such as the size of the area, its governance structure, the pressures facing the site, and resources available for management plan implementation. There is little point in developing a grandiose plan if there are no resources for implementation. A small, voluntary community reserve needs a different plan from a larger protected area managed by a government department, or from a sacred site on the land of Indigenous

peoples. In all cases, it is important that management plans for PCAs are harmonised with any other plans relating to water management within the broader basin. Some questions to consider before developing a plan are:

- Is this a broad, conceptual plan for a new protected area, or a revision and updating of an existing plan?
- How much detail is needed?
- What resources are available for putting a plan in place?
- What resources are available for implementing the management plan?

Who should be involved?
The plan will need a team of people, possibly with outside specialists, such as experts in inland water species, wetland conservation and water management. Often, ministries or agencies responsible for protected area designation and management are separate from those responsible for managing water, fisheries and aquatic biodiversity. While cross-agency coordination takes time, it can lead to more efficient implementation. For example, in Mongolia the National Protected Area Agency is working with the Water Agency responsible for River Basin Management to design an MOU with the shared goal of leveraging capacity and funding for management plan development, implementation and monitoring in and around protected areas. Building from this example, in developing the plan consider, specific to inland waters, the roles of government agencies responsible for water infrastructure and permitting, water allocation, Ramsar site management and fisheries.

Further, plans drawn up in isolation from concerned stakeholders are likely to cause resentment, particularly if they affect traditional rights of access and use. But involvement takes time and energy and not everyone can or will want to be involved. A voluntary planning process can result in domination by people with time to spare, which often leaves out those who don't have the time or capacity to participate (e.g. poorer people or those with demanding jobs). Working out who should be involved, and how, needs to be done carefully and early in the process. Non-governmental communities that may be particularly important to consider from an inland water perspective include:

- Indigenous communities (see Chapter 3)
- fishing communities
- inland water-based resource users, such as reed collectors
- community members (often women) who rely directly on the system for drinking water collection, washing or other domestic uses
- river or lake-based tourism operators
- river-, wetland- or lake-based recreationists (e.g. kayakers, birdwatchers, fishers, hunters)
- agricultural sector or farmers operating near or upstream of the protected area, especially if their practices generate downstream water quality or quantity impacts
- scientists or academic/research institutions with knowledge of the inland water ecosystems
- water companies and other commercial water users.

What form should the plan take?
Should it be a printed plan, or an electronic document that can be widely shared? Or just a verbal community agreement? Formal agreements about things like number and size of fish caught and types of fishing tackle should be recorded in the way that is likely to be most understandable by community members. Is this a permanent plan that will last the whole planning period (often 5–10 years for management plans) or a living document that can be adapted if new needs become apparent? Protected area managers are often now turning away from rigid, unchanging plans that go out of date, but at the same time plans should not be changed casually, particularly if many stakeholders have worked together to reach consensus. Once these basic decisions have been made, most detailed management plans contain a range of elements, outlined in Table 6.1.

Table 6.1. General outline of a management plan with notes on inland water application

Section	Details	Inland water aspects
Introduction	Describes the vision, how the plan was completed, targets, and some key statements about the proposed strategies and actions.	Vision includes inland waters. In key statements, describe how strategies and actions will address *key ecological attributes* in order to achieve inland water goals and vision.
Planning team appointment and roles	Lays out roles and responsibilities.	Ensure at least one member of the team has inland water experience.
Mechanisms for stakeholders' participation	Lists the main stakeholders and how they have been able to participate in the design and implementation of the plan.	Indigenous peoples and local communities (including local fishing communities), recreational and resource user associations (e.g. sports fishers, hunters, birders, gatherers, boaters), water user associations, water companies (e.g. water utility, water bottling), agribusinesses and smallholder farmers, conservation groups.
Context review	Includes the relevant biological, social, economic, legal, political, administrative and historical issues at a local, regional, national and international level.	Include summary of the legal and policy framework as it relates to inland waters including PA regulations as they apply to inland water ecosystems, water use regulations, fish and wildlife regulations, and international commitments (e.g. NBSAP, analysis of historic inland water issues (e.g. has the area been drained, streamflow altered, etc.), inland water resource rights (see Chapter 3), and wider basin values.
Threats and opportunities assessment	Summarises local and regional threats.	Remember offsite issues like dams, upstream pollution or interruption of water flow, as well as downstream implications for biodiversity and water users.
Vision	A short statement that gives a clear, inspirational but realistic description of hopes for the protected area by an agreed time.	Include inland water ecosystems and biodiversity in the vision.
Objectives	Clear statements of the desired outcomes.	Include explicit inland water conservation and/or management outcomes.
Targets	A series of targets (biodiversity, social, economic, cultural) intended to support achieving the desired outcomes.	Include explicit inland water targets (e.g. ecosystem representation, aquatic connectivity, inclusion of places important for biodiversity and ecosystem services).
Protected area management category	A brief description of the agreed IUCN protected area management category and any international designation (e.g. World Heritage, Ramsar, etc.).	Confirm that the category aligns with the management regimes of both terrestrial and inland water areas. If a Ramsar site, check that key values in the Ramsar Sites Information Service are reflected. https://rsis.ramsar.org/
Viability of targets and objectives	An analysis of the status of the objectives and targets (e.g. if a population of a target species is stable, increasing or declining).	Consider the status of objectives and targets through the lens of inland waters' ecological integrity, as expressed via the five *key ecological attributes*. Consider how the entire basin (uplands, as well as wetlands and water bodies) affects inland waters' viability. Consider how the status of inland water ecosystems affects linked management goals (e.g. for uplands, human well-being, nearshore coastal zones).

Section	Details	Inland water aspects
Indicators for targets and management actions	Measurable indicators used to monitor success of management actions (outputs) and status of targets (outcomes).	Consider the inland water objectives and all five *key ecological attributes* when identifying indicators.
Zoning	Identifies different management approaches in different parts of the protected area.	E.g. riparian and floodplain buffers (Chapter 3), temporary or permanent no fishing zones to protect vulnerable populations or lifecycle stages. Zoning should ideally follow a nested basin approach/design. Avoid using rivers as management zone boundaries if possible, or at a minimum include both banks of the river and associated floodplains within the same management zone.
Strategies and management actions	Identifies strategies and actions based on the status of targets (current and desired future condition), threats and opportunities, and resulting management needs. These are the basis of operational planning.	Consider how inland water strategies and management actions may affect other management goals, and vice versa.
Management programmes	If there are pre-determined legal or policy programmes, the plan should show how proposed strategies fit this framework.	For rivers or large lakes partly outside the site, consider programmes affecting these areas also.
Monitoring	Indicators for each target need to be selected and ways of measurement described, along with location of monitoring, frequency, level of effort and who is in charge. This can be a separate monitoring plan.	Select indicators that represent key ecological attributes associated with inland water targets and objectives (see Section 6.3). This could include a mixture of automatic monitoring (such as flow rate), expert review and traditional knowledge (e.g. fish numbers).
Management effectiveness	The plan should include, and respond to, regular assessments.	Whatever system is used, check that inland waters are adequately addressed.
Data collection, management, analysis and archive	Explains how data are going to be collected (for instance for monitoring), managed, analysed and archived.	Similar, with the exception of coordination of data with water and aquatic resource management agencies.
Management plan consultation/ review	Details of how often the plan should be reviewed (e.g. during the development of the annual operational plans).	Consider synchronising review with regional basin plans or water management plans, as appropriate.
Relation of the management plan with the operation plan	The plan should include a section that explains how the operational plans will be drafted and for what period of time.	n/a
Budget	Annual budget and notes of additional costs depending on fund raising (e.g. for infrastructure projects, restoration work, etc).	Ensure that costs associated with management and monitoring of inland water targets are accounted for (see Section 6.4).
Other elements	For instance, organisational charts; glossaries of key terms; case studies; maps.	Where tourism or fisheries occur, relevant parts of the plan might be included in a poster at water's edge.



Great blue heron (*Ardea herodias*). © Barry Berman/TNC Photo Contest 2022

Not all plans will need to be so detailed, particularly for smaller reserves. But the above should act as a checklist to see what could be required. Even the smallest reserve should have, at a minimum, (i) a clear set of objectives, (ii) a list of management actions, (ii) a monitoring system, (iv) a sensible budget and, if there are other people present, (v) a process of stakeholder engagement.[400] Very few inland waters around the world are not used in some fashion by local communities, so stakeholder engagement will likely be key.

OECMs are recognised because their existing management has been successful in conserving biodiversity, whether or not this was the intention. Many will not have a specific management plan, and probably do not require one, although once recognised as an OECM they will need some kind of monitoring plan. Management authorities of OECMs that do have explicit management plans are encouraged to consider inland water issues, including inland water biodiversity. Some OECMs will, we hope, over time be managed to increase their biodiversity as managers become more involved with the wider aims of inland water conservation. In these cases, they may need a management plan of the type outlined above.

6.2 Common management interventions and activities for inland water ecosystem integrity

The following list should act as a checklist for anyone managing a protected area or OECM. It is particularly aimed at protected areas that include rivers, ponds, lakes or other inland water ecosystems,[401] suggesting how and where these could be added to a management plan – with targets, indicators and associated management actions – and where interventions could make a difference to conservation outcomes. The table also links actions to specific inland water key ecological attributes (KEAs).

Table 6.2. Checklist of management actions to support inland water conservation in protected and conserved areas including (a) incorporating inland waters in the PCA baseline and management plan, (b) actions focused within the PCA, (c) joint actions within the PCA and in the broader basin, and (d) actions predominantly in the broader basin, including policy changes.

Table 6.2.a Management actions to incorporate inland waters in the PCA baseline and management plan
Many PCA managers will have only a vague idea of the inland water biodiversity and ecosystem services likely to be present. The first step is therefore to build a picture of what inland waters ecosystems, species and services occur within the PCA, their status and trends, and to decide how to measure future trends. Analysis should take into account the concept of inland waters ecosystem integrity and the five key ecological attributes identified for those systems: **hydrologic regime, connectivity, water quality, habitat** and **biotic composition**. Links to these are indicated in the table below.

✔	Action	Details	Key Ecological Attribute (KEA)
	Carry out a baseline survey	With a focus on rare, threatened and endemic inland waters species, harmful invasive alien species, water quality and water flow regime or dynamics, social and cultural values and pressures and threats. Traditional survey techniques can be augmented with newer approaches such as bioacoustics[402,403] DNA sampling[404] and camera trapping.[405] Traditional ecological knowledge[406] and citizen science approaches[407] should be incorporated wherever relevant. This information will be used to identify key inland waters conservation targets; see next section.	All
	Select key indicators for monitoring	Indicators will likely be developed for a subset of inland waters conservation targets, such as population trends of target species, key social indicators, trends in flow and water quality.[408,409]	All
	Agree and describe monitoring process	It is important to ensure continuity of approach and therefore of data quality over time (e.g., to ensure smooth transition if monitoring staff change).[410]	All
Most protected areas will have a management plan; this step aims to ensure that inland waters issues are included.			
	Identify key inland waters actions needed	Actions fall into four main groups: ✔ Actions taken within the protected area boundary. ✔ Negotiations leading to actions in surrounding areas that impact inland waters integrity in the protected area. ✔ Advocacy for policy changes or resource mobilization at a regional or national scale to improve inland waters integrity in the protected area.[411] Actions taken in a protected area need to be harmonised with overarching water management institutions in the area.	All

Table 6.2.b Management actions that can be taken on-site within the PCA
Things that the manager or management group can do on land and in water that they own or control themselves and will not damage wider stakeholder interests. All the following recommendations will depend on the particular ecosystem or habitat involved and choices need to be made in this context.

✔	Action	Details	Key Ecological Attribute (KEA)
	Optimise diversity of aquatic habitat	✔ Re-introduce or increase coarse woody debris, which provides additional habitat, variation in flow rates and often suitable spawning grounds for fish.[412] ✔ Restore meanders in streams and rivers that have been straightened to provide additional habitats, fish spawning areas, etc.[413]	Connectivity, Water quality, Habitat, Biotic composition
	Ensure healthy riparian and lakeside ecosystems	✔ Conserve or restore native vegetation to provide cool, shady areas in water, natural buffering of floodwaters, cover for semi-aquatic animals and migration pathways.[414]	Habitat, Biotic composition
	Maintain or restore natural flow patterns and inland waters connectivity (lateral, longitudinal, temporal, vertical)	✔ Prohibit new stream barriers, like undersized road-crossings and new dams ✔ Consider removing on-site dams or other human-made obstacles within the protected area.[415,416] ✔ Remove culverts and levees to restore natural floodplains if this can be done without impacting human communities.[417418] ✔ Upgrade or modify existing on-site dams and/or culverts to allow for better fish passage ✔ Work with on-site dam operators to negotiate changes in dam operations to meet environmental flow needs	Connectivity, Hydrologic regime, Habitat
	Protect water quality	✔ Eliminate herbicide and insecticide use in the PCA (e.g., to control invasive species) or at least ensure application takes place a safe distance from inland water habitats, with large buffer zones and chemicals that quickly break down to harmless components.[419] ✔ Control point and nonpoint nutrient sources in the PCA including wastewater from tourist camps, settlements or farms.[420] This can include a nutrient management plan with a combination of approaches including waste water treatment, retention and filtration ponds and riparian buffers.	Water quality, Biotic composition
	Introduce erosion control measures	✔ Restore natural vegetation, targeting areas that will maximize erosion control.	Habitat, Water quality
	Restore wetlands	✔ Rewet peatland and wetland habitats to increase biodiversity, flood and carbon storage.[421,422] ✔ Fill in drainage channels to restore natural wetlands in areas previously drained for agriculture or forestry. ✔ Remove levees on natural floodplains, to recreate wetland habitat, restore lateral connectivity and access to floodplain habitats, and reduce downstream flooding.	Connectivity, Hydrologic regime, Habitat

Table 6.2.c Management actions that can be taken both on-site within the PCA and in the broader basin
Some changes will also often need negotiation with other stakeholders, whether or not activities occur within the boundaries of a PCA.

✔	Action	Details	Key Ecological Attribute (KEA)
	Restore natural vegetation in the wider basin	Deforestation or land degradation in river and lake basins can result in soil erosion, siltation, excessive flooding and other problems.[423]	Habitat, Water quality
	Prevent invasive species	Prevention is always far cheaper and more effective than control.[424] Prevention includes: ✔ Work with users of the PCA and surrounding inland waters to agree on joint strategies against invasive species. ✔ Carry out educational campaigns to inform users about sanitary measures to avoid accidental introduction of non-native species: check, clean, dry all boats, footwear, fishing equipment, etc. ✔ Where necessary, introduce regulations and practices to minimise risks of invasive species, such as mandatory cleaning of equipment, etc. [425]	Biotic composition
	Control invasive species	Control is very difficult at a site level if the surrounding environment remains heavily impacted. Several stages are needed: ✔ Analyse whether a non-native species is likely to become invasive, and if so whether it will seriously disrupt the ecosystem. ✔ Assess the potential for control, and if eradication is not possible, consider containment. ✔ Investigate the most effective control methods, with the least damaging side effects. ✔ Ensure that local communities and other regular users are supportive of control plans (and find out whether they are willing to help). ✔ Initiate a control programme.[426]	Biotic composition
	Minimise risks to native biota from aquaculture and fish stocking	✔ Assess potential harm (via hybridisation, predation, disease, pollution) to native biota from on-site aquaculture operations and consider removing those operations if the risks can't be mitigated. ✔ Work with off-site aquaculture operators to reduce risk to on-site biotic communities by instituting best practices. ✔ Assess the potential risks of fish stocking, especially of non-native species, and take appropriate mitigation actions.	
	Protect breeding and feeding grounds and access to these sites	For most inland water species, some focal habitats will occur within the protected area and some will be outside (e.g. in critical management zones). ✔ Protect and/or restore focal habitats within the protected area and engage with stewards of focal habitats in the broader basin, through careful negotiation, to conserve species' access to those sites.	Habitat, Biotic composition

Table 6.2.c (continued)

✔	Action	Details	Key Ecological Attribute (KEA)
	Ensure sustainability of inland water fisheries	Ensure the sustainability of fisheries both inside the PCA – if fishing is permitted at all – and in the wider inland water ecosystem. Voluntary agreements, legally required agreements and compensation schemes can all reduce the negative impacts of unsustainable fishing practices, although compensation schemes need to be monitored to ensure they do not put pressure on inland waters in different ways.[427] Amongst the issues to be covered are: ✔ Replace gear or equipment likely to be damaging to either the sustainability of fish populations or the wider environment. ✔ Introduce regulations or voluntary agreements relating to fishing boats, covering size, pollution and engine noise. ✔ Implement temporal (seasonal or permanent) or spatial (no take zone, community reserve) closures. ✔ Measure species composition of fish catch to track changes in inland multispecies fisheries. ✔ If applicable, calculate sustainable catch levels and introduce quotas to ensure these are not exceeded. ✔ In river dolphin habitat, introduce pingers (acoustic devices to scare off river dolphins) to deter dolphins from taking fish from nets and traps.[428]	Biotic composition
	Maintain natural flow patterns, migration pathways and inland water connectivity corridors	✔ Support surface and groundwater regulations that sustain environmental flows to and through the area.[429,430] ✔ Remove obsolete dams and other constructed obstacles both inside and outside the PCA.[431] ✔ Modify dam operations to maintain environmental flows (i.e. water flows to support freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on them).[432,433] ✔ Design or upgrade structures to minimise impacts on migratory species (e.g. fishways on dams, structures or technologies that reduce entrainment and related mortality through turbines, culverts that increase fish passage).[434,435]	Connectivity, Hydrologic regime
	Manage non-point source pollution	Chemical inputs from surrounding ecosystems play a critical role in the health of both standing and running inland waters. Many protected landscapes (IUCN Category V) contain farms and managed forests, both of which can produce substantial pollution from nutrients and pesticides, leading to eutrophication, while tourist operations and other settlements can add their own pollution loads. Steps may include: ✔ Apply effective riparian buffer zones to reduce leakage into inland waters.[436] ✔ Negotiate with surrounding land managers to reduce levels of inputs, avoid application before heavy rain is forecast, use the most effective application techniques and encourage safer alternatives such as organic agriculture.[437] ✔ Introduce erosion control methods – e.g. bunds, shelter beds – where soil erosion and siltation are having a negative effect on inland water ecosystems.[438]	Water quality
	Mitigate thermal pollution	✔ Cold-water pollution from existing dams can be reduced by adding warmer tempering water to the cold water as it is being released, or by taking the water for release from near the surface of the dam where it is warmer. ✔ Warm water pollution from point source discharges and existing dams can be controlled, reducing the amount of water released by such facilities and capturing heated wastewater for other purposes, like desalination.[439]	Water quality

Table 6.2.c (continued)

✔	Action	Details	Key Ecological Attribute (KEA)
	Manage tourist and recreational use	Tourism is a mixed blessing for PCAs. It can be a source of revenue and a key pathway for educational campaigns, and visitors can experience health and wellness benefits. Yet, poorly managed tourism can overwhelm a site and destroy the very values for which it has been designated. From the perspective of inland waters, steps to minimise detrimental impacts can include: ✔ Consider likely impact on inland water species from tourist use, particularly boating and angling; within protected areas there should be strict controls on powered boats, high-speed boats and jet skis. ✔ Design paths, viewing areas, boat access points, and permitted fishing zones to minimise disturbance to nesting and breeding waterbirds and other aquatic and semi-aquatic species (e.g. turtles, fish). ✔ Regulate numbers of visitors in the most sensitive parts of the protected area (e.g. riverbanks, wetlands).[440]	Habitat, Biotic composition
	Consider and protect cultural and sacred sites	Many PCAs contain sites of local and/or national importance for their historical, cultural and sacred values and inland water sites need particular attention to management, in liaison with the relevant stakeholders. Such sites include: ✔ Sacred lakes, rivers and springs.[441] ✔ Any inland water-related historical features, such as historic irrigation systems, abandoned leats (channels) used for carrying water to mills, or other features likely to be of heritage interest.	Could have implications for one or more KEAs
	Shifting boundaries	✔ In places where a river or stream is used to mark the boundary of a protected area, consider extending the boundary so that both banks of the watercourse are under the same conservation management.	Habitat

Table 6.2.d Management actions in the broader basin (including off-site policy changes) that can support the PCA.

As noted in the set of actions directly above, many issues cannot be solved within a single protected area, nor by a single manager or community managing a single site. Wider changes in policy and practice are often needed to buffer PCAs against pollution, fragmentation, invasive species and other pressures. Off-site policy changes are usually undertaken by a protected area agency, Ministry of Environment or sympathetic politician. On the other hand, if good relations are built up, small policy changes by nearby land and water managers can have a beneficial impact. Below highlights some of the off-site policy changes that can take place.

✔	Action	Details	Key Ecological Attribute (KEA)
	Agriculture: livestock management	If not managed well, livestock can impact inland waters ecosystems through direct impacts on riparian areas and more generally through run-off of nutrients from manure and sediment from erosion, impacts of vegetation clearance to create pasture, compaction of soils, and leaching of fertilizers from grassland (Williams et al., 2021; UK Parliament, 2022).[442,443] A number of options can help buffer and recover inland waters biodiversity. ✔ Negotiate reductions in livestock numbers close to the PCA. ✔ Change rangeland management around PCAs to reduce use of fertilizers and herbicides, moving to a low impact or organic system. ✔ Introduce or strengthen buffer zones at the edges of water bodies to reduce the levels of leaching and to prevent livestock from coming into direct contact with inland waters systems.	Water quality, Biotic composition
	Agriculture: management of crops	Leaching of nitrate and phosphate fertilizer and of insecticides, fungicides and herbicides causes devastating impacts on many inland waters systems. PCAs that are isolated within an intensively farmed landscape are likely to experience significant losses.[444] ✔ Reduce contamination through changes in chemicals used. ✔ Investigate more effective application methods to reduce spray drift and levels of waste. ✔ Make greater use of buffers and timing of applications to reduce overall impacts. ✔ Move to a low impact or organic system	Water quality, Biotic composition

Table 6.2.d (continued)

✔	Action	Details	Key Ecological Attribute (KEA)
	Forestry	Forest management can either be beneficial or damaging to inland waters depending on how it is done. Key steps to reducing negative impacts include:[445] ✔ Avoid heavy ploughing or clearcuts that result in elevated soil erosion. ✔ Reduce or eliminate routine use of fertilizers and broad-action pesticides in forestry and ensure that any applications are as effective and contained as possible. ✔ Choose appropriate species, e.g., conifers on base-poor soils can increase acidification in inland waters. ✔ Practice continuous cover forestry in those areas closest to the PCA. ✔ Maintain buffer zones of continuous forest cover around rivers, streams and lakes. ✔ Take care that afforesting grasslands does not significantly reduce stream inflows through greater evapotranspiration (as in some Mediterranean climates).	Hydrological regime, Water quality
	Inland water fisheries management	Changes in management of inland fisheries to reduce negative impacts have been outlined above. Sometimes these require changes in national or regional policies to provide the legal power for enforcement.	Biotic composition
	Aquaculture	Aquaculture operations exist alongside and sometimes within PCAs; their impacts vary. Intensive operations, particularly those involving non-native species, supplementary feeding and use of antibiotics can carry substantial risks to native biodiversity. [Refer to new guidance when ready]	Water quality, Biotic composition
	Flood defence and water, transport and/or energy supply agencies	There is increasing recognition that channelling water with levees and dykes is not always an optimal solution for flood protection, carrying floodwater further to impact communities downstream. A similar situation is true for structures like dams and culverts that fragment inland waters habitats. Restoration of natural floodplains in and around PCAs can provide important conservation benefits along with significant disaster risk reduction and removal or upgrades of obsolete structures can similarly reduce risk from dam failures or fragmentation of systems. Changes in national or regional policies or regulations as well as funding from government may be required to support changes in built infrastructure.	Connectivity Hydrological regime Habitat

6.3 Measuring management effectiveness and supporting adaptive management

Research suggests that protected and conserved areas are only effective in conserving inland water biodiversity if properly designed and managed, in ways that account for the needs of inland water ecosystems and species.[446, 447] The first global review of the effectiveness of protected areas for inland waters found that less than one per cent of published studies include the information needed to assess effectiveness for inland water biodiversity conservation.[448] Of the 75 available case studies that did include data to assess inland water biodiversity, 38 reported positive, 25 neutral and 12 negative outcomes as the result of protected area establishment and management. Therefore, it is important that management plans include a monitoring plan with components tailored for assessing effectiveness for inland water objectives.

IUCN WCPA considers management effectiveness through six elements.[449]

- It begins with reviewing **context** – the importance of the site and other significant factors – and establishing a vision for site management, within the context of existing status and pressures,
- Progresses through **planning** (often including management plans and annual work plans), and
- Allocation of resources of time, equipment, staff and finance (**inputs**), and
- As a result of management actions (**process**),
- Produces goods and services, typically identified in the management plan or work plan (**outputs**),
- That result in impacts or **outcomes** in terms of nature conservation benefits, ecosystem services and social benefits.

Assessing all six elements, using qualitative and quantitative methods, will help answer three main sets of questions: (1) Were management actions implemented as planned? (2) Did actions lead to expected results? (3) What other factors may have influenced results and were there any unintended consequences? This information, in turn, will inform adaptive management of a PCA or other conservation strategy. A management assessment system that focuses solely on outcomes, on the other hand, may provide little insight into why a particular result was or was not achieved, which hampers efforts at adaptive management.



In Gabon, a group of scientists use electric fishing to collect freshwater fish and assess population health.
© Roshni Lodhia

6.3.1 Developing a monitoring plan for a PCA

A management plan should include a monitoring plan, with the six management effectiveness elements guiding data collection and evaluation. A good monitoring plan should focus on both outputs and outcomes defined in the management plan. For instance, an *outcome* could be maintaining river dolphin populations, while associated *outputs* (e.g. activities carried out to achieve the outcome) might be to integrate dolphin pingers (acoustic devices to scare off river dolphins) into local fishing practices, or to identify no-go areas for fishing. It may also be important to track pressures beyond the PCA boundary that could undermine conservation (e.g. land conversion in the contributing basin that changes water quality and quantity in the area).

Process of monitoring plan development

The process to develop or update a monitoring plan includes the following iterative steps:

1. **Clarify audience and information needs:** An essential starting point for monitoring and evaluation is specifying *who* needs to know *what* information by *when*.
2. **Identify team and resources:** Suggested subject-matter expertise includes conservation planning, freshwater ecology, and social science, as well as key stakeholders (especially IP&LC members); this step is about preparation but also clarifying constraints.
3. **Review PCA management plan:** Review relevant content in the management plan (including the viability assessment, management objectives, strategies and management actions, etc. as described in Table 6.1) to highlight outputs and outcomes.
4. **Identify attributes and indicators:** Develop and validate indicators for outputs and outcomes.
5. **Identify other monitoring objectives:** Review if it is necessary to monitor confounding factors such as enabling conditions, threats beyond the area boundaries, or newly emerging factors.
6. **Prioritise what to monitor:** Considering any resource constraints identified in Step 2, designate a subset of output and outcome indicators to prioritise and provide a justification.
7. **Develop monitoring plan:** See Box 6.1 for details.
8. **Implement and adapt:** integrate robust data management practices when implementing data collection and analyses, conduct periodic pause and reflect to review results, and adjust management plan as needed.

Below we unpack a few key aspects along these steps:

Output indicators

Output indicators track progress on implementation of actions identified in the management plan. At a minimum, a basic table is required that includes information on whether each action was completed, where, when, and by whom. If a planned action was not implemented, it should be documented. Output indicators can also be numerical measures of activity, for example:

- *Numbers of users*: e.g. numbers of visitors, average length of stay.
- *Volume of work output*: e.g. numbers of meetings held with local communities, number of patrols undertaken, extent of area surveyed in a research programme.
- *Physical outputs*: e.g. length of site boundary delineated and marked, numbers of brochures produced or distributed, length of river with meanders restored.

Whenever possible, **spatially explicit data** (e.g. polygons) for specific on-site management actions (e.g. site of reforestation, site of floodplain restoration, area under active fisheries management) should be collected.

Outcome indicators

Output indicators may be similar in many ways across inland waters, terrestrial and coastal/marine realms. Outcome indicators, on the other hand, will be tailored to the ecosystem(s) being conserved. Outcomes are the single most important measure of success. A site can be managed well and still lose biodiversity; conversely sites that are virtually ignored may through chance events be successful. For inland waters, outcome indicators will typically be tied to one or more of the five KEAs, the different aspects of ecosystem health. Given the interdependence of ecosystems, wherever possible, all five freshwater KEAs should be assessed in monitoring, with a focus on issues that are directly and significantly being managed for.

There are numerous possible indicators for each KEA. For example:

- Hydrologic regime: measuring discharge for rivers like inflow and outflow measurements; magnitude, frequency, duration and timing of flow events; measuring hydraulic properties for all wetland types like seasonal depth and wetted width;
- Connectivity: extent to which species can migrate along a water course; longitudinal (percentage of free-flowing river reach), lateral (per cent of floodplain connection), vertical (percentage of active wetland area (bed, banks and seasonally wetted zone) with natural bed);
- Water quality: standardised indicator on physical (e.g. temperature, clarity, colour), biological (e.g. biochemical oxygen demand), chemical (e.g. pH, presence of toxic chemicals) attributes;
- Physical habitat: structure (e.g. substrate composition and distribution, presence of coarse woody debris), distribution (e.g. riffles, pools, runs, continuity of riparian vegetation);
- Biotic composition: distribution of target species, abundance of target species, aquatic community structure, presence of and trends in target species population.

In Serengeti National Park in Tanzania, for example, planners identified water quality of the Mara River as a target and water flow and water quality as two of the priority key ecological attributes important for meeting their inland water objectives (see Table 6.3).

Table 6.3. Example of monitoring plan from Serengeti National Park General Management Plan

Key Ecological Attribute/ Threat	Indicator of change	Method of measurement	Collection frequency	Data source	Responsibility	Data currently collected
Water flow	Minimum flow rates	Physical flow rate and pressure/ temperature	Monthly (flow rate); Every 30 minutes (for pressure/ temperature)	Research	SENAPA Ecological Monitoring	Yes
Water quality	Dissolved 02 pH, salinity, clarity, temperature	Data collected using automatic samplers.	Monthly	Research	SENAPA Ecological Monitoring	Yes

Prioritise what to monitor

Resource and time constraints will require prioritisation of indicators. Monitoring plans that contain dozens or even hundreds of indicators seldom survive for long. Therefore, it is important to explore and understand potential uses of existing monitoring occurring in the project area. Although this may not exactly match identified monitoring needs, managers can consider modifying indicators to draw on existing sources, and thus save time and money. For example, if river flow is an indicator, a government agency may have an automated stream flow gauge 10 miles upstream that provides a reasonably reliable estimate of stream flows within the PCA.

For state-run and private protected areas, it is important to involve other concerned stakeholders in evaluations. This ensures that a wide variety of voices are heard, which is particularly important with respect to social and governance issues and can also draw on local expertise. Traditional ecological knowledge is likely to exceed that of the professionals with respect to some species. There is a growing body of work looking at alternative approaches to monitoring that involve local people.[450,451] Such approaches present a cost-effective way of collecting data, can help to increase local involvement in management and may increase support for the PCA overall by increasing understanding of the objectives. Locally based options may be particularly appropriate when local communities are actively using the natural resources within the PCA (e.g. fishing communities monitoring size and number of fish caught can signal if sustainable yield is being exceeded).

The cost of monitoring is always a challenge unless volunteer help is available. Managers have to prioritise the most important outcome indicators (see Table 6.4).

Table 6.4. What makes an effective indicator?

Key Components	Inland water considerations
Has a clear, predictable and verifiable relationship to the element that is being measured.	Same
Is sensitive to change and thus able to show that management actions are having an effect.	Same
Reflects long-term changes rather than only short-term or localised fluctuations.	Such as changes in numbers of migratory species over decades rather than year-to-year fluctuations.
Reflects changes that have direct implications for management (including biological, social, cultural, economic and political changes).	Key issues in inland waters might be population trends of key species, biochemical oxygen demand, water flow, willingness to maintain agreed fishing levels, ecotourism revenue, etc.
Reflects changes on a scale and over a period that is relevant to management.	It is important to select some indicators that react quickly to conditions, to facilitate adaptive management, such as survival of waterbird young or nutrient levels in water.
Is cost-effective in terms of data collection, analysis and interpretation.	Liaising with local communities can often help here, for example in monitoring populations of fish.
Is simple to measure and interpret.	It is particularly important that local communities understand why some things are monitored, so fish populations, water quality, level of flooding are all good in this respect.
Is able to be collected, analysed and reported on in a timely fashion.	Same
Assesses impacts of known pressures and detects new pressures.	Same

Content of a monitoring plan

The final monitoring plan should be relatively detailed (see Box 6.1 below) so that it is easy for new staff members to work from. It is important that monitoring is carried out in the same way over time, or results will not be comparable, so a new monitoring officer needs to be able to read and understand exactly what to do.

Using the results of monitoring

Monitoring is only worth doing if the results help improve management and/or add to our general knowledge about the environment and ecosystem services. Results therefore need to be analysed regularly to see if they suggest that changes in management are needed. The best indicators include **thresholds** that trigger action – for instance, if a population of a fish species declines below a certain level, or nutrient levels rise above a point regarded as hazardous. It is also important that the people doing the monitoring – usually field rangers – know how the information they collect is being used; otherwise, this is likely to become a chore and may not be carried out as accurately as needed.

While monitoring necessarily focuses on a small suite of carefully chosen indicators, it is important that managers, rangers and anyone involved in the site also keep watch for changes in other species, habitats and conditions as well, and address any problems that emerge.

Other monitoring objectives

1.Threats and conditions beyond PA boundaries

Inland water ecosystems face particular challenges of impacts from beyond their borders, given the characteristics of inland water ecosystems (especially rivers and groundwater systems) and the extent of interconnections between terrestrial and in-stream actions. External impacts should be taken into account when interpreting monitoring results, to help understand observed trends and to better inform adaptive management responses. Potential upstream changes to be monitored include the extent and type of land use change; number of dams and other barriers; volume and seasonality of water withdrawals (e.g. for agriculture); alterations to stream morphology and levees; and extractive activities (mining, oil), wastewater, or other sources of contamination. Stream gauges upstream of PCAs can be an excellent source of data to understand the aggregate impacts of upstream impacts.

Box 6.1

Contents of a monitoring plan

✔ **Background Information**

- *Objectives*: Why monitoring is being carried out. What questions will be answered through monitoring and evaluation, and how are they linked and aligned with the PCA's objectives. This should be linked to the indicator(s) monitored and the thresholds used.
- *Audience*: Monitoring objectives should also be representative of stakeholder needs.
- *Bibliography*: A list of relevant material (e.g. journal articles and reports) and information on previous activities (including constraints to monitoring activities).
- *Ethics and human rights considerations in monitoring*: Including consent from stakeholders (especially communities involved in monitoring) and agreements on data ownership, security, privacy, etc.

✔ **Monitoring protocols**

- *Definition*: Definition of each indicator.
- *Method*: Method or methods used (e.g. sampling, interviews, observation, line transect techniques, traps or strip census methodology). Overall design that allows sufficient ability to detect changes resulting from management actions.
- *Procedures*: Standardised procedures for collecting data, including area of monitoring, staffing requirements (e.g. numbers, required training, time allocated), equipment requirements (e.g. boats, binoculars, GIS, traps) and safety procedures; quality control and quality assurance procedures.
- *Frequency of data collection*: Monthly, quarterly, annually, etc.
- *Data collection*: Indicators to be measured (e.g. numbers of sightings, average earnings of communities).
- *Data analysis and evaluation*: Advice regarding analysis and comparison (e.g. use of graphs, analysis software).
- *Data management*: Records should include the monitoring results (datasets) and the history of monitoring development and revision.
- *Budget*:

✔ **The process of review and revision**

- *Review*: Monitoring should be regularly reviewed to ensure that the right things are being monitored and that monitoring is carried out in the most effective way.
- *Revision*: Although monitoring protocols aim to ensure standardisation of monitoring, they should also be adapted and revised if the review process indicates this need. Revision may need to take place due to changes in technology, gaps in data, budget changes and new pressures.

2.Other effective area-based conservation measures

In theory, any assessment system used in a protected area could be applied to an OECM as well. But for many sites, additional challenges exist because the managers neither prioritise nor are likely to have expertise in biodiversity, so that monitoring will be an additional burden and one where outside help will likely be required. Given that OECMs are defined by their effectiveness, this is arguably even more critical than in the case of a protected area. There is, as yet, no general guidance on monitoring and reporting for OECMs.

3. Ecosystem services

Natural inland waters provide numerous important ecosystem services, including water provision and regulation, food security and disaster risk reduction (mitigating floods and droughts),[452] and critical navigation/transportation pathways. Mapping and quantifying these services can inform site management by setting a baseline. This is particularly valuable when assessing the consequences of management decisions or policy changes on ecosystem services. Data can be utilised to ensure equity in resource use and benefit sharing among stakeholder groups, to support the development of compensation mechanisms for those implementing conservation management practices, or to provide evidence in applications to accreditation or certification systems.

Ecosystem services can be valued by assigning a monetary value to biophysical, social and economic benefits, or by a qualitative description of biophysical and sociocultural values.[453] Some of these are available for monitoring on site, including the Protected Areas-Benefits Assessment Tool.[454] Monetary valuation can sometimes conflict with conservation; if the economic value for conservation is not as high as its alternative use (e.g. industrial fishing or hydropower), the non-monetary values of conservation should also be assessed (e.g. the biodiversity or cultural values).[455,456]

6.3.2 Existing tools for measuring management effectiveness

Table 6.5 summarises examples of tools for measuring management effectiveness at the site level, with an initial assessment on their strengths, weaknesses and state of application in inland water conservation. Most focus predominantly on effectiveness in terms of biodiversity conservation, although there are a growing number of systems that look at issues relating to social values[457] and governance.[458] The Management Effectiveness Tracking Tool (METT) was designed for tracking progress on an individual site over time and already has a number of national and regional variations – there are distinct versions, for instance, in Bhutan, Indonesia, Myanmar and South Africa.[459] Apart from the Ramsar-METT (R-METT), a version of the METT designed by the Convention on Wetlands for inland waters,[460] there has been comparatively little attention paid to inland waters in management effectiveness tools. Here are three reasons for encouraging local adaptation for site management-related evaluations:

1. Any one system is unlikely to be equally applicable in every situation. Particularly if dealing with stakeholders not familiar with the assessment processes, the inclusion of questions that are not relevant to the local conditions can create a negative reaction or waste a lot of time.
2. The inclusion of many different people thinking about a system, rather than simply using a pre-determined system, leads to continual refinement; in effect, a crowd-sourced assessment system. This also means that the 'central' assessment system can continue to be improved over time.
3. At a psychological/cultural level, ownership of the tool is greater when there is flexibility to create it or shape it; this is often attractive to governments and thus encourages sustained uptake. Tools and processes imposed from outside are more likely to be abandoned.



Water buffaloes moving through wetland habitat to feed on aquatic plants, Vietnam. © Nguyen Sinh/TNC Photo Contest 2021

Table 6.5. Some site-level management effectiveness tools

Tool	Aim	Time required	Details and notes	Strengths	Weaknesses	Inland water application
Management effectiveness tracking tool (METT)[461]	Rapid assessment of management	Low (1–2 days)	Simple, multiple-choice questionnaire ideally done by PA staff and other stakeholders, assessment by consensus.	Quick to apply, driven mainly by expert opinion, creates list of action points.	Weak on outcomes – variations exist using more data to track conservation outcomes.	A specific R-METT has been developed by Ramsar but is now slightly outdated.
Protected Area Benefits Assessment Tool (PA-BAT)[462]	Assessment of social benefits from protected areas	Low (1 day)	Works with stakeholders to identify what they value from a PA, actual and potential, and where and when benefits accrue.	Quick method to identify what communities value from a protected area.	May miss 'global values' like carbon.	Has been applied to inland waters.
Social Assessment of Protected Areas (SAPA)[463]	Assessment of social impacts of protected areas	Low (1–2 days)	System for working with local rightsholders and stakeholders to assess the impact of a protected area on their livelihoods.	Focuses on social impacts and human issues.	No data on effectiveness from an ecological perspective.	Little application as yet.
Site-level assessment of governance and equity (SAGE)	Assessment of governance and its impact on equity	Medium	Also aims to provide information to report at national and global levels.	Unusual in including equity in consideration.	Not suitable for use alone because doesn't look at conservation values.	Little application as yet.
Elinor	Tracking WWF protected area projects	Fairly short	Combines elements of METT and SAGE.	Quick to use, both conservation and social issues.	Fairly untested as yet.	Unknown.
Governance Assessment for Protected and Conserved Areas (GAPA)[464]	Assessment of governance quality of protected areas	Medium	Methodology for assessing governance quality, aimed at managers and a wider group of stakeholders, working together.	Uses a combination of interviews, workshops and an optional site-level scorecard.	No data on ecological effectiveness or wider social impacts.	Little application as yet.
Green List of Protected Areas[465]	Setting standards for protected areas	Medium	Global standards against which to measure management, verified by third parties.	Detailed management standards.	Relatively time-intensive and expensive.	Some Green List sites in PCAs with inland waters.
Conservation Assured	Setting standards for species in protected areas	Medium	Verified standards aimed at particular species or groups, for tigers, jaguars and river dolphins.	Suitable for priority species and tailored to their needs.	Relatively time intensive and expensive.	One module specifically designed for river dolphins.[466]
Enhancing our Heritage toolkit[467]	Detailed assessment of management	High (several days, long-term monitoring)	Developed for UNESCO natural World Heritage, has 12 different toolkits, for a comprehensive monitoring system.	Detailed toolkit for sites needing particular attention.	Relatively time intensive and expensive.	Newly updated, little application in inland waters.
SMART[468]	Monitoring system for PA rangers	Daily use	Monitoring system to record animal sightings, poaching, traps found, etc.	Helps build data, also builds competencies of rangers.	Requires basic training and equipment, management.	

6.4 Budgeting and sustainable financing

This section presents guidance for developing a budget for PCAs that integrates inland water objectives, as well as outlining sustainable financing mechanisms that have or could be applied to PCAs that include inland waters.

6.4.1 Budgeting for inland water conservation and management within protected areas

Designating, designing and managing a protected area with inland water objectives will require accounting for those activities in the budget. Most budget categories will be the same as for a conventional terrestrial protected area, but there are some special considerations that should be accounted for to achieve inland water objectives. The guidance provided is for an individual protected area budget, and only some elements will be relevant in any given area. Parts of this guidance will be applicable to OECMs as well.

Personnel

One of the primary differences in budgeting will be the consideration of staff expertise. The conservation and management of inland waters requires specific skillsets throughout the process of scoping, designation, management planning and implementation. Recognising staffing costs for an individual area can be prohibitive, it will often be beneficial to consider pooling resources or co-management arrangements to incorporate and meet inland water objectives. Some examples include:

- Staffing an inland water team at the national or regional level to provide advisory support to the PCA network.
- Developing an MOU or co-management arrangement across agencies with overlapping goals and jurisdictions for water-related resource management.
- Establishing a standing inland water expert advisory group of representatives from government agencies, academia, community members and NGOs to provide guidance through scoping, designation and management.
- Training a network of river/lake guardians or rangers, preferencing members of the local communities (rivers and lakes that attract fishing activity may require a greater enforcement presence if there are many access points).

Pre-designation and designation phase for new protected areas, or when inland water objectives are being included for the first time for an existing protected area.

- Cadastral surveys, which may be more complicated for rivers than for lands.
- Baseline data collation and studies of inland water parameters of interest (e.g. biotic community composition and abundance, water flow and quality parameters, level of fishing and/or recreational activity).
- Participatory planning processes with stakeholders who have a particular interest in the use and management of inland waters within the protected area (e.g. local communities directly using the water resource, fishing communities, recreational services and tourism operators) (Chapter 3).
- Threat assessment (on-site and basin-wide) to understand and assess the current and future viability of the protected areas' inland waters, and development of a mitigation plan to address threats, where possible (Chapters 2 and 4).
- Spatial planning and zoning within the PCA to structure management regimes for areas sensitive to encroachment like riparian and floodplain zones, peatlands, critical habitats (Chapter 4).
- Legal/policy mechanism assessment to identify inland water protection options, where necessary (Chapter 5).
- Designation justification packages (e.g. proposal maps, literature review, baseline summary and rationale for new PCA designations often required as a stage of the decision process).
- Sustainable finance assessment, focused on inland water-specific options (e.g. payments for ecosystem services like water provisioning, climate mitigation and adaptation).



A river chub (*Nocomis micropogon*) hard at work moving stones to build a nest while saffron shiners (*Notropis rubricroceus*) swim by. © David Herasimtschuk / Freshwaters Illustrated

Management planning

- Baseline management effectiveness assessment for an existing protected area or a protected area network, with a focus on management attributes specific to inland waters (Section 6.3.2).
- Carrying capacity assessment for on-site tourism, recreation, and community-based fisheries, through the lens of inland water impacts; tourism should also include the impacts of land-based activities and infrastructure.
- Community engagement with a focus on the inland water stakeholder groups directly affected by management decisions, and including community co-managers.
- Monitoring plan development inclusive of inland water indicators, and a budget for their measurement.
- Development of site-specific environmental standards literature review, data analysis and stakeholder workshops to define standards for environmental flows, connectivity, water quality, etc.

Management

- Boats, fuel and safety equipment (including equipment maintenance and training in its operation).
- Infrastructure (e.g. wastewater treatment, well-designed and managed trails and road–stream crossings, access points for boats, observation areas).
- Boundary markers and signage, more may be required for rivers, as linear systems.
- Legal support and equipment for implementing environmental standards linked to revising designations, establishing water reserves as well as monitoring and may include staff gauges, water quality data loggers.
- Monitoring including general monitoring of inland water indicators, inclusive of transportation, time, equipment and processing – often in a lab.
- Remediation/restoration if necessary, such as through improvements to road–stream crossings to restore connectivity; hydraulic modelling, which can be expensive, may be necessary for river channel and floodplain restoration.
- Maintenance (costs for inland water maintenance, like regular removal of invasive vegetation, should not be underestimated).

- Community relations and communications including resources to strengthen community relations through management implementation; educational displays and events to convey the importance of conserving the protected area's inland waters to local communities and other stakeholders, visitors, and even to the protected area managers.

Inland water area-based conservation, especially in less-developed country contexts, is relatively new and examples of budgets are few. As more protections are enacted and budgets evolve over time, activities and indicative costs should become somewhat easier to forecast.

6.4.2 Conservation finance

The Conservation Finance Alliance (CFA) defines conservation finance as "*mechanisms and strategies that generate, manage, and deploy financial resources and align incentives to achieve nature conservation outcomes.*"[469] The annual finance gap for conservation is estimated at US$ 300–400 billion.[470,471] One consequence is that available funding needs to be used as efficiently as possible.. This section presents examples and guidance for developing a budget for inland water conservation as well as outlining sustainable financing mechanisms that have or could be applied to PCAs that include inland waters.

Conservation finance solutions aim to achieve four main outcomes:[472]

a. decreasing conservation costs
b. increasing the flow of capital
c. discouraging harmful actions
d. incentivising positive actions

Whilst this section focuses on B (increasing the flow of capital), it is imperative that A, C and D are also tackled at the site and systems levels. Several opportunities exist to increase the flow of capital to support inland water conservation including public funding and grant-based instruments (government allocations, philanthropic grants, GEF-funded programmes like the GEF Global Biodiversity Framework Fund).[473] In addition, several emerging instruments have the potential to provide self-sustaining capital over longer periods of time, here referred to as sustainable finance mechanisms or SFMs. The remainder of this section summarises ten examples of SFMs that could be considered for reducing the finance gap for the conservation of inland water ecosystems within existing and new PCAs.

1. Entrance fees and other Tourism User Fees. Inland waters often provide points of attraction, like waterfalls, for tourists,[474] making the option of Tourism User Fees (TUFs) more viable. TUFs are market-based mechanisms, defined as "fees on tourism-based activities designed to generate revenues to support conservation".[475] TUFs can include entrance fees, concession fees, licences, permits and other tourism-related fees and taxes. A tourism concession could provide accommodation, food and beverages, recreation, education, retail and interpretive services.[476]

Not all PCAs are suitable for tourism; for example, tourism is often inappropriate in 'Strict Nature Reserves' because of environmental sensitivities. The types of tourism concessions allowed in PCAs varies greatly, depending on what type of protected area it is, as well as the relevant national level legislation around sustainable use. PCAs that do choose to pursue tourism should note that capacity to generate revenues from concessions depends on their ability to attract tourists, dependent on location, facilities, access, and the feasibility of offering services that visitors are willing to pay for. A feasibility study can match tourism products to the demand.

For an optimal chance of success, several important building blocks and enablers must be in place. These include that tourism is aligned with conservation goals, tourism is attractive, activities are accessible and infrastructure is in place, and there should be robust governance and management, fair benefit-sharing models and other good practices.

Some examples include:

- Lake Naivasha Ramsar site, Kenya – Boat safari concessions (viewing hippos, birds, water buffalo).
- Upper Snake Wild and Scenic River, US – Rafting and flyfishing concessions and user-day permitting programme.
- Pacaya Samiria, Peru – Park navigation by river boat, entrance fees along the river, concession permits for ecotours to see pink and grey river dolphins, etc.



Nomadic community at the edge of Khar-Us Lake and wetland complex, in the shadow of Jargalent Khairkhan, Mongolia. © Baya Balgantseren

2. Conservation Trust Funds (CTFs). Conservation Trust Funds (CTFs), often called Environmental Funds in Latin America, are private, legally independent institutions that provide sustainable financing for biodiversity conservation and community development. The core business of CTFs is to mobilise resources from diverse sources – including international donors (e.g. in project finance for permanence), national governments, the private sector, and sustainable finance sources (e.g. debt-conversions; payments for ecosystem services) – and to direct them, primarily through grants, to a diverse range of environmental programmes and projects through NGOs, community-based organisations and governmental agencies (such as national park agencies).

3. Debt conversion and finance mechanisms. There are several debt-related conservation and finance mechanisms available to governments seeking sources of conservation funding. Traditional Debt-for-Nature Swaps that originated in the late 1980s usually involved a creditor forgiving a portion of a country's debt in exchange for an equivalent amount of funding being channelled towards a specific conservation outcome, normally through a CTF. Recently, other debt conversion mechanisms have been designed, including debt refinancing mechanisms.

For example, The Nature Conservancy's **Nature Bonds Program** focuses on refinancing a country's external commercial debt in support of long-term conservation and climate projects, guided by robust conservation plans to support national governments and local communities. Specific to inland waters, in Belize, while the instrument focuses on marine and coastal reef areas, it includes a voluntary conservation commitment to prioritise watersheds with important 'ridge to reef' connections, and to fund watershed management plans and activities to maintain the quality and quantity of freshwater inflows to priority coastal reef areas. The Nature Bonds Toolkit (2024)[477] provides additional information on the instrument and key enabling conditions.

4. Project Finance for Permanence (PFP) is a PCA network-level financing model developed by governments and local communities, funders and NGOs, in partnership, to secure long-term conservation financing, effective protected area management and sustainable development benefits for local communities. The central concept is development of a single closing agreement that leverages national government investment against capital raised from private and philanthropic funds, shifting conservation to a more durable, long-term approach.

A national CTF is the vehicle responsible for managing and disbursing the PFP's financial resources and measuring progress and accountability towards the conservation goals agreed.

Enduring Earth, a collaboration of The Nature Conservancy, The Pew Charitable Trusts, World Wildlife Fund and ZOMALAB, the family office of Ben and Lucy Ana Walton, is working with countries and communities to advance at least 20 PFPs by 2030. Enduring Earth established a process to determine the viability and feasibility of a PFP before it moves into the planning phase, which uses five key enabling factors:[478,479]

1. **Ecological viability:** ensuring the long-term health of an ecosystem, areas must be sufficiently large and well protected to maintain biodiversity.
2. **Political stability:** strong, high-level, sustained government commitment and good national governance.
3. **Organisational capacity:** to successfully design, execute and monitor activities to deliver on conservation goals.
4. **Capital:** sufficient funds, strong funds management, obviating need for future fundraising.
5. **Social:** supported and/or led by those who live in or near the PFP area.

The most recent **PFP, Eternal Mongolia** was the first to be launched under the KM-GBF and includes goals and interventions to support Mongolia's commitment to achieve Target 3 (30 x 30) for both terrestrial and inland water areas. The Eternal Mongolia PFP will deliver US$ 198 million of new investment in conservation and community economic development over 15 years to support locally driven proposals to safeguard an additional 14.4 million hectares of Mongolia's lands and waters including intact grasslands, forests, deserts, rivers and wetlands; strengthen the management of Mongolia's network of protected areas; and extend sustainable and climate-resilient community-managed practices to 34 million hectares in the buffers and ecological corridors outside of protected areas

5. Collaborative Management Partnerships (CMPs) are a type of public-private partnership (PPP) whereby a PA authority (government, private or community) enters a contract with a partner (private or NGO) for the management of a protected area.[480] CMPs can be established with a partner with fundraising, financial or other technical skills to support the management authority; CMPs can attract donor funding and increase investment flows. In some cases, CMPs are actually a prerequisite for donor funding.

6. Payments for Ecosystem Services (PES) provide payment to communities who are managing ecosystems with benefits to societal needs like climate mitigation or provision of fresh water. Protected and conserved areas, through maintenance of natural land cover and soil health, and by restricting water withdrawals, maladaptive infrastructure and polluting activities, can serve as a buffer against forces (like land cover conversion) contributing to water insecurity.

Because of the benefits that they provide, protected and conserved areas can receive financing through payments for ecosystem services (PES) schemes. Through PES, those who benefit from ecosystem services like water provision and regulation compensate those who provide those services, such as the protectors of upstream water sources.[481] PES is a market-based approach defined by:

1. "a *voluntary transaction* where
2. a *well-defined* ecosystem service
3. is being 'bought' by a (minimum one) *buyer*
4. from a (minimum one) *provider*
5. if, and only if, the ecosystem service provider secures ecosystem service provision (*conditionality*)."[482]

There are two main types of payment models for PES:

- **'Output-based' payments** are determined by the actual delivery of ecosystem services. These payments are made based on measurable factors such as carbon sequestration levels or water flow.
- **'Input-based' payments** are made based on the implementation of specific natural resource management practices. For instance, payments may be made for establishing and maintaining buffer strips along watercourses or for the restoration and maintenance of natural water bodies.

Water-related PES is the most mature PES sector in terms of transaction value and geographical distribution, with objectives focused principally on water quality and water quantity.[483] In support of water-based PES projects, the Resilient Watersheds Network and Toolbox, and the Nature for Water facility, offer resources for communities, organisations and governments addressing water insecurity via PES.[484] Water regulation works well for PES in part because it has a clearly identifiable seller (the community managing the ecosystem) and buyer (usually a water company or municipality).

Many water-related PES schemes focus on land management, restoration and/or protection principally in headwater areas and do not extend into the middle and lower portions of basins. As such, they should be considered to provide partial inland water conservation benefits. Layering PES approaches with other conservation mechanisms can achieve more comprehensive outcomes.

7. Biodiversity Credits (BC) are a novel financial instrument designed to incentivise investments into nature conservation and restoration. A BC is a verifiable, quantifiable and tradable unit of biodiversity restored or preserved over a specified period of time that represents a positive impact for biodiversity. It requires predetermined management actions aimed at enhancing or conserving biodiversity compared to a specified baseline. Actions could include the protection or enhancement of threatened species and habitats, or restoration efforts.[485,486] ValueNature offers voluntary BCs that symbolise the protection of one hectare of land for a specific project site over a period of 10 years, [487] though 10 years would be insufficient to qualify as 'long-term' protection.[488] For example, Australia's Nature Repair Market offers certificates generated from 99-year agreements.[489] An inland water PCA could set its VBCs to hectares of aquatic habitat protected, species populations restored, or other measures. Some ecosystems with high carbon stocks or potential for sequestration could be eligible for both VBCs and carbon credits (e.g. peatland contains high carbon stocks and is particularly suitable for this approach).

There is a wide spectrum of potential structures for BC markets. As with carbon credits, under a voluntary, unregulated BC mechanism an impartial standard-setting organisation issues credits to authorised project developers once the management actions have been independently verified.[490] These credits can be traded in a market or sold through direct agreements. Ultimately market demand determines the value of any credit. BCs can financially support various types of PCAs and their custodians if they can meet the emerging standards' or buyers' requirements. There is an increasing demand for biodiversity credits among private investors, individuals and governments seeking to make investments in biodiversity conservation and restoration[491] and the push for a wider development of biodiversity credit markets is gaining momentum.[492] Because, unlike carbon, biodiversity values are localized, non-fungible and often irreplaceable, there are differences to carbon markets and key questions remain to be resolved.

8. Biodiversity offsets. Unlike biodiversity credits, biodiversity offsets are measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimised, and/or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity from a project-level impact. Offsets should only be considered after following the first three steps of the mitigation hierarchy to further reduce residual impacts. Offsets are location- and project-specific and typically require the same type of habitat and biodiversity to compensate for the local nature loss.

Under environmental best practice mitigation hierarchies, development projects should aim to first avoid damage to the environment, second minimise damage and lastly restore impacted nature. However, some projects may still lead to significant adverse biodiversity impacts. In this case, biodiversity offsets can be financed to generate measurable conservation outcomes resulting from actions designed to compensate for the damages.[493] For example, if a development project will impact a wetland, a local PCA could be the beneficiary of offsets from that project, allowing the PCA to receive additional areas of similar wetland habitat for conservation.

Biodiversity offsets are estimated to provide US$ 6.3–9.2 billion for conservation per year globally, and as more countries formalise and improve their systems for environmental impact assessment this figure could increase to US$ 168 billion per year by 2030.[494] As such, biodiversity offsets are a potential avenue for much inland water conservation funding in the future. However, offsets remain controversial. Critics argue that offsets still result in a net loss of habitat and promises of permanent protection or restoration of alternative sites by no means always materialise.[495]



Whitewater rafting on the Futaleufú River in an area recently protected by a water reserve, Chile. (Case study 27) © Enoc Mancilla

9. Certification schemes are a relatively mature mechanism that use standards for production or trade, along with monitoring, certification and labelling processes, to recognise and incentivise products that meet specific environmental and social criteria.[496] Globally, more than 450 certification schemes related to environmental sustainability have been established,[497] including Certified Wildlife Friendly®, FairWild and the Forest Stewardship Council® (FSC). Many such schemes can help ensure that lands and inland waters within them are managed in ways that minimise damage to the ecosystem – for example, organic farming and forest management that protects riparian zones – and some are directly applicable to waters, including those related to responsible tourism, fishing and aquaculture. In particular, the Alliance for Water Stewardship has a globally applicable framework and standards for the sustainable use of water, including consideration of biodiversity conservation.

If structured properly, all these can benefit PCAs. For example, Salmon-Safe is an Oregon-based non-profit that certifies urban and agricultural operations based on the protection of water quality and native biodiversity. Founded by a leading US river and native fish conservation organisation, Salmon-Safe certifies organisations and sites based on riparian habitat protection, elimination of chemical pesticides harmful to fish, restoration of wetlands, reduction of runoff into streams, and other conservation practices.[498] By providing added value to certified products, voluntary certification schemes encourage management approaches around and sometimes inside PCAs that are beneficial to biodiversity and other ecosystem services, thus indirectly supporting management.

10. Conservation enterprises are businesses that generate economic, and ideally social, benefits in ways that help meet conservation objectives.[499] They stimulate biodiversity conservation by providing benefits to stakeholders engaged in producing and vending related goods and services. Enterprises range from ecotourism, sustainable fisheries, and handicrafts to the harvest of non-timber forest products like Australian crocodile eggs.[500,501]

These initiatives can be managed by protected and conserved area authorities, local communities or private contractors, often involving a conservation fee. However, in community-led cases, this fee might be waived to foster goodwill for conservation. Cooperation is crucial to ensure that these enterprises do not compromise conservation objectives and that benefits are equitably distributed.[502]

The collection within PCAs of non-timber forest products, such as crocodile eggs, highlights innovative and sustainable marketing practices. These ventures succeed when their products can compete with more intensive production methods on the open market. Often, conservation enterprises can charge higher prices than more destructive or 'business-as-usual' competitors, due to a proportion of consumers being willing to pay a premium for products associated with PCAs.

Appendix Case study compendium

Table A.1. Summary table and index to case studies

Management objectives	Designation type or mechanism	Case study	Inland water biome/ ecosystem(s)	Continent	Case study (CS) number/ location(s)
Examples of areas under IUCN protected area management categories					
Conservation	IUCN Category Ib protected areas	Fossil Springs Wilderness (USA)	Headwaters, springs, small river	North America	**CS 1**/Appendix
	IUCN Category II protected areas	Vjosa Wild River National Park (Albania)	Large river	Europe	**CS 2**/Appendix and Section 5.5.3
	IUCN Category III protected areas	Gachedili Canyon Natural Monument (Georgia)	Medium river	Europe	**CS 3**/Appendix
	IUCN Category IV protected areas	Laguna Torca (Chile)	Lake	South America	**CS 4**/Appendix
	IUCN Category V protected areas	Zones humides de l'Onilahy (Madagascar)	Wetlands	Africa	**CS 5**/Appendix
	IUCN Category VI protected areas	Pacaya-Samiria (Peru)	River and floodplain wetlands complex	South America	**CS 6**/Appendix
Areas designated under international conventions					
Conservation	UNESCO natural World Heritage Sites	Ivindo River World Heritage Site (Gabon)	Medium river, waterfalls	Africa	**CS 7**/Appendix
	UNESCO Biosphere reserve	Mura River Biosphere Reserve (Slovenia)	Transboundary, large river	Europe	**CS 8**/Appendix
	OECM & Ramsar site	Bita River (Colombia)	Large river, floodplain, wetland	South America	**CS 9**/Section 5.4.1, Field Study #4
	Ramsar site & Biosphere reserve	Dyfi Biosphere Reserve (Wales, UK)	Large river, floodplain	Europe	**CS 10**/Appendix
Other area-based approaches					
IP&LC territories	ICCAs – territories and areas conserved by Indigenous peoples and local communities	Paruku (Australia)	Medium river	Australia	**CS 11**/Appendix
	General IP&LC lands, waters and territories	Great Bear Rainforest (Canada)	Headwaters, small rivers, wetlands	North America	**CS 12**/Appendix
		Gayini (Australia)	Wetland, Medium river and floodplains	Australia	**CS 13**/Section 5.6, Field Study #6
Conservation and heritage	Rights of Nature	Rio Atrato (Colombia)	Medium river	South America	**CS 14**/Appendix and Section 5.5.1
	Sacred lakes, pools, springs and wells	Mai Pokhari (Nepal)	Lake	Asia	**CS 15**/Appendix and Section 5.5.2
	Cultural heritage areas	Krupa River (Croatia)	Medium river	Europe	**CS 16**/Appendix and Section 5.5.2
River-focused conservation	Fluvial reserve	San Franscisco River (Argentina)	Medium river	South America	**CS 17**/Section 5.5.3
		Nushiño-Curaray-Villano Community Fluvial Reserve (Ecuador)	Medium river	South America	**CS 18**/Section 5.5.6
	Wild & scenic river	Snake River headwaters (USA)	Small streams, medium rivers	North America	**CS 19**/Section 5.5.3
		Delaware River (USA)	Large river	North America	**CS 20**/Appendix

Table A.1. Summary table and index to case studies (continued)

Management objectives	Designation type or mechanism	Case study	Inland water biome/ ecosystem(s)	Continent	Case study (CS) number/ location(s)
Connectivity corridor conservation	Migratory corridor/ swimway	Pärnu River (Estonia)	Large river	Europe	**CS 21**/Appendix and Section 5.5.3
		Penobscot River (USA)	Large river	North America	**CS 22**/Section 5.5.3
	'Stepping stones' (stopover sites) for migratory birds	Laguna Mar Chiquita (Argentina)	Lakes, wetlands	South America	**CS 23**/Appendix
Groundwater-dependent ecosystem conservation	Wildlife Refuge	Okefenokee National Wildlife Refuge (USA)	Peatland, flooded forest, wetland	North America	**CS 24**/Section 4.2.2
	National Park	Ash Meadows (USA)	Spring-fed geothermal pool, limestone cavern	North America	**CS 25**/Section 5.5.4
Water reserves for conservation	Environmental water reserve	San Pedro Mezquital (Mexico)	Small and medium rivers, mangrove wetlands	South America	**CS 26**/Appendix and Sect.5.5.5
	Water flow reserve	Puelo and Futaleufú Rivers (Chile)	Medium rivers and floodplains	South America	**CS 27**/ Section.5.5.5
Provisioning/ regulating services	Source water protection areas	Upper Nile River basin/ Rwenzori Mountains National Park (Uganda)	Headwaters, small streams	Africa	**CS 28**/Appendix and Section 1.2.2
		Aguarico Chingual Cofanes Water Protection Area (Ecuador)	Headwaters, small streams	South America	**CS 29**/Section 5.5.6
	Riparian protection areas (water quality)	National riparian protection zones (Mongolia)	All rivers	Asia	**CS 30**/Appendix and Section 4.2.1
	Flood risk reduction	Flood Safety Act (USA)	River corridors	North America	**CS 31**/Sect.5.5.6
		Biloxi Marsh, Louisiana (USA)	Estuary, wetland	North America	**CS 32**/Appendix
	Area-based pollution control + corridor	Rio Muelas River Reserve (Spain)	Large river	Europe	**CS 33**/Appendix
	Carbon capture areas	Mawas Peatlands (Indonesia)	Peatlands, wetland	Asia	**CS 34**/Appendix and Section 5.5.6
	Fish reserves	Mae Ngao River Community Reserves (Thailand)	Medium river	Asia	**CS 35**/Appendix and Section 5.3.1, Field Study #3
		Lake Tanganyika (Africa)	Large lake	Africa	**CS 36**/Section 5.5.7, Field Study #5
Eco-tourism/ recreation	Seasonal wetland and floodplain reserve	Kadwa Kosi Floodplains (India)	Large river, floodplain wetlands	Asia	**CS 37**/Appendix
	Recreational fishing rivers	Onon River (Mongolia)	Medium rivers	Asia	**CS 38**/Appendix
	Boating, swimming	Isojärvi National Park (Finland)	Lake	Europe	**CS 39**/Appendix
Military/ defence	Military buffer zones	Hero River (Ukraine)	Medium river, floodplain, wetlands	Europe	**CS 40**/Appendix

Table A.2 Case study index by thematic area

Thematic area	Select cases
Governance or management led or co-led by Indigenous peoples and local communities	CS 5 Zones humides de l'Onilahy (Madagascar); CS 11 Paruku (Australia); CS 13 Gayini (Australia); CS 18 Nushino-Curaray-Villano Community Fluvial Reserve (Ecuador); CS 35 Mae Ngao River Community Reserves (Thailand); CS 36 Lake Tanganyika (Tanzania, Zambia, DRC); CS 37 Kadwa Kosi Floodplains (India)
Basin-scale conservation areas	CS 2 Vjosa Wild River National Park (Albania); CS 8 Mura River Biosphere Reserve (Slovenia); CS 9 Bita River (Colombia); CS 17 San Franscisco River (Argentina)
Includes Integrated River Basin Management	CS 20 Upper Delaware River (USA); CS 30 National riparian protection zones (Mongolia)
KBA/IBA/Natura 2000	CS 4 Laguna Torca (Chile); CS 8 Mura River Biosphere Reserve (Slovenia); CS 10 Dyfi Biosphere Reserve (Wales, UK); CS 16 Krupa River (Croatia); CS 21 Pärnu River (Estonia)
Key Ecological Attributes	
Hydrologic regime	CS 20 Upper Delaware River (USA); CS 26 San Pedro Mezquital (Mexico); CS 27 Puelo and Futaleufú Rivers (Chile); CS 34 Mawas Peatlands (Indonesia)
Connectivity	CS 1 Fossil Springs Wilderness (USA); CS 2 Vjosa Wild River National Park (Albania); CS 21 Pärnu River (Estonia)
Water quality	CS 33 Rio Muelas Reserve (Spain); CS 30 National riparian protection zones (Mongolia)
Physical habitat	CS 1 Fossil Springs Wilderness (USA); CS 15 Mai Pokhari (Nepal); CS 17 San Franscisco River (Argentina)
Biotic composition	CS 19 Snake River headwaters (USA); CS 25 Ash Meadows (USA); CS 36 Lake Tanganyika (Tanzania, Zambia, DRC)
Integrated across KEAs	CS 13 Gayini (Australia); CS 16 Krupa River (Croatia); CS 19 Snake River headwaters (USA); CS 17 San Franscisco River (Argentina)
Stressors targeted with conservation area designation and management	
Development/tourism	CS 3 Gachedili Canyon Natural Monument (Georgia); CS 19 Snake River headwaters (USA)
Extraction/mining	CS 14 Rio Atrato (Colombia); CS 18 Nushino-Curaray-Villano Community Fluvial Reserve (Ecuador); CS 20 Upper Delaware River (USA); CS 28 Upper Nile River basin/Rwenzori Mountains National Park (Uganda); CS 30 National riparian protection zones (Mongolia); CS 36 Lake Tanganyika (Tanzania, Zambia, DRC)
Dams/hydropower/water withdrawal	CS 2 Vjosa Wild River National Park (Albania); CS 16 Krupa River (Croatia); CS 21 Pärnu River (Estonia); CS 24 Okefenokee National Wildlife Refuge (USA); CS 26 San Pedro Mezquital (Mexico); CS 27 Puelo and Futaleufú Rivers (Chile)
Fisheries	CS 6 Pacaya-Samiria (Peru); CS 36 Lake Tanganyika (Tanzania, Zambia, DRC)
Agriculture/forestry	CS 5 Zones humides de l'Onilahy (Madagascar); CS 9 Bita River (Colombia); CS 33, Rio Muelas River Reserve (Spain)

CS 1. Protecting a river as part of an IUCN Category Ib Wilderness area

Name	Fossil Springs Wilderness and Wild and Scenic River (USA)
Designation type	IUCN Category Ib National Wilderness area within the Coconino National Forest, US Wild and Scenic River
Designation status	Established 1984
Primary aim	Preserve wilderness values and wildlife
Governance type	State (US Forest Service)

Category Ib Wilderness PAs are usually large, unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed to preserve their natural condition. The 42.21 km^2 Fossil Springs Wild and Scenic River lies at the bottom of a canyon at the edge of the Colorado Plateau, with a large and constant water flow that supports a diverse riparian ecosystem, with over 30 species of trees plus many mammals such as mountain lion, black bear and javelina, along with over a hundred species of birds. The area is set in a desert landscape. The area has undergone significant restoration, including in particular the removal of an early 20th century hydroelectric system that dammed the river and diverted most of the flow.[503] Native invertebrate[504] and fish populations have recovered although with some effort for fish, including removal of non-native species and installation of fish barriers to prevent arrival of invasive species from downstream.[505] Upon restoration of the river's connectivity, in 2009 Fossil Creek was designated a Wild and Scenic River.[506] The broader wilderness area has experienced serious degradation in recent years due to forest fires. However, the restored riparian areas along the designated river moderated the fire damage and the area is once again open to the public.

CS 2. Europe's first wild river national park connecting source to sea

Name	Vjosa Wild River National Park (Albania)
Designation type	IUCN Category II protected area
Designation status	Designated in 2023
Primary aim	Protect the wild nature of the river (free flowing), its native biodiversity and ecosystem processes, recreation and education
Governance type	Federal or national ministry or agency

The Vjosa is one of Europe's last wild rivers, connected and free-flowing from source to sea. It provides habitat for more than 1,100 species including 15 globally threatened species as well as cultural and economic services to 60,000 Albanians living along its shores.[507] These values have helped Blue Heart of Europe make a case for its special care and stewardship in their campaign for a National Park designation to avoid conversion from proposed hydropower and oil and gas development. In early 2022, the Albania Ministry of Tourism and Environment expressed their support for establishing the Vjosa as Europe's first Wild River National Park and in March 2023, the area was declared under Albania's Protected Areas Law No. 81/2017.[508] The Park boundaries cover 12,727 hectares including the entire length of the Vjosa River and its four tributaries the Drino, Kardhiq, Bënça, and Shushica.

The National Park is divided into two zones; Core I and Core II. Core I is the area of highest protection and covers 93 per cent of the park including the active river channel, floodplains and canyon slopes. Core II covers 7 per cent of the area and includes pastures and agriculture where traditional activities do not affect the ecological integrity of the Vjosa River system. A framework for protection has been drafted with support from IUCN, EuroNatur, EcoAlbania, Riverwatch and the Patagonia company.[509,510] In mid-2024, a proposal to divert water from the Shushica tributary raised questions about the extent to which environmental flows are protected within the park boundaries and studies are ongoing.

CS 3. Protecting a river canyon as an IUCN Category III natural monument

Name	Gachedili Canyon Natural Monument (Georgia)
Designation type	IUCN Category III protected area
Designation status	Designated as a natural monument, 2013
Primary aim	The main aim is to preserve the physical character and integrity of a canyon and associated caverns on the Abasha River
Governance type	National ministry

Category III is complex, in that it is often based on a physical feature or a sacred natural site, and geology is a stronger driver than biodiversity. Gachedili Canyon is a typical Category III natural monument, small in size (1.68 km^2) and protected due to a series of dramatic physical features; the site is famous for its deep blue green water.[511] Until recently the canyon was scarcely known outside the region. After designation, the site became a magnet for tourists and suffered overcrowding, including several accidents. Visitor numbers are now limited; there are three viewing platforms and a boat trip along several hundred metres of the canyon. Although the site is primarily aimed at preserving a particular geography, it contains important biodiversity and a cave-dwelling leech new to science was reported from there in 2021.[512]

CS 4. Lacustrine Key Biodiversity Area protected as an IUCN Category IV PA

Name	Laguna Torca (Chile)
Designation type	IUCN Management Category IV
Designation status	Designated 1975, expanded 1986
Primary aim	Nature conservation and research
Governance type	Federal or national ministry or agency and managed by Corporación Nacional Forestal (CONAF)

The management aim of a Category IV PA is to protect particular species or habitats. The 604-ha Laguna Torca reserve is located in a lacustrine system made up of several lagoons on Chile's coast, south of Santiago. This site is a KBA and an IBA.[513] It provides habitat for high densities of over 90 species of birds, including the coscoroba swan (*Coscoroba coscoroba*) and the black-necked swan (*Cygnus melancoryphus*) of which record numbers were recorded in January 2023.[514] The area is also home to coypu (*Myocastor coypus*), culpeo fox (*Lycalopex culpaeus*) and lesser grison (*Galictis cuja*), along with numerous fish species protected by the PA's no swimming, fishing or boating policy.[515]

CS 5. Collaborative conservation of inland waters under a Category V PA

Name	Zones humides de l'Onilahy (Madagascar)
Designation type	IUCN Category V Protected area, Ramsar site
Designation status	2017
Primary aim	The national park was established to preserve the endemic species and high ecological value of the river, in collaboration with local communities
Governance type	Collaboration between communities and WWF, an NGO

The management aim of IUCN Category V is to protect areas where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value, and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

In Madagascar, Category V has a more precise meaning than elsewhere, involving a high level of cultural integration and collaborative approaches to nature conservation.[516] The Amoron'i Onilahy community-run protected area encompasses a 75-km stretch of the lower Onilahy River, known as the Zones humides de l'Onilahy Ramsar site, in south-west Madagascar. The community protects the river's adjacent valleys, tributaries, lakes, marshes, swamps and gallery forests on each side of the river.

The site has a high level of endemism of flora and fauna with 56 reptile species including crocodiles, two species of freshwater turtles, amphibians and the recently identified toadfish *Allenbatrachus meridionalis*. The wetlands are threatened by the expansion of agriculture and by upstream charcoal production, which promotes erosion. WWF supported the establishment of the protected area and has helped local resource-dependent communities identify alternative sustainable livelihoods.

CS 6. Sustainable fisheries and water use under an IUCN Category VI PA

Name	Pacaya-Samiria (Peru)
Designation type	Seasonal wetland and floodplain reserve, National reserve, IUCN Management Category VI, Ramsar site
Designation status	Reserve established 1972
Primary aim	Originally to protect the *Arapaima gigas* fish[517]
Governance type	National government (Ministry of the Environment) through the National Service of Natural Protected Areas (SERNANP)

Category VI PAs allow for sustainable use of natural resources explicitly within their aims. These PAs conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

Pacaya-Samiria is a Peruvian wetland and floodplain reserve extremely rich in socio-cultural values and particularly freshwater biodiversity. The area provides habitat for two species of river dolphin, manatee, freshwater turtles and many fish species. The original aim in designating this protected area was to protect just arapaima, and important fish. However, this aim has grown and now SERNANP's stated goals for the area are to conserve representative ecosystems of the lowland forest of the Amazon in Peru and preserve its genetic diversity and to protect locally endangered flora and fauna species such as black caiman, giant otter and arapaima. The sustainable management of fish populations as an important food source for local communities is another stated management objective and is aligned with Category VI.

The two large river basins of the two-million-hectare Pacaya-Samiria reserve form a vast complex of permanent freshwater lakes, lagoons and seasonally flooded, tropical forested wetlands. The floodplain wetlands also provide an important service in flood management and prevention for the more than 120,000 people living in settlements within and surrounding the reserve.[518] This service may be especially important in years to come as climate change increases the level of flooding in the area.[519] The reserve has also been consistently identified as providing important water provision services.[520]

CS 7. A World Heritage Site protecting rivers and wetlands

Name	Ivindo River World Heritage Site (Gabon)
Designation type	World Heritage Site, IUCN Category II, Ramsar site
Designation status	National park established in 2002, given World Heritage status in 2021, Ramsar in 2009
Primary aim	To protect important habitat for endemism, speciation and threatened species
Governance type	Federal or national ministry or agency

Ivindo River World Heritage Site and Ivindo National Park encompasses 300,000 ha of forests crossed by a network of blackwater rivers and wetland clearings, feeding the mainstem Ivindo River. The mainstem river includes a series of iconic waterfalls and pools. The falls limit species' movement during low to average streamflow conditions, which has generated important sites for fostering speciation of fish and insects. The site's aquatic habitats harbour numerous endemic fish species, 13 of which are threatened, and many others are yet to be described. It has also been deemed an important habitat for threatened slender-snouted crocodiles, forest elephant, chimpanzee, western lowland gorilla and three species of pangolin. The Ivindo River flows into the Ogooué River and together, represent one of the few remaining large free-flowing rivers on the continent. Thus, the site meets WHS criteria IX and X. It is noted that Ivindo River World Heritage Site and National Park connect to the downstream Ivindo River Ramsar site.

This site is a protected area, providing ecosystem services for local communities including water purification and regulation.[521] An upstream mining proposal, adjacent forestry operations and a downstream hydropower proposal could affect the future water quality and connectivity of the site.

CS 8. UNESCO Biosphere Reserve connected through a 5-country transboundary network

Name	Mura River Biosphere Reserve (Slovenia)
Designation type	Biosphere Reserve, Natura 2000
Designation status	Designated 2018, linked to Mura-Drava-Danube Biosphere Reserve in 2021
Primary aim	To support a green and sustainable future that balances both economic and conservation goals
Governance type	Mixed

The Mura is the last large free-flowing river in Slovenia. It supports the highest fish biodiversity in the country, 70 per cent of which are threatened and provides high quality drinking water for 57,000 people.[522] The Mura River Biosphere Reserve was established in 2018. The 16,298-ha core and buffer zones make up the legally protected area (Natura 2000) and the 12,354-ha transition zone is an area for sustainable resource management, equivalent to a conservation area.[523] At the same time the Mura River site was being scoped, a network of 12 additional protected areas including Natura 2000 sites were being established across the transboundary Mura-Drava-Danube basin. In 2021, together with the Danube and Drava rivers in Austria, Croatia, Hungary, Slovenia and Serbia, the Mura-Drave-Danube Biosphere Reserve was established as a UNESCO Transboundary Biosphere Reserve, encompassing an area often referred to as "the Amazon of Europe," and marking the world's first 5-country Biosphere Reserve.

CS 10. Layered PAs, UNESCO Biosphere Reserve and Ramsar site to protect floodplains

Name	Dyfi Biosphere Reserve (Wales, UK)
Designation type	IUCN Category IV, IUCN Category V; UNESCO Biosphere Reserve; Ramsar sites; two privately protected areas
Designation status	Various parts declared protected areas at different times (1954, 1976, 1992), 1970 for bird reserve, 1976 for Ramsar, 2009 for UNESCO biosphere status.
Primary aim	"Maintaining the biosphere's diversity of its natural beauty, heritage and wildlife, and for its people's efforts to make a positive contribution to a more sustainable world…".[524]
Governance type	Mixed: one state-run PA, two PPAs, state and privately-run forestry and many small upland farms in private ownership.

The 840 km^2 Biosphere Reserve includes 78 km^2 of marine area and 762 km^2 of terrestrial and inland water area (Biosffer Dyfi Biosphere, n.d.), encompassing the length of the river, Afon Dyfi, estuary and surrounding hills. There are three core zones. The estuary core zone and much of the buffer zone form a floodplain, kept free of development and able to absorb regular flood events when the river inundates the floodplain, which happens several times a year,[525] thus reducing downstream flooding. At other times the floodplain is devoted to conservation (a bird reserve) or low-level grazing (cattle and sheep)[526], with some hay production. Tourism is the major source of income in rural areas. Afon Dyfi is a salmon and sea trout river, although both are declining, with salmon "at risk" and sea trout "probably at risk".[527] The area has multiple, often overlapping conservation designations and high wildlife value (it is also a recognised Important Bird Area), along with providing a range of ecosystem services.

CS 11. An Indigenous people's territory protecting terrestrial and inland water areas

Name	Paruku (Australia)
Designation type	ICCA/IPA, Buffer around lakes IUCN Category II and surrounding area/basin is IUCN Category VI
Designation status	Indigenous Protected Area title was recognised in 2001
Primary aim	To protect cultural and environmental values
Governance type	Indigenous-led with support from the government

Paruku is an Indigenous Protected Area (IPA) encompassing a huge wetland on the edge of the Great Sandy and Tanami deserts, in Western Australia. The Walmajarri believe their people were created by a star falling into the lakes and transforming itself into a man, becoming the very first Traditional Owner of Paruku. The lakes are the endpoint of many "Dreaming tracks" giving them great cultural importance to the aboriginal peoples. The lakes support at least 73 species of waterbird and 175 species of aquatic invertebrates. They provide a stopover for 16 species of migrant shorebirds and, during droughts, a major refuge and breeding pool for waterbird and are recognised as an Important Bird Area.

The lands and waters belong to the Walmajarri people and decisions for the IPA are made by a steering committee of sixteen elders, working with technical and financial support of the government. Prior to 2001, tourists were free to visit the area unmanaged and unmonitored, this along with unregulated cattle damaging wetlands and nesting habitats created some serious environmental impacts. Having declared Paruku as an IPA, the Traditional Owners can now regulate cattle and manage visitors through a permit system and education on minimizing their impact and respecting local environmental and cultural values.[528]

CS 12. First Nations protecting terrestrial and inland water areas

Name	Great Bear Rainforest (Canada)
Designation type	British Columbia Conservancy and Indigenous Protected and Conserved Areas
Designation status	Established 2009
Primary aim	Protect and sustainably manage the forests, rivers, wetlands and coastal waters in First Nations Territories
Governance type	Co-management between Indigenous peoples and the Province

In 2009, First Nations and the Province agreed to the protection and sustainable management of the Great Bear Rainforest, an area with rare and important free-flowing rivers from a region that sustains 20 per cent of the world's wild salmon. This partnership resulted in the Great Bear Rainforest Agreement, which was signed between First Nations and the British Columbia government in 2016. Here, the First Nations implement Ecosystem Based Management, promoting human well-being and ecology,[529] and have led 291 scientific research or habitat restoration initiatives, several of which were focused on salmon.[530]

CS 14. Rights of Rivers – building the foundation for biodiversity and biocultural rights

Name	Rio Atrato (Colombia)
Designation type	Rights of Nature / Rights of Rivers
Designation status	Constitutional rights recognised in 2016
Primary aim	Protect the rights of the river from infrastructure development
Governance type	Afro-Colombian and Indigenous communities of the Atrato, Ministry of the Environment

The Atrato River ecosystem, flowing 650 km and encompassing vast connected floodplains, is considered one of the ten most biodiverse spots in the world. In 2016, the Atrato River and its tributaries were granted legal personhood by the Colombian Constitutional Court with rights to protection, conservation and restoration.[531,532] This was in response to local Indigenous and Afro-Colombian communities that had filed a petition for guardianship of the river demonstrating that illegal mining was violating their right to a healthy environment, that they are interrelated with nature and that you cannot separate their rights to a healthy river from the well-being of nature itself.[533,534] A critical foundation to the Constitutional Court decision was the 1991 Constitutional recognition of Afro-Colombians and Indigenous peoples, creating the enabling conditions for standing and participation. Through their decision, the court recognised the Atrato River and its tributaries as an entity subject to rights, established biocultural rights and with them the recognition of the role that Indigenous and ethnic communities have played in preserving the region's natural resources, as well as recognising their territorial autonomy. The court decision contains eleven orders that include requirements to end illegal mining, develop and monitor for environmental indicators and conduct toxicology and epidemiological studies. The area is managed through the Guardians of the Atrato River, established by resolution and including the Ministry of the Environment and 14 guardians from communities in the region. This case helped to set a global legal precedent for the granting of rights to rivers.[535]

CS 15. Protecting a sacred lake with biodiversity conservation value

Name	Mai Pokhari Lake (Nepal)
Designation type	Sacred lake and Ramsar site
Designation status	Added to the Ramsar list in 2008
Primary aim	Ramsar designation notes the importance of the natural lake as a water source, for supporting significant biodiversity and as a site of spiritual significance to Buddhist, Taoist and Mundhum (animist) faiths.
Governance type	The site is managed by the local community and by religious leaders

The 90-ha Mai Pokhari Lake, sitting at 2,100 m elevation in a community forest area, is believed to have been created when nine goddesses descended to Earth and inhabited the nine corners of the lake, and any activity impacting the lake and its surrounding forest is thought to bring bad luck. Communities have traditionally revered the area for these reasons. The lake is also the site of religious festivals and the Maruni Dance, a traditional dance performed during Deepawali, the light festival. The site supports important biodiversity,[536,537,538] including aquatic fauna and species of the surrounding forest such as leopard cat and epiphytic orchids.[539] But preserving the spiritual value of the lake is the main objective driving its conservation. In their stewardship of the lake, local people conduct restoration activities including tree planting, and influential individuals within the community advocate for its protection. WWF is supporting this work through the 'Sacred Landscapes of the Himalayas' initiative,[540] the driving force of which is to maintain the religious significance of the lake and ensure that the current levels of biodiversity and ecosystem services are maintained.

Despite low levels of ecotourism,[541] the government did try to develop a tourism boating enterprise on the lake. This caused damage to lake vegetation, which is now being restored, and the enterprise was eventually abandoned following lobbying by the local community. The lake has some invasive species, including the goldfish (Carassius auratus) and water hyacinth (Eichhornia crassipes) and some pollution is reported. Villagers also report that old traditions are dying out and some of the religious significance of the area is in danger of being lost.

CS 16. Communities lobbying for protection of a river as a cultural heritage landscape

Name	Krupa River (Croatia)
Designation type	Cultural landscape and Natura 2000
Designation status	Designated 2019
Primary aim	Preservation from any interventions or developments that would threaten or destroy its values
Governance type	Ministry of Culture (country-level)

A little less than 11 km in length[542] the Krupa River is located at the foot of the Velebit Mountains in Zadar County near the village of the same name.[543] The Krupa is a karst river, cutting through a deep canyon (up to 300 m) where it meets the Zrmanja River and eventually flows into the Adriatic Sea. It is home to eight fish species, including three that are endemic to the Zrmanja River Basin and also hosts the globally threatened European eel. It is a rare location of tufa formations, a porous calcium carbonate deposit, which creates 19 waterfalls. The people of Krupa live above the canyon and agricultural fields along the river were historically accessed by horses and donkeys. To this day, only one road to the Krupa River exists that leads to a 14th century Orthodox monastery.

Based on its cultural significance and sheer natural beauty, the desire to protect the Krupa River began to take shape in the early 2000s. Between 2001 and 2016, a number of plans to develop hydropower plants were proposed on the Krupa River. Early hydropower proposals were stopped by a county employee. When proposed again in 2016, local communities with support from local and international organisations, used social media to bring visibility to the issue and coordinated members of the local government. They also proposed alternative options for meeting energy needs through solar and wind energy.

In 2019, after nearly two decades of advocacy, lobbying and the hard work of community members and conservation organisations, the Krupa River was protected through designation as a cultural heritage landscape. The Ministry of Culture used relevant legislation and noted that the Krupa River has a unique natural and cultural heritage.[544] This marked the first river in Croatia to be protected based on cultural significance and one of few in Europe. Under Croatian law, cultural heritage areas protect natural and cultural heritages from development. This success story sheds light on the advocacy power of community members and organisations, but also the importance of working with different levels of government. In the case of the Krupa River, it was more effective to build support with members of the local government first, rather than starting at a high level.

CS 20. More than 50 years as a Wild and Scenic River

Name	Delaware River (USA)
Designation type	National Recreation Area, National Wild and Scenic River
Designation status	National Recreation Area established in 1965 and W&SR in 1978 and 2000
Primary aim	Protect the free-flowing quality and its associated biodiversity and recreational values
Governance type	Cooperative through state and federal governments

The Delaware River is the longest free-flowing river in the eastern United States. The designation of the Upper Delaware river as a Wild and Scenic River occurred in 1978 with the initial passing of the U.S. Wild and Scenic Rivers Act. The designation covers 73.4 miles of the river, which is essential for fish that migrate from the ocean to spawn in freshwater ecosystems, such as the American shad (Alosa sapidissima) and America eel (Anguilla rostrata). The river also supports the federally endangered dwarf wedge mussel (Alasmidonta heterodon), which depends on migratory fish species to support reproduction (with the fish acting as a host for larval development). The Lower Delaware river was added to the national list of Wild and Scenic Rivers in 2000. The Delaware river supports 45 fish species, is an important source of water and has high recreational values alongside its importance as an unusual example of freshwater integrity. Given the demands on the river to supply drinking water to major cities including New York City, an environmental flow prescription has been established for the protected area. The Delaware River Basin Compact provides complementary protection authorities within the basin for environmental flows and water quality of the mainstem river and major tributaries. It was under Compact authorities that fracking was banned in the Delaware River Basin.

CS 21. Restoring and protecting migratory corridors, or swimways for salmon

Name	Pärnu River (Estonia)
Designation type	Salmon Migration and Spawning Habitat (Water Act & Nature Conservation Act), Natura 2000
Designation status	Natura 2000 in 1992, Dam removal 2019
Primary aim	To restore the free-flowing condition and important habitat of salmon and other fishes throughout their historic migration route
Governance type	National agency (restoration work led by Estonia's Environment Agency)

Building on the idea of 'flyways' for migratory birds, 'migratory swimways' are defined as "rivers and associated ecosystems that support the entire migration routes of biologically and/or socioeconomically important freshwater fishes."[545] Migratory fish are disproportionately threatened compared to other fish groups[546] and swimways lead to improved habitat, connectivity, ecosystem functioning and nutrient transport. A Global Swimways programme provides metrics to assess development impacts and identify rivers in need of restoration and protection.

The Pärnu River (144 km) is the second longest river in Estonia, with 270 tributaries covering 20 per cent of the country.[547] The river was historically important for salmon, before dams and weirs impeded its flow and connectivity. The most significant barrier was the privately-owned 150 m wide, 4.5 m high Sindi Dam built in 1834, a mere 14 km from the estuary.[548] In an effort to restore salmon populations nationally, Estonia's Water Act includes a provision protecting the connectivity and flow of all rivers within the extent of historic salmon migration pathways by requiring effective fish passage at dams and barriers and sufficient water to support spawning migrations and habitats. Further, the 2004 Nature Conservation Act required protection of salmon spawning areas. Estonia's Environment Agency led the development of an Environmental Impact Assessment (including socio-economic costs) to comprehensively assess alternatives for dams to comply with the salmon protection regulations. It was determined that removal would be the cost-effective alternative. Estonia's Environment Agency led restoration efforts through a multi-year consultation process with non-profits, companies, academic institutes and local communities. After the consultation process, the Environment Agency removed the Sindi Dam as well as other smaller dams upstream. The majority (85 per cent) of the €15 million Pärnu River restoration project (2015–2023) was funded by the European Union, with the rest covered by the Estonian Government.[549] The government had to purchase the Sindi Dam and surrounding land for €1.3 million. The restoration enabled over 3,300 km of waterway to flow freely again, with salmon and other fish able to resume their natural migratory routes within the migratory swimway.[550] It provided considerable benefits from improved fisheries, flood protection, drinking water quality, and cultural aspects important to local communities and visitors including enhanced recreational opportunities like fishing, paddling and other nature-based tourism. In terms of averted costs, Estonia's Environment Agency estimates the dam's impact on nature was costing about €4 million annually.[551] Restoration efforts also helped Estonia meet the EU Framework Directive goal to restore salmon habitat.

Moving forward, it is important that the restored condition of the Pärnu River is sustained through legal and other effective mechanisms. The river and floodplain are recognized as a Natura 2000 site. In addition, Estonia's Nature Conservation Act (2004), prohibits the construction (including reconstruction) of dams, alteration of the natural channel bed or water regimes in spawning areas for salmon and other migratory fish.

CS 23. Protecting stepping-stones along migratory bird flyways

Designation type	IUCN Management Category VI, Ramsar site
Designation status	Designated as a Multi-Use Provincial Reserve (VI) in 1994
Primary aim	To provide stepping stone (stopover) habitats for migratory birds
Governance type	Provincial government

The Western Heritage Shorebird Reserve Network (WHSRN) is made up of 15.7 million hectares across 114 sites in 18 participating countries in North and South America.[552] The WHSRN represents some of the most important habitat and stopover sites for shorebirds and migratory birds in the Americas. WHSRN relies on in-country partners to ensure the relevant conservation for the sites.

Many sites are inland waters that provide habitat for dozens of bird species, such as Laguna Mar Chiquita, South America's largest lake,[553] a huge, permanent, saline lagoon up to 4 m deep, edged by brackish water. Laguna Mar Chiquita has been listed as a VI protected reserve since 1994. Many stopover sites world-wide that are currently not actively protected, but are delivering effective long-term conservation, would be ideal places to prioritise for protection and conservation designations.

CS 26. Water reserve safeguards environmental flow and sediment regimes

Name	San Pedro Mezquital River (Mexico)
Designation type	Environmental water reserve, overlapping Ramsar sites and protected areas
Designation status	Established (2014) – Mexico's first water reserve
Primary aim	Providing water, particularly in the face of changing climate, by maintaining natural flow and sediment regimes.
Governance type	Ministry of Culture (country-level)

In 2008, the Government of Mexico inquired with the Federal Electricity Commission about the potential to construct the Las Cruces hydropower dam along the San Pedro Mezquital River. In 2009, non-profit organisations presented a petition to the Secretariat of the Ramsar Convention detailing concerns about how the dam would affect the river and its resources. In September 2014, Mexico's Secretariat of Environment and Natural Resources authorised the Las Cruces dam project with a set of 18 conditions, including that it should not violate the Environmental Water Reserve. Experts, including scientists from local, regional and national universities, representatives from federal agencies, and NGOs, among others, indicated that the project design and proposed operation would not fulfil environmental flow requirements. As originally designed, the dam would modify the hydrology of the river and reduce the linkage between the river and the Marismas Nacionales.[554] Thus, the construction of the dam has been delayed unless it can meet the environmental flow requirements, in addition to the other 17 conditions set out in the decree.

The San Pedro Mezquital is the last free-flowing river in the western Sierra Madre Mountains in Mexico. As the river flows 540 km en route to the Pacific Ocean, the mainstem of the river ebbs and flows depending on the time of year.[555] During the rainy season, the San Pedro Mezquital swells with runoff, inundates the floodplain, and supplies the water and nutrients that support the highly productive Marismas Nacionales (National Wetlands, Biosphere Reserve and Ramsar site), home to a 200,000-ha mangrove forest. During high flows, the river spreads across its floodplain, depositing nutrient-rich sediment. As such, agriculture and fisheries sustain the surrounding 432 local communities.

The San Pedro Mezquital was the first Environmental Water Reserve designated by Mexico with around 80 per cent of its mean annual runoff allocated to ensure water and nutrients are supplied to the Marismas Nacionales. In September 2014, the President of Mexico signed a decree for the 11 sub-basins that constitute the San Pedro Mezquital Basin.[556] This Reserve decree outlines three segments of use: one for domestic use, another for hydropower generation, and the third for the environment. The Environmental Water Reserve regulates any water-related infrastructure. Before construction can be authorised, projects must prove that they will not exceed the Environmental Water Reserve and negatively affect flow to the Marismas Nacionales. In addition to environmental flow requirements, other conditions placed on development within the Reserve include sediment parameters and protection of social resources related to Indigenous peoples' rights and land (cultural sites), among others. The San Pedro Mezquital Basin is one of six pilots designed to test the effectiveness of implementing water reserves and associated flow regimes.[557] It is anticipated that this Reserve will protect and maintain connectivity for seven aquifers, three natural protected areas, two Ramsar sites and 100 protected species in the region.

The main obstacle hindering the implementation of environmental flows and guaranteeing water security in Mexico is lack of water in the dry season. The reserves serve as a means of addressing water security issues as well as adapting to climate variability. The water reserve represents a percentage of the mean annual runoff which can be used to buffer climate impacts and help to manage risks.

CS 28. Protecting an important water source for the River Nile

Name	Rwenzori Mountains National Park (Uganda)
Designation type	Source water protection area, national park, World Heritage Site (VII and X), Ramsar site
Designation status	National park established 1993
Primary aim	To protect a vital water basin for drinking, irrigation, hydropower and a source of fish and cultural-political value in provisioning water to the Nile
Governance type	Government-owned and managed by the Ugandan Wildlife Authority (UWA)

The Rwenzori Mountains National Park covers nearly 100,000 ha and comprises the main part of the Rwenzori Mountain chain.[558] The Rwenzori's extensive upland bogs act as a huge sponge absorbing and regulating the rainfall, constituting a vital water basin.[559] Its glaciers, waterfalls and lakes are the highest and most permanent source of water for the River Nile and the biggest contributor of water in the region for domestic and industrial use. These waters supply 500,000 Ugandans with flood protection, water for drinking, irrigation and hydropower and inflow to Lakes Rutanzige and George. The park's long history of protection as a vital water catchment area has contributed to the protection of this site from external threats. However, there are concerns that the potential reopening of a copper mine located adjacent to the park may create water pollution and damage the park's rich aquatic biodiversity including endemic species of fish that are sensitive to water pollution.[560]

CS 30. National-scale planning to protect riparian run-off zones from mining and industrial activities

Name	National riparian protection zones (Mongolia)
Designation type	Riparian protection zones, Integrated River Basin Management Plans
Designation status	Approved in 2020: millions of hectares of riparian and adjacent areas now considered nationally protected
Primary aim	To protect water basins from the negative effects of mining and infrastructure
Governance type	National, regional and local governments

Mongolia has relatively scarce water resources on which people and biodiversity depend. Over the past decades, rapid growth of the industrial mining sector has resulted in significant impacts and sustained threats to freshwater ecosystems. In response, the Government of Mongolia has passed progressive laws to manage and protect water resources at different scales. This includes the establishment of 29 River Basin Organizations (RBOs) responsible for developing Integrated River Basin Management Plans for each of the major basins in the country. Further, in 2009 the government made mining and other industrial activities in protected water zones illegal. This law was refined in 2012, differentiating ordinary from special (stricter) protection areas. The ordinary protection zone extends within 200 m of a water body and prohibits tree cutting, construction of buildings without wastewater treatment, storage of petroleum, chemicals, radioactive materials, fertilizers, and pesticides, and discharge of wastes and pollutants. The special protection zone extends within 50 m of a river, stream, natural spring, or floodplain, or may extend the length of riparian area; and within at least 100 m from a lake or other water bodies and prohibits mineral exploration and mining, gravel or stone mining, any construction of buildings and facilities, agricultural cropping, and timber harvest. Since accurate maps of riparian zones did not exists, a group of partners led by WWF-Mongolia, used a spatial model to develop a national delineation of riparian areas and worked with local RBOs to validate the information. Local governments have the authority to designate protection zones and River Basin Organizations were tasked with the monitoring and enforcement of riparian zones for 29 basins across Mongolia.[561]

By 2020, the government had declared 8.2 million hectares of riparian areas as protected zones across 29 river basins chosen for their role in maintaining aquatic habitat, water quality, and connectivity.

CS 32. Protecting a coastal river and wetland to reduce flood risk

Name	Biloxi River and Marsh (USA)
Designation type	Wildlife Management Area, Biloxi river marshes and coastal preserve (IUCN IV) and Biloxi river (IUCN V)
Designation status	Designated as a protected area in 1992
Primary aim	Storm and flood protection
Governance type	Co-management between Indigenous peoples and the Province

Between 1932 and 1990, the 11 km stretch of marsh surrounding Lake Borgne and the 16,000-hectare Biloxi Wildlife Management Area, Louisiana, lost over 6,300 hectares to flood and wave induced erosion. In recent years, some parts of the shoreline have receded up to 15 metres, greatly endangering the Wildlife Management Area and posing a risk to the City of New Orleans against storm and hurricane surges. The ecosystem has also suffered significant degradation from the unintended effects of the Mississippi River levees and the Mississippi River Gulf Outlet, which prevented annual over bank flooding. The Biloxi Marsh project focuses on restoration and minimizing shoreline retreat to help protect the Wildlife Management Area and dissipate hurricane surges threatening the New Orleans' newly rebuilt hurricane flood defences.

CS 33. Protecting an ecological corridor to reduce nutrients and support biodiversity

Name	Rio Muelas River Reserve (Spain)
Designation type	River reserve established under the EU Water Framework Directive
Designation status	Recognized in 2000
Primary aim	Nutrient reduction and water quality maintenance, Ecological corridor
Governance type	Regional River Basin Authority

The River Reserve is 8.39 km long and connects different protected areas in central-western Spain, namely Sierra de Gredos Nature to the north, and Valle del Tietar, thus acting as an ecological corridor. Approximately 7 km of the reserve is outside protected areas. It protects a range of priority species, including brown trout (*Salmo trutta*), otter (*Lutra lutra*), dipper (*Cinclus cinclus*), Iberian painted frog (*Discoglossus galganoi*), southern marbled newt (*Triturus pygmaeus*), plus some priority riparian habitats. Key actions includes exclusion zones and best management practices to control nonpoint source pollution, in particular nitrate as well as restoration activities in the riparian corridor. The site continues to have management challenges including illegal hunting, obstacles to water flow, unmanaged grazing and invasive species. Nonetheless, natural values remain largely intact.

CS 35. Community fish reserve network sustains livelihoods and fish biodiversity

Name	Mae Ngao Community Fish Reserve Network (Thailand)
Designation type	Community fish reserve
Designation status	Undesignated
Primary aim	Sustainable fisheries
Governance type	Indigenous communities

Over the last three decades Indigenous P'ganyaw (Karen) communities along the Mae Ngao River in the Salween basin have established a network of more than 50 no-take river reserves ranging between 0.2 and 2 km long. The communities were unified in their opposition to a national park designation, clear that their primary goal was the maintenance and augmentation of fish stocks. Communities delineate the boundaries, develop and enforce penalties for noncompliance and some cases sell licenses for catch and release angling. Relative to non-protected sites, the reserves contain an estimated 27 per cent more fish species, 124 per cent higher fish density, and 2,247 per cent more fish biomass.[562] In summary, based on the data collected from these fishery reserves, markedly increased fish richness, density and biomass was documented relative to adjacent areas and three indicators predicted increased fish diversity – reserve size, enforcement and connectivity. This suggests networks of small, community no-take reserves offer a model for protecting biodiversity and augmenting fisheries.

CS 37. Communities conserve wetland and floodplain for bird tourism

Name	Kadwa Kosi Floodplains (India)
Designation type	Community-conserved area
Designation status	The community landowners have yet to consent to the official recognition of this site as a PA or OECM.
Primary aim	Eco-tourism
Governance type	Community-led

The Kosi River and floodplains are a 1,600-ha community-conserved area that function as a breeding and foraging ground for the globally threatened greater adjutant stork. The wetlands also provide habitat for the black-necked stork, Asian woollyneck, lesser adjutant stork and painted stork. Other key fauna includes the endangered Gangetic dolphin, Indian monitor lizard, nilgai, wild boar, jackal, Indian grey mongoose, and species of turtles and snakes. There are also some large tree species and fruit orchards.[563]

The area is governed by local communities and elected members of the local village council with management support from the Mandar Nature Club (local NGO), Bhagalpur Forest Division (Department of Environment, Forest and Climate Change), and the local individuals.

The site provides a perfect ground for bird tourism and each year many naturalists and ornithologists from India and abroad visit the breeding sites of the greater adjutants and interact with the local community involved in bird conservation.[564]

CS 38. A national park safeguards culturally significant area and fly-fishing tourism

Name	Onon River (Mongolia)
Designation type	National Park (IUCN Category II) protects a portion of the river and basin
Designation status	Established in 2000, expanded in 2020
Primary aim	Multi-objective including cultural heritage, supporting eco-tourism, water supplies
Governance type	National ministry (Ministry of Environment and Tourism)

The Onon River is the historical birthplace of Chinggis Khan, it is also one of just two sources of the Amur River – the ninth-longest free-flowing river in the world, supporting millions of people across Mongolia, China, and Russia. Fly fishing tourism is a significant source of income for rural communities in the basin. In 2017, the government abolished the "U and B", gold mining company's Onon River license after the company polluted the river and changed the river flow direction without authorization. In 2020, the government officially designated large swaths of the Onon river watershed for protection by expanding the Onon Balj National Park. The protection prevents future mines, dams, and other development that would pollute, fragment, and alter the natural flow of nutrients and resources throughout the region.

CS 39. Recreation drives protection of Finland's Lakelands

Name	Isojärvi National Park (Finland)
Designation type	Recreational natural lake, National Park (II), Special Protection Area (Birds Directive)
Designation status	Designated as a protected area in 1998
Primary aim	Recreation and conservation
Governance type	Federal or national ministry or agency

Finland's Lakeland has 17 lakes where canoeing and boating are allowable recreational activities (National Parks.FI, 2022). The lakelands also provide important bird habitat. Isojärvi National Park protects one such area, an old logging site with a range of activities from hiking and canoeing to enjoying the views. Isojärvi is a clear-water lake formed at the bottom of a ravine. Its deepest point is more than 70 m, it is 20 km long and as narrow as a fjord in places, making it ideal for exploring the lake edges in a canoe. There are also two rowing boats for rent in Kalalahti bay. In addition to canoeing and boating, visitors to the park can swim in the lakes and enjoy hook and line and ice fishing.[565]

CS 40. A military defence area protecting inland waters

Name	Irpin wetlands, Hero River floodplain (Ukraine)
Designation type	Potential 'Hero River'; Military buffer zone
Designation status	Uncertain, reflooded February 2022
Primary aim	To act as a buffer for the city of Kyiv to invasions
Governance type	Uncertain

During the 2022 Russian invasion of Ukraine, the breaching of the Irpin dam at the end of February held back advancing Russian soldiers and tanks, and reflooded 13,000 ha of wetlands that were drained by the Soviets in the 1960s. For its role in protecting the city of Kyiv from multiple invasions, there are calls among cultural leaders for the floodplain to be officially protected as a 'Hero River' along with other natural areas in Ukraine that have helped to protect soldiers and civilians in the war effort.[566] The Hero River fringes the Polissia region; one of Europe's largest contiguous wetland and woodland areas; consisting of a dozen Ramsar sites and many protected areas that run along the northern border of the country. Before it was drained, the floodplain was a vast biodiversity hotspot composed of bogs, swamps and marshes providing habitat for giant catfish, sturgeon, wetland bird species and birds of prey, like the white-tailed eagle.[567]



Wetlands of the Polissia region. © Jody Bragger / Tellus Reserves

Officially protecting this river and floodplain and supporting the area to restore habitat would contribute to the connectivity of these sites and expand Ukraine's impressive wetland environment. Should the Ukrainian government prioritise conservation of the Irpin wetlands after the war, their primary goal may be to ensure the wetlands continue to act as a barrier to Russian aggression through a defensive rewilding approach.[568]

References

1 Salafsky, N., Mejía Cortez, P., de Meyer, K., Dudley, N., Klimmek, H., et al. (2024). A standard lexicon of terms for area-based conservation version 1.0. *Conservation Biology* **38**: e14269. https://doi.org/10.1111/cobi.14269

2 Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., et al. (2006). Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biological Reviews* **81** (2): 163–182. https://doi.org/10.1017/S1464793105006950

3 Arthington, Á.H., Naiman, R.J., Mcclain, M.E. and Nilsson, C. (2010). Preserving the biodiversity and ecological services of rivers: New challenges and research opportunities. *Freshwater Biology* **55** (1): 1–16. https://doi.org/10.1111/j.1365-2427.2009.02340.x

4 Strayer, D.L. and Dudgeon, D. (2010). Freshwater biodiversity conservation: Recent progress and future challenges. *Journal of the North American Benthological Society* **29** (1): 344–358. https://doi.org/10.1899/08-171.1

5 Garcia-Moreno, J., Harrison, I.J., Dudgeon, D., Claunitzer, V., Darwall, W., et al. (2014). Sustaining Freshwater Biodiversity in the Anthropocene. In: Bhaduri, A., Bogardi, J. and Marx, S. (eds.) *The Global Water System in the Anthropocene* (pp. 247–270). Delft, The Netherlands: GWSP, Springer, UNESCO-IHE.

6 Dudgeon, D., et al. (2006). Op cit

7 Strayer, D. and Dudgeon, D. (2010). Op cit.

8 UNEP and CBD. (2023). *GBO-5 Inland Water Highlights.* UNEP and CBD.

9 Fricke, R., Eschmeyer, W. and van der Laan, R. (2022). *Eschmeyer's Catalog of Fishes: Genera, Species, References.* California Academy of Sciences.

10 Collen, B., Whitton, F., Dyer, E.E., Baille, J.E.M., Cumberlidge, N., et al. (2013). Global patterns of freshwater species diversity, threat and endemism. *Global Ecology and Biogeography* **23** (1): 40–51. https://doi.org/10.1111/geb.12096

11 Edmonstone, M. (2023). *New Species 2022: The Freshwater Fish Species Described in 2022.* Shoal Conservation.

12 Thieme, M., Birnie-Gauvin, K., Opperman, J.J., Franklin, P.A., Richter, H., et al. (2023). Measures to safeguard and restore river connectivity. *Environmental Reviews* **32** (3): 366–386. https://doi.org/10.1139/er-2023-0019.

13 Shao, X., Fang, Y., Jawitz, J.W., Yan, J. and Cui, B. (2019). River network connectivity and fish diversity. *Science of The Total Environment* **689** (1): 21–30. https://doi.org/10.1016/j.scitotenv.2019.06.340

14 Stoffers, T., Buijse, A.D., Geerling, G.W., Jans, L.H., Schoor, M.M., et al. (2022). Freshwater fish biodiversity restoration in floodplain rivers requires connectivity and habitat heterogeneity at multiple spatial scales. *Science of The Total Environment* **838** (4): 156509. https://doi.org/10.1016/j.scitotenv.2022.156509

15 Zhang, Z., Ci, X., Hu, J., Bai, Y., Thornhill, A.H., et al. (2023b). Riparian areas as a conservation priority under climate change. *Science of The Total Environment* **858** (2): 159879. https://doi.org/10.1016/j.scitotenv.2022.159879

16 Perry, D., Praskievicz, S., McManamay, R., Saxena, A., Grimm, K., et al. (2024). Resilient riverine social-ecological systems: A new paradigm to meet global conservation targets. *WIREs Water*, e1753. https://doi.org/10.1002/wat2.1753.

17 Krosby, M., Theobald, D., Norheim, R. and McRae, B. (2018). Identifying riparian climate corridors to inform climate adaptation planning. *PLoS ONE* **13** (11): e0205156. https://doi.org/10.1371/journal.pone.0205156

18 Lees, A. and Peres, C. (2008). Conservation value of remnant riparian forest corridors of varying quality for Amazonian birds and mammals. *Conservation Biology* **22** (2): 439–449. https://doi.org/10.1111/j.1523-1739.2007.00870.x.

19 Riis, T., Kelly-Quinn, M., Aguiar, F.C., Manolaki, P., Bruno, D., et al. (2020). Global overview of ecosystem services provided by riparian vegetation, *BioScience* **70** (6): 501–514. https://doi.org/10.1093/biosci/biaa041

20 Mathews, R., Tenberg, A., Sjödin, J. and Lymer, B. (2019). *Implementing the source-to-sea approach: A guide for practitioners.* Stockholm: SIWI.

21 Brink, K., Gough, P., Royte, J., Schollerna, P.P. and Wanningen, H. (2018). *From sea to source 2.0. Protection and restoration of fish migration in rivers worldwide*. World Fish Migration Foundation.

22 Schindler, D., Scheuerell, M.D., Moore, J.W., Gende, S.M., Francis, T.B. and Palen, W.J. (2003). Pacific salmon and the ecology of coastal ecosystems. *Frontiers in Ecology* **1** (1): 31–37.

23 Russi, D., ten, Brink P., Farmer, A., Badura, T., Coates, D., et al. (2013). *The Economics of Ecosystems and Biodiversity for Water and Wetlands*. Brussels and Gland: IEEP and the Ramsar Secretariat.

24 Rinke, K., Keller, P.S., Kong, X., Borchardt, D. and Weitere, M. (2019). Ecosystem Services from Inland Waters and their Aquatic Ecosystems. In: Schröter, M., Bonn, A., Klotz, S., Seppelt, R. and Baessler, C. (eds.) *Atlas of Ecosystem Services: Drivers, Risks and Societal Responses.* Springer.

25 Lynch, A.J., Cooke, S.J., Arthington, A.H., Baigun, C., Bossenbroek, L., et al. (2023). People need freshwater biodiversity. *WIREs Water* **10**: e1633. https://doi.org/10.1002/wat2.1633

26 Convention on Wetlands. (2021). *Global Wetland Outlook: Special Edition 2021.* Gland, Switzerland: Secretariat of the Convention on Wetlands.

27 Capon, S., Chambers. L.E., MacNally, R., Naiman, R.J., Davies, P., et al. (2013). Riparian ecosystems in the 21st century: Hotspots for climate change adaptation? *Ecosystems* **16**: 359–381. https://doi.org/10.1007/s10021-013-9656-1

28 Gonçalves, D. and Hermoso, V. (2022). Global goals overlook freshwater conservation. *Science* 377: 380. https://doi.org/10.1126/science.add62

29 DeWit, W.,Lawson-Johns, J., Lottner, F. and Guinchard, J.-C. (2023). HighCost of Water: *The true value of water and freshwater systems to people and planet*. Gland, Switzerland, WWF.

30 Kayranli, B., Scholz, M., Mustafa, A. and Hedmark, Å. (2010). Carbon storage and fluxes in freshwater wetlands: A critical review. *Wetlands* **30**: 111–124. https://doi.org/10.1007/s13157-009-0003-4

31 Moomaw, W., Chmura, G.L., Davies, G., Finlayson, M., Middleton, B.A., et al. (2018). Wetlands in a changing climate: Science, policy and management. *Wetlands* **10**: 1007/s13157-018-1023-8.

32 Lin, Q., Liu, E., Zhang, E., Bindler, R., Nath, B., et al. (2022). Spatial variation of organic carbon sequestration in large lakes and implications for carbon stock quantification. *CATENA* **208**: 105768. https://doi.org/10.1016/j.catena.2021.105768

33 Joosten, H., Sirin, A., Couwenberg, J., Laine, J. and Smith, P. (2016). The role of peatlands in climate regulation. In: A. Bonn, et al. (eds.) *Peatland Restoration and Ecosystem Services.* Cambridge: Cambridge University Press.

34 Yang, C., Li, Z., Wang, S., Ran, F., Nie, X., et al. (2023). Anthropogenic activities control the source dynamics of sediment organic carbon in the lower reach of an inland river. *Water Research* 233: 119779. https://doi.org/10.1016/j.watres.2023.119779

35 Ewers Lewis, C., Carnell, P.E., Sanderman, J., Baldock, J.A. and Macreadie, P.I. (2018). Variability and vulnerability of coastal "blue carbon" stocks: A case study from Southeast Australia. *Ecosystems* **21**: 263–279. https://doi.org/10.1007/s10021-017-0150-z

36 Giosan, L., Syvitski, J., Constantinescu, S. and Day, J. (2014). Protect the world's deltas. *Nature* **516**: 31–33.

37 Noble, M., Duncan, P., Perry, D., Prosper, K., Rose, D., et al. (2016). Culturally significant fisheries: Keystones for management of freshwater social-ecological systems. *Ecology and Society* **21**: 22. https://doi.org/10.5751/ES-08353-210222

38 Vári, A., Podschun, S.A., Erős, T., Hein, T, Pataki, B., et al. (2022). Freshwater systems and ecosystem services: Challenges and chances for cross-fertilization of disciplines. *Ambio* **51** (1): 135–151. https://doi.org/10.1007/s13280-021-01556-4

39 FAO. (2020). *The State of World Fisheries and Aquaculture 2020.* Rome: FAO.

40 Dudley, N. and Stolton, S. (2003). *Running Pure: The importance of forest protected areas to drinking water.* Gland and Washington, DC: WWF International and The World Bank.

41 Verschuuren, B., Mallarach, J.M., Bernbaum, E., Spoon, J., Brown, S., et al. (2021). *Cultural and spiritual significance of nature. Guidance for protected and conserved area governance and management*. Best Practice Protected Area Guidelines Series No. 32, Gland, Switzerland.

42 Pearson, A., Shortridge, A., Delamater, P.L., Horton, T.H., Dahlin, K., et al. (2019). Effects of freshwater blue spaces may be beneficial for mental health: A first ecological study in the North American Great Lakes region. *PLoS ONE* **14** (8): e0221977. https://doi.org/10.1371/journal.pone.0221977

43 Maund, P., Irvine, K.N., Reevews, J., Strong, E., Cromie, R., et al. (2019). Wetlands for Wellbeing: Piloting a Nature-Based Health Intervention for the Management of Anxiety and Depression. *International Journal of Environmental Research and Public Health* **16**: 4413. https://doi.org/10.3390/ijerph16224413.

44 Kumar, R., McInnes, R.J., Everard, M., Gardner, R.C., Kulindwa, K.A.A., et al. (2017). *Integrating multiple wetland values into decision-making*. Ramsar Policy Brief No. 2. Gland, Switzerland: Ramsar Convention Secretariat.

45 Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C.A.J., et al. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology* **26**: 6134–6155. https://doi.org/10.1111/gcb.15310

46 IUCN. (2024). The IUCN Red List of Threatened Species. Version 2024-1. https://www.iucnredlist.org

47 Böhm, M., Dewhurst-Richman, N., Seddon, M., Albrecht, C., Allen, D., et al. (2020). The conservation status of the world's freshwater molluscs. Hydrobiologia **848**: 3231–3254. https://doi.org/10.1007/s10750-020-04385-w

48 WWF. (2022). Living Planet Report 2022 – Building a nature positive society. Gland: WWF.

49 Deinet, S., Scott-Gatty, K., Rotton, H., Twardek, W.M., Marconi, V., et al. (2024). The Living Planet Index (LPI) for migratory freshwater fish. 2024 Update. Technical Report. The Netherlands: World Fish Migration Foundation.

50 He, F., Zarfl, C., Bremerich, V., David, J.N.W., Hogan, Z., et al. (2019). The global decline of freshwater megafauna. Global Change Biology **25**: 3883–3892. https://doi.org/10.1111/gcb.14753

51 Keith, D.A., Rodríguez, J.P., Rodríguez-Clark, K.M., Nicholson, E., Aapala, K., et al. (2013). Scientific Foundations for an IUCN Red List of Ecosystems. PLoS ONE **8** (5): e62111. https://doi.org/10.1371/journal.pone.0062111

52 Convention on Wetlands. (2021). Global Wetland Outlook: Special Edition 2021. Gland, Switzerland: Secretariat of the Convention on Wetlands.

53 Grill, G., Lehner, B., Thieme, M., Geenen, B., Tickner, D., et al. (2019). Mapping the world's free-flowing rivers. Nature **569**: 215–221. https://doi.org/10.1038/s41586-019-1111-9

54 The Nature Conservancy, IUCN World Commission on Protected Areas, Conservation International and WWF. (2022). *A Pathway for Inland Waters in the 30x30 Target: Discussion Document*. Washington DC and Gland, Switzerland.

55 Lehner, B., Anand, M., Fluet-Chouinard, E., Tan, F., Aires, F., et al. (2024). Mapping the world's inland surface waters: An update to the Global Lakes and Wetlands Database (GLWD v2), *Earth System Science Data* [preprint], https://doi.org/10.5194/essd-2024-204, in review.

56 Linke, S., Lehner, B., Ouellet Dallaire, C., Ariwi, J, Grill, G., *et al.* (2019). Global hydro-environmental sub-basin and river reach characteristics at high spatial resolution. *Scientific Data* **6**, 283 (2019). https://doi.org/10.1038/s41597-019-0300-6

57 Abell, R., Allan, J.D. and Lehner, B. (2007). Unlocking the potential of protected areas for freshwaters. *Biological Conservation* **134**: 48–63. https://doi.org/10.1016/j.biocon.2006.08.017

58 Confluvio Consulting. (2024). Inland Waters – 30x30 Indicator Research. Unpublished report produced under consultancy for The Nature Conservancy.

59 Ibid.

60 Wetlands International, 2023. *Wetlands sustaining birdlife*. Leaflet.

61 Higgins, J.V., Zablocki, J., Newsock, A., Krolopp, A., Tabas, P. and Salama, M. (2021). Durable freshwater protection: A framework for establishing and maintaining long-term protection for freshwater ecosystems and the values they sustain. *Sustainability* **13** (4): 1950. https://doi.org/10.3390/su13041950.

62 Finlayson, C.M., Arthington, A.H. and Pittock, J. (eds.) (2018). *Freshwater ecosystems in protected areas: Conservation and management*. Routledge, Taylor & Francis Group.

63 Abell, R., et al. (2007). Op cit.

64 Tickner, D., Opperman, J.J., Abell, R., Acreman, M., Arthington, A.H., et al. (2020). Bending the curve of global freshwater biodiversity loss: An emergency recovery plan. *BioScience* **70** (4): 330–342. https://doi.org/10.1093/biosci/biaa002

65 Abell, R. et al. (2007). Op cit.

66 Ibid.

67 Ibid.

68 Karr, J.R. and Dudley, D.R. (1981). Ecological perspective on water quality goals. *Environmental Management* **5**: 55–68. https://doi.org/10.1007/BF01866609

69 Ibid.

70 Karr, J.R., Fausch, K.D., Angermeier, P.L., Yant, P.R. and Schlosser, I.J. (1986). *Assessing Biological Integrity in Running Waters: A method and its rationale*. Illinois Natural History Survey Special Publication 5. Champaign, Illinois.

71 Ibid.

72 Karr, J.R. (1991). Biological Integrity: A long-neglected aspect of water resource management. *Ecological Applications* **1** (1): 66–84. https://doi.org/10.2307/1941848.

73 Bunn, S.E. and Arthington, A.H. (2002). Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management* **30**: 492–507. https://doi.org/10.1007/s00267-002-2737-0.

74 Mathews, R. and Richter, B.D. (2007). Application of the indicators of hydrologic alteration software in environmental flow setting. *Journal of the American Water Resources Association* **43** (6): 1400–1413. https://doi.org/10.1111/j.1752-1688.2007.00099.x

75 Poff, N.L., Allan, J.D., Bain, M.B., Karr, J.R., Prestegaard, K.L., et al. (1997). The natural flow regime: A paradigm for river conservation and restoration. *BioScience* **47** (11): 769–784. https://doi.org/10.2307/1313099

76 Postell, S. and Richter, B. (2003). *Rivers for Life: Managing water for people and nature*. Covelo and London: Island Press.

77 Kendy, E., Apse, C. and Blann, K. (2012). *A practical guide to environmental flows for policy and planning.* The Nature Conservancy, Arlington, VA, USA.

78 Richter, B.D. and Thomas, G.A. (2007). Restoring environmental flows by modifying dams. *Ecology and Society* **12** (1)

79 Vannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R. and Cushing, C.E. (1980). The River Continuum Concept. *Canadian Journal of Fisheries and Aquatic Sciences* **37**: 130–137. https://doi.org/10.1139/f80-017

80 Ward, J.V. and Stanford, J.A. (1983). The serial discontinuity concept of lotic ecosystems. In: Fontaine, T.D. and Bartell, S.M. (eds.) *Dynamics of Lotic Ecosystems* (pp. 29–42). Ann Arbor: Ann Arbor Science.

81 Grill, G., et al. (2019). Op cit.

82 Carr, G.M. and Neary, J.P. (2008). *Water quality for ecosystem and human health*. UNEP/Earthprint.

83 Hall L.S., Krausman P.R. and Morrison M.L. (1997). The habitat concept and a plea for standard terminology. *Wildlife Society Bulletin* **24** (1): 173–182.

84 Frissell, C.A., Liss, W.J., Warren, C.E. and Hurley, M.D. (1986). A hierarchical framework for stream habitat classification: Viewing streams in a watershed context. *Environmental Management* **10** (2): 199–214. https://doi.org/10.1007/BF01867358

85 MacArthur, R.H. and MacArthur. J.W. (1961). On bird species diversity. *Ecology* **42**: 594–598. https://doi.org/10.2307/1932254

86 Tews, J., Brose, U., Grimm, V., Tielborger, K., Wichmann, M.C., et al. (2004). Animal species diversity driven by habitat heterogeneity/diversity: The importance of keystone structures. *Journal of Biogeography* **31**: 79–92. https://doi.org/10.1046/j.0305-0270.2003.00994.x

87 Gorman, O.T. and Karr, J.R. (1978). Habitat structure and stream fish communities. *Ecology* 59: 507–515.

88 Abell, R., Thieme, M.L., Revenga, C., Bryer, M., Kottelat, M., et al. (2008). Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. *BioScience* **58** (5): 403–414. https://doi.org/10.1641/B580507

89 Vaughn, C.C. (2018). Ecosystem services provided by freshwater mussels. *Hydrobiologia* **810**: 15–27. https://doi.org/10.1007/s10750-017-3139-x

90 Williams, J.D., Warren Jr, M.L., Cummings, K.S., Harris, J.L. and Neves, R.J. (1993). Conservation status of freshwater mussels of the United States and Canada. *Fisheries* **18** (9): 6–22. DO: 10.1577/1548-8446(1993)018<0006:CSOFMO>2.0.CO;2

91 Karr and Dudley. (1981). Op cit.

92 Finlayson, C. M., Arthington, A. H., and Pittock, J. (2018). *Freshwater ecosystems in protected areas*. Taylor & Francis.

93 Pittock, J., Baumgartner, L., Finlayson, C.M., Thiem, J.D., Forbes, J.P., et al. (2018). Managing threats to freshwater systems within protected areas. In: Finlayson, C.M., Arthington, A.H. and Pittock, J. (eds.) *Freshwater Ecosystems in Protected Areas* (pp. 84–109). Routledge, London.

94 Higgins et al. (2021). Op cit.

95 Convention on Wetlands. (2021). Op cit.

96 Zeiringer, B., Seliger, C., Greimel, F. and Schmutz, S. (2018). River Hydrology, Flow Alteration, and Environmental Flow. *Riverine Ecosystem Management* Chapter 8: 67–89.

97 Ibid.

98 Kingsford, R. and Biggs, H. (2012). *Strategic adaptive management guidelines for effective conservation of freshwater ecosystems in and around protected areas of the world,* Sydney: IUCN WCPA Freshwater Taskforce, Australian Wetlands and Rivers Centre.

99 Grill, G., et al. (2019). Op cit.

100 Thieme, M., Tickner, D., Grill, G., Carvallo, J.P., Goichot, M., et al. (2021). Navigating trade-offs between dams and river conservation. *Global Sustainability* **4**: e17. https://doi.org/10.1017/sus.2021.15

101 Xie, H. and Ringler, C. (2017). Agricultural nutrient loadings to the freshwater environment: The role of climate change and socioeconomic change. *Environmental Research Letters* **12** (10): 104008. https://doi.org/10.1088/1748-9326/aa8148

102 Stehle, S. and Schulz, R. (2015). Agricultural insecticides threaten surface waters at the global scale. *Proceedings of the National Academy of Sciences* **112** (18): 5750–5755. https://doi.org/10.1073/pnas.150023211

103 Treibskorn, R., Braunbeck, T., Grummt, T., Hanslik, L., Huppertsberg, S., et al. (2019). Relevance of nano- and microplastics for freshwater ecosystems: A review. *Trends in Analytical Chemistry* **119**: 375–392. https://doi.org/10.1016/j.trac.2018.11.023

104 Campanale, C., Massarelli, C., Savino, I., Locaputo, V. and Uricchio, V.F. (2020). A detailed review study on potential effects of microplastics and additives of concern on human health. *International Journal of Environmental Research and Public Health* **17** (4): 1212. https://doi.org/10.3390/ijerph17041212

105 UNICEF and WHO. (2020). *State of the world's sanitation: An urgent call to transform sanitation for better health, environments, economies and societies.* New York: United Nations Children's Fund and World Health Organization.

106 Collen et al. (2013). Op cit.

107 Revenga, C., Campbell, I., Abell, R., de Villers, P. and Bryer, M. (2005). Prospects for monitoring freshwater ecosystems towards the 2010 targets. *Philosophical Transactions of the Royal Society B: Biological Sciences* **360**: 397–413. https://doi.org/10.1098/rstb.2004.1595

108 Fluet-Chouinard, E., Stocker, B.D., Zhang, Z. *et al.* (2023). Extensive global wetland loss over the past three centuries. *Nature* **614**: 281–286. https://doi.org/10.1038/s41586-022-05572-6

109 Albert, J.S., Destounis, G., Duke-Sylvester, S.M., Magurran, A.E., Oberdorff, T., et al. (2020). Scientists' warning to humanity on the freshwater biodiversity crisis. *Ambio* **50** (25): 85–94. https://doi.org/10.1007/s13280-020-01318-8

110 Patino, J. and Estupinan-Suarez, L. (2016). Hotspots of wetland area loss in Colombia. *Wetlands* **36**: 935–943. https://doi.org/10.1007/s13157-016-0806-z

111 Mao, D., Luo, L., Wang, Z., Wilson, M.C., Zeng, Y., et al. (2018). Conversions between natural wetlands and farmland in China: A multiscale geospatial analysis. *Science of the Total Environment* **634**: 550–560. https://doi.org/10.1016/j.scitotenv.2018.04.009

112 Robertson, H., Ausseil, A.-G., Rance, B., Betts, H. and Pomeroy, E. (2019). Loss of wetlands since 1990 in Southland, New Zealand. *New Zealand Journal of Ecology* **43**: 3355.

113 Zou, Y., Wang, L., Xue, Z., Mingju, E., Jiang, M. et al. (2018). Impacts of agricultural and reclamation practices on wetlands in the Amur River Basin, Northeastern China. *Wetlands* **38**: 383–389. https://doi.org/10.1007/s13157-017-0975-4

114 Fluet-Chouinard et al. (2023). Op cit.

115 Convention on Wetlands. (2021). Op cit.

116 Davidson, N., Dinesen, L., Fennessy, S., Finlayson, C.M., Mcinnes, R., et al. (2020). Trends in the ecological character of the world's wetlands. *Marine and Freshwater Research* **71**: 127–138. https://doi.org/10.1071/MF18329

117 Dudgeon, D., et al. (2006). Op cit.

118 Cooke, S.J., Piczak, M.L., Nyboer, E.A., Michalski, F., Bennett, A., et al. (2023). Managing exploitation of freshwater species and aggregates to protect and restore freshwater biodiversity. *Environmental Reviews* **32** (3): 414–437. https://doi.org/10.1139/er-2022-0118

119 He, F., Zarfl, C., Bremerich, V., Henshaw, A., Darwall, W., et al. (2017). Disappearing giants: A review of threats to freshwater megafauna. *Wiley Interdisciplinary Reviews: Water 4* (3): e1208. https://doi.org/10.1002/wat2.1208

120 Kiruba-Sankar, R., Raj, P.J., Kumar, L.K., Jani Angel, J.R., Velmurugan, A., et al. (2018). invasive species in freshwater ecosystems – threats to ecosystem services. In: *Biodiversity and Climate Change Adaptation in Tropical Islands* (pp. 257–296). Port Blair, India: ICAR-Central Island Agricultural Research Institute.

121 Convention on Wetlands. (2021). Op cit.

122 Fullerton, A., Torgersen, C.E., Lawler, J.J., Steel, E.A., Ebersole, J.L. and Lee, S.Y. (2018). Longitudinal thermal hydrogeneity in rivers and refugia for coldwater species: Effects of scale and climate change. *Aquatic Sciences* **80** (1): 1–15. https://doi.org/10.1007/s00027-017-0557-9

123 IPCC. (2019). *IPCC Special Report on the ocean and cryosphere in a changing climate,* Paris: IPCC.

124 Joosten et al. (2016). Op cit.

125 Convention on Wetlands. (2021). Op cit.

126 Ibid.

127 Pittock, J. (2015). The nexus, biodiversity and ecosystems. In: Pittock, J., Hussey, K. and Dovers, S. (eds.) *Climate, energy and water* (pp. 283–302). Cambridge University Press.

128 Pittock, J., Corbett, S., Colloff, M.J., Wyrwoll, P., Alexandra, J., et al. (2023). A review of the risks to shared water resources in the Murray–Darling Basin. *Australasian Journal of Water Resources* **27** (1): 1–17. https://doi.org/10.1080/13241583.2023.2190493.

129 Maxwell, S.L., Cazalis, V., Dudley, N., Hoffmann, M., Rodrigues, A.S., et al. (2020). Area-based conservation in the twenty-first century. *Nature* **586** (7828): 217–227. https://doi.org/10.1038/s41586-020-2773-z

130 Higgins, J., Zablocki, J., Newsock, A., Krolopp, A., Tabas, P. and Salama, M. (2021). Durable freshwater protection: A framework for establishing and maintaining long-term protection for freshwater ecosystems and the values they sustain. *Sustainability* **13** (4): 1950. https://doi.org/doi.org/10.3390/su13041950

131 Abell, R., et al. (2007). Op cit.

132 Higgins et al. (2021). Op cit.

133 Ibid.

134 United Nations. (2007). United Nations Declaration on the Rights of Indigenous Peoples. Resolution adopted by the General Assembly on 13 September 2007.

135 WWF and IUCN WCPA. (2023). *A Guide to Inclusive, Equitable and Effective Implementation of Target 3 of the Kunming-Montreal Global Biodiversity Framework*: Version 1, August 2023.

136 Franks, P., Blythe, J., Campese, J., Dawson, N., Gurney, G., et al. (2024). *Advancing equitable governance in area-based conservation*, IUCN WCPA Issues Paper Series No. 3. Gland, Switzerland: IUCN.

137 UNGA. (2018). Human Rights Council. Report of the Special Rapporteur on the issue of human rights obligations relating to the enjoyment of a safe, clean, healthy and sustainable environment. A/HRC/37/59. New York: United Nations.

138 FAO. (2016). *Free Prior and Informed Consent: An indigenous peoples' right and a good practice for local communities. Manual for Project Practitioners*. Rome.

139 TNC. (2020). *The Nature Conservancy's Human Rights Guide for Working with Indigenous Peoples and Local Communities.* Arlington, VA.

140 USAID. (2021). *USAID Guidance on Monitoring Free, Prior, and Informed Consent (FPIC)*. Washington, DC, USA.

141 Cultural Survival and First Peoples Worldwide. (2023). *Securing Indigenous Peoples' Right to Self-determination: A Guide on Free, Prior and Informed Consent*. Cambridge, MA, USA: Cultural Survival.

142 WWF. (2019). *WWF Social Safeguards Standards Framework*. Gland, Switzerland.

143 CEPF. (2022). *CEPF Environmental and Social Management Framework (ESMF)*. Version 1.1. https://www.cepf.net/sites/default/files/cepf-environmental-and-social-management-framework-2022-en.pdf

144 Global Environment Facility. (2019). *Guidelines on GEF's Policy on Environmental and Social Safeguards*. Washington DC.

145 Franks et al. (2024). Op cit.

146 WWF and IUCN WCPA. (2023). Op cit.

147 Franks et al. (2024). Op cit.

148 McDermott, M., Mahanty, S. and Schreckenberg, K. (2013). Examining equity: A multidimensional framework for assessing equity in payments for ecosystem services. *Environment Science and Policy* **33**: 416–427. https://doi.org/10.1016/j.envsci.2012.10.006.

149 Friedman, R.S., Law, E.A., Bennett, N.J., Ives, C.D., Thorn, J.P. and Wilson, K.A. (2018). How just and just how? A systematic review of social equity in conservation research. *Environmental Research Letters* **13** (5): 053001.https://iopscience.iop.org/article/10.1088/1748-9326/aabcde/pdf

150 Fromerz, N. and Lyman, E. (2022). *Analyzing Freshwater Resource Rights in the Context of Indigenous Peoples and Local Communities: A Guidance Document for Consultants and Practitioners*. The Nature Conservancy.

151 Zhang, W., ElDidi, H., Masuda, Y.J., Meinzen-Dick, R.S., Swallow, K.A., et al. (2023a). Community-based conservation of freshwater resources: Learning from a critical review of the literature and case studies. *Society & Natural Resources* 36 (6): 733–754. https://doi.org/10.1080/08941920.2023.2191228

152 Meinzen-Dick, R.S. and Pradhan, R. (2002). *Legal pluralism and dynamic property rights*. CAPRi Working Paper 22. Washington, DC: International Food Policy Research Institute.

153 Fromherz, N. and Lyman, E. (2022). Understanding Freshwater Resource Rights in the Context of Indigenous Peoples and Local Communities: Substantive Advice: A guidance document for consultants and practitioners. Global Law Alliance for Animals and the Environment.

154 Zhang et al. (2023a). Op cit.

155 Convention on Wetlands. (2000). Establishing and strengthening local communities' and indigenous people's participation in the management of wetlands. Ramsar handbooks for the wise use of wetlands, Series 5. Gland, Switzerland: Ramsar Convention Secretariat.

156 Roux, D.J., Nel, J.L., Ashton, P.J., Deacon, A.R., de Moor, F.C., et al. (2008). Designing protected areas to conserve riverine biodiversity: Lessons from a hypothetical redesign of the Kruger National Park. *Biological Conservation* **141**: 100–117. https://doi.org/10.1016/j.biocon.2007.09.002.

157 Thieme, M.L., Sindorf, N., Higgins, J., Abell, R., Naidoo, R. and Barnett, A. (2016). Freshwater conservation potential of protected areas in the Tennessee and Cumberland River Basins, USA. *Aquatic Conservation: Marine and Freshwater Systems* **26** (S1): 60–77. https://doi.org/10.1002/aqc.2644

158 Higgins et al. (2021). Op cit.

159 Margules, C. and Pressey, R. (2000). Systematic conservation planning. *Nature* **405**: 243–253. https://doi.org/10.1038/35012251

160 Flitcroft, R., Abell, R., Harrison, I., Arismendi, I. and Penaluna, B.E. (2023). Making global targets local for freshwater protection. *Nature Sustainability* **6**: 1499–1502. https://doi.org/10.1038/s41893-023-01193-7

161 Pittock, J., Finlayson, C., Arthington, A., Roux, D., Matthews, J.H., et al. (2015). Managing freshwater, river, wetland and estuarine protected areas. In: Worboys, G.L., Lockwood, M., Kothari, A., Feary, S. and Pulsford, I. (eds.) *Protected area governance and management* (pp. 569–608). ANU E Press.

162 Leal, C.G., Lennox, G.D., Ferraz, S.F.B., Ferreira, J., Gardner, T.A., et al. (2020). Integrated terrestrial-freshwater planning doubles conservation of tropical aquatic species. *Science* **370** (6512): 117–121. https://doi.org/10.1126/science.aba758

163 Hermoso, V., Vasconcelos, R.P., Henriques, S., Filipe, A.F. and Carvalho, S.B. (2021). Conservation planning across realms: Enhancing connectivity for multi-realm species. *Journal of Applied Ecology* **58**: 644–654. https://doi.org/10.1111/1365-2664.13796

164 https://conservationstandards.org/about/

165 Acreman, M., Hughes, K.A., Arthington, A.H., Tickner, D. and Dueñas, M.A. (2020). Protected areas and freshwater biodiversity: A novel systematic review distils eight lessons for effective conservation. *Conservation Letters* **13** (1): e12684. https://doi.org/10.1111/conl.12684

166 Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D.J., et al. (2011). *Implementation Manual for Freshwater Ecosystem Priority Areas*. Report for the Water Research Commission.

167 Abell, R. (2002). Conservation biology for the biodiversity crisis: A freshwater follow-up. *Conservation Biology* **16** (5): 1435–1437. https://doi.org/10.1046/j.1523-1739.2002.01532.x

168 Opperman, J., Shahbol, N., Maynard, J., Grill, G., Higgins, J., et al. (2021). Safeguarding free-flowing rivers: The global extent of free-flowing rivers in protected areas. *Sustainability* **13** (5): 2805. https://doi.org/10.3390/su13052805

169 Thieme et al. (2020). Op cit.

170 Abell et al. (2007). Op cit.

171 Ward, J.V. (1989). The four-dimensional nature of lotic systems. *The North American Benthological Society* **8** (1): 2–8.

172 Fausch, K., Torgersen, C.E., Baxter, C.V. and Li, H. (2002). Landscapes to riverscapes: Bridging the gap between research and conservation of stream fishes. *Bioscience* **52**: 483–498. https://doi.org/10.1641/0006-3568(2002)052[0483:LTRBTG]2.0.CO;2

173 Perry, D., Praskievicz, S., McManamay, R., Saxena, A., Grimm, K., et al. (2024). Resilient riverine social-ecological systems: A new paradigm to meet global conservation targets. *Wiley Interdisciplinary Reviews: Water*: e1753. https://doi.org/10.1002/wat2.1753

174 Linke, S., Kennard, M.J., Hermoso, V., Olden, J.D., Stein, J. and Pusey, B.J. (2012). Merging connectivity rules and large-scale condition assessment improves conservation adequacy in river systems. *Journal of Applied Ecology* **49**: 1036–1045.

175 Linke, S., Pressey, R.L., Bailey, R.C. and Norris, R.H. (2011). Management options for river conservation planning: Condition and conservation revisited. *Freshwater Biology* **52** (5): 918–938. https://doi.org/10.1111/j.1365-2427.2006.01690.x

176 Juffe-Bignoli, D., Harrison, I., Butchart, S.H.M., Flitcroft, R., Hermeso, V., et al. (2016). Achieving Aichi Biodiversity Target 11 to improve the performance of protected areas and conserve freshwater biodiversity. *Marine and Freshwater Ecosystems* **26**: 133–151. https://doi.org/10.1002/aqc.2638

177 Nel, J.L., Roux, D.J., Maree, G., Kleynhans, C.J., Moolman, J., et al. (2007). Rivers in peril inside and outside protected areas: A systematic approach to conservation assessment of river ecosystems. *Diversity and Distributions* **13** (3): 341–352. https://doi.org/10.1111/j.1472-4642.2007.00308.x

178 Nel, J.L., Roux, D.J., Abell, R., Ashton, P.J., Cowling, R.M., et al. (2009). Progress and challenges in freshwater conservation planning. *Aquatic Conservation: Marine and Freshwater Systems* **19** (4): 474–485. https://doi.org/10.1002/aqc.1010

179 Perry et al. (2024). Op cit.

180 Convention on Wetlands. (2024). *Scaling up wetland conservation and restoration to deliver the Kunming-Montreal Global Biodiversity Framework: Guidance on including wetlands in National Biodiversity Strategy and Action Plans (NBSAPs) to boost biodiversity and halt wetland loss and degradation*. Ramsar Technical Report No. 12. Gland, Switzerland: Secretariat of the Convention on Wetlands.

181 Higgins, J.V., Bryer, M.T., Khoury, M.L. and Fitzhugh, T.W. (2005). A freshwater classification approach for biodiversity conservation planning. *Conservation Biology* **19** (2): 432–445. https://doi.org/10.1111/j.1523-1739.2005.00504.x

182 Thieme, M., Lehner, B., Abell, R., Hamilton, S.K., Kellndorfer, J., et al. (2007). Freshwater conservation planning in data-poor areas: An example from a remote Amazonian basin (Madre de Dios River, Peru and Bolivia). *Biological Conservation* **135** (4): 484–501. https://doi.org/10.1016/j.biocon.2006.10.054

183 Ochoa, V. and Urbina-Cardona, N. (2017). Tools for spatially modelling ecosystem services: Publication trends, conceptual reflections and future challenges. *Ecosystem Services* **26**: 155–169. https://doi.org/10.1016/j.ecoser.2017.06.011

184 Benra, F., De Frutos, A., Gaglio, M., Álvarez-Garretón, C., Felipe-Lucia, M. and Bonn, A. (2021). Mapping water ecosystem services: Evaluating InVEST model predictions in data scarce regions. *Environmental Modelling & Software* **138**: 104982. https://doi.org/10.1016/j.envsoft.2021.104982

185 Hermoso, V. (2024). Stress-testing protected areas against global change. *Biological Conservation* **291**: 110505. https://doi.org/10.1016/j.biocon.2024.110505

186 Hermoso, V., Linke, S., Prenda, J. and Possingham, H.P. (2011). Addressing longitudinal connectivity in the systematic conservation planning of fresh waters. *Freshwater Biology* **56**: 57–70. https://doi.org/10.1111/j.1365-2427.2009.02390.x

187 Hermoso, V., Cattarino, L., Kennard, M.J., Watts, M. and Linke, S. (2015). Catchment zoning for freshwater conservation: Refining plans to enhance action on the ground. *Journal of Applied Ecology* **52**: 940–949. https://doi.org/10.1111/1365-2664.12454

188 Pittock, J. and Finlayson, C.M. (2011). Australia's Murray-Darling Basin: Freshwater ecosystem conservation options in an era of climate change. *Marine and Freshwater Research* **62**: 232–243. https://doi.org/10.1071/MF09319.

189 Perry et al. (2024). Op cit.

190 Margules and Pressey (2000). Op cit.

191 Linke, S., Turak, E. and Nel, J. (2011). Freshwater conservation planning: The case for systematic approaches. *Freshwater Biology* **56** (1): 6–20.https://doi.org/10.1111/j.1365-2427.2010.02456.x

192 Ball, I.R., Possingham, H.P. and Watts, M.E. (2009). Marxan and relatives: Software for spatial conservation prioritization. In: Moilanen, A., Wilson, K.A. and Possingham, H.P. (eds.) *Spatial conservation prioritisation: Quantitative methods and computational tools* (pp. 185–210). Oxford University Press.

193 Moilanen, A., Lehtinen, P., Kohonen, I., Jalkanen, J., Virtanen, E.A. and Kujala, H. (2022). Novel methods for spatial prioritization with applications in conservation, land use planning and ecological impact avoidance. *Methods in Ecology and Evolution* **13**: 1062–1072. https://doi.org/10.1111/2041-210X.13819

194 CMP. (2020). *Open Standards for the Practice of Conservation Version 4.0*. Conservation Measures Partnership.

195 Conservation Coaches Network. (2024). Coaches Notebook: Chapter 7. Situation Analysis. https://www.ccnetglobal.com/coaches-notebook/7-situation-analysis/

196 Schäfer, T. (2019). Legal Protection Schemes for Free-Flowing Rivers in Europe. Brussels, Belgium: Living Rivers Foundation.

197 Foundations of Success. (2024). Recipes for Conservation: A Conservation Standards Toolkit. Working Draft, Phase 1. https://conservationstandards.org/library-item/cs-toolkit/

198 Convention on Wetlands. (2024). *Scaling up wetland conservation and restoration to deliver the Kunming-Montreal Global Biodiversity Framework: Guidance on including wetlands in National Biodiversity Strategy and Action Plans (NBSAPs) to boost biodiversity and halt wetland loss and degradation.* Annex 1. Ramsar Technical Report No. 14. Gland, Switzerland: Secretariat of the Convention on Wetlands.

199 Linke, S., Lehner, B., Ouellet Dallaire, C., Ariwi, J., Grill, G., et al. (2019). Global hydro-environmental sub-basin and river reach characteristics at high spatial resolution. *Scientific Data* **283** (6): 283. https://doi.org/10.1038/s41597-019-0300-6

200 Lehner, B., Anand, M., Fluet-Chouinard, E., Tan, F., Aires, F., et al. (2024). Mapping the world's inland waters: An update to the Global Lakes and Wetlands Database (GLWD v2). https://www.hydrosheds.org/products/glwd

201 Ouellet Dallaire, C., Lehner, B., Sayre, R. and Thieme, M. (2019). A multidisciplinary framework to derive global river reach classifications at high spatial resolution. *Environmental Research Letters* **14** (2). https://doi.org/10.1088/1748-9326/aad8e9

202 Abell, R., et al. (2008). Op cit.

203 Keith, D.A., Ferrer-Paris, J.R., Nicholson, E., Bishop, M.J., Polidoro, B.A., et al. (2022). A function-based typology for Earth's ecosystems. *Nature*, **610** (7932): 513–518. https://doi.org/10.1038/s41586-022-05318-4

204 IUCN. (2024). The IUCN Red List of Threatened Species. Version 2024-1. https://www.iucnredlist.org

205 IUCN. (2024). The IUCN Red List of Ecosystems. Version 2024-1. https://www.iucnrle.org/

206 BirdLife International. (2024). World Database of Key Biodiversity Areas. Version 2024. https://wdkba.keybiodiversityareas.org/

207 Convention on Wetlands. (2024). Ramsar Sites Information Service. Version 2024. https://rsis.ramsar.org/

208 BirdLife International. (2024). Important Bird Areas. Online Data Zone. https://datazone.birdlife.org/site/mapsearch

209 Global Biodiversity Information Facility. (2024). Open access biodiversity database. https://www.gbif.org/

210 AMAZON FISH. (2020). Amazon River Basin fish biodiversity database. https://www.amazon-fish.com/about

211 Freshwater Information Platform. (2024). Network for freshwater research database. http://www.freshwaterplatform.eu/

212 European Environmental Agency. (2022). Natura 2000 Network Viewer. https://natura2000.eea.europa.eu/

213 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Helmholtz Centre for Environmental Research (UFZ) and Conservation Strategies Fund. (2024). ValuES Method Navigator and Database.

214 European Commission. (2024). Joint Research Centre Data Catalogue. https://data.jrc.ec.europa.eu/collection/maes

215 Conservation Management Partnership. (2016). Threats and Actions Classifications. https://conservationstandards.org/library-item/threats-and-actions-taxonomies/

216 Grill, G., et al. (2019). Op cit.

217 WWF. (2022). Free-flowing Rivers Assessment Training Tools. https://world-wildlife-fund.gitbook.io/free-flowing-rivers

218 Lehner, B., Beames, P., Mulligan, M., Zarfl, C., De Felice, L., van Soesbergen, A., ... & Higgins, J. (2024). The Global Dam Watch database of river barrier and reservoir information for large-scale applications. Scientific Data, 11(1), 1069. https://www.nature.com/articles/s41597-024-03752-9.pdf

219 Macedo, H. E., Lehner, B., Nicell, J., & Grill, G. (2024). HydroFATE (v1): a high-resolution contaminant fate model for the global river system. *Geoscientific Model Development,* 17(7): 2877-2899. https://doi.org/10.5194/gmd-17-2877-2024

220 Linke, S., Lehner, B., Ouellet Dallaire, C., Ariwi, J., Grill, G., et al. (2019). Global hydro-environmental sub-basin and river reach characteristics at high spatial resolution. *Scientific Data* 283(6). https://doi.org/10.1038/s41597-019-0300-6

221 Barbarossa, V., Bosmans, J., Wanders, N., King, H., Bierkens, M. F., et al. (2021). Threats of global warming to the world's freshwater fishes. *Nature communications* 12(1). https://doi.org/10.1038/s41467-021-21655-w

222 Linke, S., Kennard, M. J., Hermoso, V., Olden, J. D., Stein, J., & Pusey, B. J. (2012). Merging connectivity rules and large-scale condition assessment improves conservation adequacy in river systems. *Journal of Applied Ecology*, 49(5): 1036-1045. https://doi.org/10.1111/j.1365-2664.2012.02177.x

223 da Silva, J. P., Hermoso, V., Lopes-Lima, M., Miranda, R., Filipe, A. F., & Sousa, R. (2024). The role of connectivity in conservation planning for species with obligatory interactions: Prospects for future climate scenarios. Global Change Biology 30(2), e17169. https://doi.org/10.1111/gcb.17169

224 Stein, J. L., Stein, J. A., & Nix, H. A. (2002). Spatial analysis of anthropogenic river disturbance at regional and continental scales: identifying the wild rivers of Australia. Landscape and urban planning, 60(1), 1-25. https://doi.org/10.1016/S0169-2046(02)00048-8

225 Mattson, K. M., & Angermeier, P. L. (2007). Integrating human impacts and ecological integrity into a risk-based protocol for conservation planning. *Environmental management*, 39:125-138. https://doi.org/10.1007/s00267-005-0238-7

226 UNEP World Conservation Monitoring Centre. (2024). World Database on Protected Areas and World Database on Other Effective Area-Based Conservation Measures. https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA

227 IUCN. (2024) IUCN Green List of Protected Areas. https://iucngreenlist.org/

228 Thieme, M., Lehner, B., Abell, R., Hamilton, S. K., Kellndorfer, J., Powell, G., & Riveros, J. C. (2007). Freshwater conservation planning in data-poor areas: an example from a remote Amazonian basin (Madre de Dios River, Peru and Bolivia). *Biological conservation*, **135**(4): 484-501. https://doi.org/10.1016/j.biocon.2006.10.054

229 Amis, M. A., Rouget, M., Lotter, M., & Day, J. (2009). Integrating freshwater and terrestrial priorities in conservation planning. Biological Conservation, **142**(10): 2217-2226. https://doi.org/10.1016/j.biocon.2009.04.021

230 Hermoso, V., Cattarino, L., Kennard, M. J., Watts, M., & Linke, S. (2015). Catchment zoning for freshwater conservation: refining plans to enhance action on the ground. *Journal of Applied Ecology*, **52**(4): 940-949. https://doi.org/10.1016/j.biocon.2009.04.021

231 Cañedo-Argüelles, M., Hermoso, V., Herrera-Grao, T., Barquín, J., & Bonada, N. (2019). Freshwater conservation planning informed and validated by public participation: The Ebro catchment, Spain, as a case study. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **29**(8): 1253-1267. https://doi.org/10.1002/aqc.3108

232 Mair, L., Bennun, L. A., Brooks, T. M., Butchart, S. H., Bolam, F. C., Burgess, N. D., ... & McGowan, P. J. (2021). A metric for spatially explicit contributions to science-based species targets. *Nature Ecology & Evolution*, **5**(6): 836-844. https://doi.org/10.1038/s41559-021-01432-0

233 Grill, G., Thieme, K.C., Kumar, J., Shahbol, N., Sada, R., et al. (2020). High conservation value river assessment – methodology and results, USAID Paani Program, DAI and WWF.

234 Abell, R., Lehner, B., Thieme, M. and Linke, S. (2016). Looking beyond the fenceline: Assessing the protection gaps for the world's rivers. *Conservation Letters* 10 (4): 384–394. https://doi.org/10.1111/conl.12312

235 Acreman et al. (2020). Op cit.

236 Finlayson, C.M., Arthington, A.H. and Pittock, J. (eds.) (2018). *Freshwater ecosystems in protected areas: Conservation and management*. Routledge, Taylor & Francis Group.

237 Hilty, J., Worboys, G.L., Keeley, A., Woodley, S., Lausche, B.J., et al. (2020). *Guidelines for conserving connectivity through ecological networks and corridors.* Best Practice Protected Area Guidelines Series No. 30. Gland, Switzerland: IUCN.

238 Opperman, J. J., Shahbol, N., Maynard, J., Grill, G., Higgins, J., Tracey, D., & Thieme, M. (2021). Safeguarding free-flowing rivers: the global extent of free-flowing rivers in protected areas. *Sustainability*, *13*(5), 2805.

239 Smith, M.P., Schiff, R., Olivero, A. and MacBroom, J.G. (2008). The Active River Area: A Conservation Framework for Protecting Rivers and Streams. Boston, MA: The Nature Conservancy.

240 Surenkhorloo, P., Buyanaa, C., Dolgorjav, S., Bazarsad, C., Zamba, B., et al. (2021). Identifying riparian areas of free flowing rivers for legal protection: Model region Mongolia. Sustainability 13 (2): 551. https://doi.org/10.3390/su13020551

241 Richter, B.B., Davis, M.M. and Konrad, C. (2011). A presumptive standard for environmental flow protection. *River Research and Applications*. https://doi.org/10.1002/rra.1511

242 King, J.M., Tharme, R.E. and de Villiers, M.S. (eds.) (2008). *Environmental Flow Assessments for Rivers: Manual for the Building Block Technology*. WRC Report TT 354/08. Cape Town: Water Research Commission.

243 Kendy, E. et al. (2012). Op cit.

244 Opperman, J.J., Kendy, E., Tharme, R.E., Warner, A.T., Barrios, E. and Richter, B.D. (2018). A three-level framework for assessing and implementing environmental flows. Frontiers in Environmental Science 6. DOI : 10.3389/fenvs.2018.00076

245 Grill, G. et al. (2019). Op cit.

246 Linke, S., Lehner, B., Ouellet Dallaire, C., Ariwi, J., Grill, G., et al. *(*2019). Global hydro-environmental sub-basin and river reach characteristics at high spatial resolution. *Scientific Data* **6**: 283. https://doi.org/10.1038/s41597-019-0300-6

247 https://world-wildlife-fund.gitbook.io/free-flowing-rivers

248 Pittock, J. and Hartmann, J. (2011). Taking a second look: Climate change, periodic re-licensing and better management of old dams. *Marine and Freshwater Research* **62**: 312–320. https://doi.org/10.1071/MF09302

249 O'Connor, J., Hale, R., Mallen-Cooper, M., Cooke, S.J. and Stuart, I. (2022). Developing performance standards in fish passage: Integrating ecology, engineering and socio-economics. *Ecological Engineering* 182, 106732. https://doi.org/10.1016/j.ecoleng.2022.106732

250 Huggins, X., Gleeson, T., Serrano, D., Zipper, S., Jehn, F., et al. (2023). Overlooked risks and opportunities in groundwatersheds of the world's protected areas. *Nature Sustainability* **6** (7): 855–864. https://doi.org/10.1038/s41893-023-01086-9

251 Thieme, M.L., Rudulph, J., Higgins, J. and Takats, J.A. (2012). Protected areas and freshwater conservation: A survey of protected area managers in the Tennessee and Cumberland River Basins, USA. *Journal of Environmental Management* **109**: 189–199. https://doi.org/10.1016/j.jenvman.2012.06.021

252 Dudley, N. (ed.) (2008). *Guidelines for Applying Protected Area Management Categories.* Gland, Switzerland: IUCN.

253 Ibid.

254 Stolton, S., Shadie, P. and Dudley, N. (2013). *IUCN WCPA Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types*. In: Dudley, N. (ed.) (2008). *Guidelines for Applying Protected Area Management Categories* – a reprint of the 2008 guidelines with additional guidance on assignment of categories. Best Practice Protected Area Guidelines Series No. 21, Gland, Switzerland: IUCN.

255 Stolton, S., Redford, K.H. and Dudley, N. (2014). *The Futures of Privately Protected Areas*. IUCN, Gland, Switzerland: IUCN.

256 Mitchell, B.A., Stolton, S., Bezaury-Creel, J., Bingham, H.C., Cumming, T.L., et al. (2018). *Guidelines for privately protected areas*. Best Practice Protected Area Guidelines Series No. 29. Gland, Switzerland: IUCN.

257 Dudley, N. (2008). Op cit.

258 Ibid.

259 CBD. (2018). *Protected areas and other effective area-based conservation measures (Decision 14/8)*. https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-08-en.pdf

260 CBD. (2022). Decision adopted by the Conference of the Parties to the Convention on Biological Diversity. CBD/COP/DEC/15/5. Monitoring framework for the Kunming-Montreal Global Biodiversity Framework.

261 Jonas, H.D., Wood, P. and Woodley S. (eds.) (2024). *Guidance on other effective area-based conservation measures (OECMs)*. IUCN WCPA Good Practice Series No.36. Gland, Switzerland: IUCN and WWF.

262 CBD. (2018). Conference of the Parties to the Convention on Biological Diversity. Fourteenth meeting. Decision adopted by the Conference of the Parties to the Convention on Biological Diversity. UN Environment Programme.

263 Fausch, K., Torgersen, C.E., Baxter, C.V. and Li, H. (2002). Landscapes to riverscapes: Bridging the gap between research and conservation of stream fishes. *Bioscience* **52**: 483–498. https://doi.org/10.1641/0006-3568(2002)052[0483:LTRBTG]2.0.CO;2

264 Jonas, H.D., MacKinnon, K., Marnewick, D. and Wood, P. (2023). *Site-level tool for identifying other effective area-based conservation measures (OECMs)*. First edition. IUCN WCPA Technical Report Series No. 6. Gland, Switzerland: IUCN.

265 Jonas, H.D. et al. (2024). Op cit.

266 Jonas, H.D. et al. (2023). Op cit.

267 Jonas, H.D. et al. (2024). Op cit.

268 Ibid.

269 Abell, R., Vigerstol, K., Higgins, J., Kang, S., Karres, N., et al. (2019). Freshwater biodiversity conservation through source water protection: Quantifying the potential and addressing the challenges. *Aquatic Conservation: Marine and Freshwater Ecosystems* **29** (7): 1022–1038. https://doi.org/10.1002/aqc.3091

270 Jonas, H.D. et al. (2023). Op cit.

271 Ibid.

272 Jonas, H.D. et al. (2024). Op cit.

273 Ibid.

274 The Nature Conservancy, Conservation International, IUCN World Commission on Protected Areas and WWF. (2022). *A Pathway for Inland Waters in the 30x30 Target: Discussion Document*. Washington DC and Gland, Switzerland.

275 Jonas, H.D. et al. (2023). Op cit.

276 https://www.ramsar.org/our-work/wetlands-international-importance.

277 Ramsar Convention Secretariat. (2010). *Addressing change in wetland ecological character: Addressing change in the ecological character of Ramsar Sites and other wetlands*. Ramsar handbooks for the wise use of wetlands, 4th edition, vol. 19. Gland, Switzerland: Ramsar Convention Secretariat.

278 Ramsar Convention Secretariat. (2014). *Change in Ecological Character of Wetland Sites: Ramsar Guidance and Mechanisms*. Gland, Switzerland: Ramsar Convention Secretariat.

279 Pittock, J., Finlayson, C., Gardner, A. and MacKay, C. (2010). Changing character: The Ramsar Convention on Wetlands and climate change in the Murray-Darling Basin, Australia. *Environmental and Planning Law Journal* **27** (6): 401–425.

280 Ramsar Convention Secretariat. (2010b). *Participatory skills: Establishing and strengthening local communities' and indigenous people's participation in the management of wetlands*. Ramsar Handbooks for the Wise Use of Wetlands, 4th edition, vol. 7. Gland, Switzerland: Ramsar Convention Secretariat.

281 International Court of Justice. (2011). Order for the Case of Costa Rice v. Nicaragua. March 8, 2011. General List No. 150.

282 Romero, M., O. Ocampo, H. Polanco and A. Sarmiento. (2016). *Análisis de Información Cartográfica, Elaboración del Mapa de Cobertura y Ecosistemas, y Las Unidades Hidrológicas Para el Río Bita*; Departamento De Vichada.

283 WWF and University of Maryland Centre for Environmental Science. (2016). *Orinoco River Basin Report Card*

284 Suárez, C.F., Paez-Vasquez, M., Trujillo, F., Usma, J.S., Thieme, M., et al. (2021). How to protect free flowing rivers: The Bita River Ramsar site as an example of science and management tools working together. *Sustainability*, *13*, 1775. https://doi.org/10.3390/su13041775

285 Suárez, C.F., Paez-Vasquez, M., Trujillo, F., Usma, J.S., Thieme, M., et al. (2021). How to protect free flowing rivers: The Bita River Ramsar site as an example of science and management tools working together. *Sustainability*, *13*, 1775. https://doi.org/10.3390/su13041775

286 Convention on Wetlands. (2021). *Global Wetland Outlook: Special Edition 2021.* Gland, Switzerland: Secretariat of the Convention on Wetlands.

287 Mauerhofer, V., Kim, R.E. and Stevens, C. (2015). When implementation works: A comparison of Ramsar Convention implementation in different continents. *Environmental Science & Policy* **51**: 95–105. https://doi.org/10.1016/j.envsci.2015.03.016

288 UNESCO. (2020). *Statutory framework of the World Network of Biosphere Reserves*. Paris

289 Ibid.

290 Higgins et al. (2021). Op cit.

291 International Center for the Rights of Nature. (2018). Rights of Nature: FAQs, Community Environmental Legal Defense Fund (Feb. 27,2018). Available from: https://celdf.org/rights/rights-of-nature/rights-nature/faqs/

292 Cyrus R. Vance Center for International Justice, Earth Law Center and International Rivers. (2020). *Rights of Rivers: A global survey of rapidly developing Rights of Nature jurisprudence pertaining to rivers*.

293 Cyrus R. Vance Center for International Justice et al. (2020). Op cit.

294 Safi, M. and Agencies. (2017). Ganges and Yamuna Rivers Granted Same Legal Rights as Human Beings. Guardian 21 March 2017.

295 Cyrus R. Vance Center for International Justice et al. (2020). Op cit.

296 Ibid.

297 Ibid.

298 https://www.rightsofrivers.org/#declaration

299 Davies, G.T., Finlayson, C.M., Pritchard, D.E., Davidson, N.C., Gardner, R.C., et al. (2021). Towards a Universal Declaration of the Rights of Wetlands. *Marine and Freshwater Research* **72**: 593–600. https://doi.org/10.1071/MF20219

300 Yurok Tribe. (2019). Resolution to the Yirok Tribal Council: Resolution establishing the Rights of the Klamath River.

301 Kauffman, C.M. and Martin, P.L. (2021). *The Politics of Rights of Nature: Strategies for building a more sustainable future*. Oxford University Press.

302 Science Learning Hub Pokapū Akoranga Pūtaiao. (2022). Mahingakai: New Zealand Government. Retrieved from: https://www.sciencelearn.org.nz/resources/3174-mahinga-kai

303 Kitson, J. and Cain, A. (2022). Navigating towards Te Mana o te Wai in Murihiku. *New Zealand Geographer* **78**: 92–97. https://doi.org/10.1111/nzg.12330

304 Papua New Guinea Travel. (2023). Sepik River Crocodile and Arts Festival. *Papua New Guinea Travel.*

305 Lynch et al. (2023). Op cit.

306 Noble et al. (2016). Op cit.

307 Verschuuren, B. (2016). Religious and spiritual aspects of wetland management. *The Wetland Book*: 1405–1415.

308 White, J.P. (2012). Water—Recognizing the Indigenous perspective. *The International Indigenous Policy Journal* **3** (3). https://doi.org/10.18584/iipj.2012.3.3.1

309 Lemieux, C.L., Groulx, M.W., Buxton, T.T., Reining, C.E., Blye, C.J., et al. (2022). The "Healthy Parks-Healthy People" Movement in Canada: Progress, challenges, and an emerging knowledge and action agenda. *PARKS* **28**: 7–21. https://doi.org/10.2305/IUCN.CH.2022.PARKS-28-1CJL.en

310 Verschuuren. (2021). Op cit.

311 https://ecopeaceme.org/jordan-river/

312 Bunn and Arthington (2002). Op cit.

313 Poff et al. (1997). Op cit.

314 Naiman, R.J., Decamps, H. and Pollock, M. (1993). The role of riparian corridors in maintaining regional biodiversity. *Ecological Applications* **3**: 209–212. DOI : 10.2307/1941822

315 Fausch et al. (2002). Op cit.

316 Vannote et al. (1980). Op cit.

317 Abell et al. (2007). Op cit.

318 Perry, D., Harrison, I., Fernandes, S., Burnham, S. and Nichols, A. (2021). Global analysis of durable policies for free-flowing river protections. *Sustainability* **13**: 2347. https://doi.org/10.3390/su130423

319 Boss, S. (2010). Conserving native trout at landscape scale using the Wild and Scenic Rivers Act. In: Carline, B. (ed.) *Proceedings of the Wild Trout X Symposium, West Yellowstone, Montana, September 28–30, 2010*.

320 Worthington, T.A., van Soesbergen, A., Berkhuysen, A., Brink, K., Royte, J., et al. (2022). Global Swimways for the conservation of migratory freshwater fishes. *Frontiers in Ecology and the Environment* **20** (10): 573–580. https://doi.org/10.1002/fee.2550

321 Thieme, M., Birnie-Gauvin, K., Opperman, J.J., Franklin, P.A., Richter, H., et al. (2023). Measures to safeguard and restore river connectivity. *Environmental Reviews* **32**: 366–386. https://doi.org/10.1139/er-2023-0019.

322 Deinet, S., Flint, R., Puleston, H., Baratech, A., Royte, J., et al. (2024). *The Living Planet Index (LPI) for migratory freshwater fish 2024 update – Technical Report*. World Fish Migration Foundation, The Netherlands.

323 UNEP. (2023). Decision no.155, dated 13 March 2023 on the declaration of the natural ecosystem of the Vjosa river as National Park, category II.

324 Dam Removal Europe. Dam Removal Case Studies. Available from https://damremoval.eu/case-studies/

325 O'Connor, J.E., Duda, J.J. and Grant, G.E. (2015). 1000 dams down and counting. *Science* **348** (6234): 496–497. https://doi.org/10.1126/science.aaa9204.

326 Opperman, J.J., Royte, J. Banks, J., Day, L.R. and Apse, C. (2011). The Penobscot River, Maine, USA: A basin-scale approach to balancing power generation and ecosystem restoration. *Ecology and Society* **16** (3): 7. https://doi.org/10.5751/ES-04117-160307

327 Sánchez-Fernández, D., Galassi, D.M.P., Wynne, J.J., Cardoso, P. and Mammola, S. (2021). Don't forget subterranean ecosystems in climate change agendas. *Nature Climate Change* **11**: 458–459. https://doi.org/10.1038/s41558-021-01057-y

328 van Rees, C.B., Waylen, K.A., Schmidt-Kloiber, A., Thackeray, S.J., Kalinkat, G., et al. (2021). Safeguarding freshwater life beyond 2020. *Conservation Letters* **14**: e12771. https://doi.org/10.1111/conl.12771

329 Huggins, X., Gleeson, T., Serrano, D., Zipper, S., Jehn, F., et al. (2023). Overlooked risks and opportunities in groundwatersheds of the world's protected areas. *Nature Sustainability* **6**: 855–864. https://doi.org/10.1038/s41893-023-01086-9

330 Sánchez-Fernández, D., et al. (2021). Op cit.

331 Arthington A.H. (2021). Grand challenges to support the Freshwater Biodiversity Emergency Recovery Plan. *Frontiers in Environmental Science* **9**: 664313. https://doi.org/ 10.3389/fenvs.2021.664313.

332 Stiassny, M.L.J., Revenga, C. and Comer, P. (2010). Aquatic ecosystems: Diversity and dynamism. In: Mittermeier, R.A., Farrell, T.A., Harrison, I.J., Upgren, A.J. and Brooks T.M. (eds.) *Fresh water: the essence of life* (pp. 93–116). CEMEX & ILCP, Arlington, VA.

333 Proudlove, G. (2006). *Subterranean fishes of the world. An account of the subterranean (hypogean) fishes described up to 2003 with a bibliography 1541–2004*. Moulis: International Society for Subterranean Biology.

334 Sánchez-Fernández, D., et al. (2021). Op cit.

335 Hauer, F.R., Locke, H., Dreitz, V.J. Hebblewhite, M., Lowe, W.H., et al. (2016). Gravel-bed river floodplains are the ecological nexus of glaciated mountain landscapes. *Science Advances* **2**: e1600026. DOI : 10.1126/sciadv.1600026

336 Huggins et al. (2023). Op cit.

337 Linke, S., Lehner, B., Ouellet Dallaire, C., Ariwi, J., Grill, G. et al. (2019). Global hydro-environmental sub-basin and river reach characteristics at high spatial resolution. *Scientific Data* **6**: 283. DOI : 10.1038/s41597-019-0300-6

338 Huggins et al. (2023). Op cit.

339 Pittock et al. (2016). Op cit.

340 Sanchez-Fernandez et al. (2021). Op cit.

341 Huggins et al. (2023). Op cit.

342 Cyrus R. Vance Center for International Justice & EarthLaw Center (2020). Op cit.

343 NatureServe. (2014). *Cyprinodon diabolis*. The IUCN Red List of Threatened Species 2014: e.T6149A15362335. https://doi.org/10.2305/IUCN.UK.2014-3.RLTS.T6149A15362335.en.

344 Sneider, R., Harrison, I., Feuerbacher, O. and Wilson, K.P. (2017). *Cyprindon diabolis*: Devils Hole Pupfish. In: Mittermeier, R.A., Ryands, A.B., Sechrest, W., Langhammer, P.F., Mittermeier, J.C., et al. (eds.). *Back from the Brink* (pp. 129–131). CEMEX & Earth in Focus, Inc.

345 National Park Service. (2024). Devils Hole pupfish spring population at 25-year high. https://www.nps.gov/deva/learn/news/devils-hole-spring-2024.htm.

346 Bills, R. (2007). *Clarias cavernicola*. The IUCN Red List of Threatened Species 2007: e.T63363A12662977..

347 Jacobs, F.J., Jacobs, P.G., Hay, C.J. and Naesje, N.F. (2020). Status update of the endemic and critically endangered cave catfish *Clarias cavernicola* Trewavas 1936, from the Aigamas Cave system, Namibia. *African Journal of Aquatic Science* **46** (1): 18–21. https://doi.org/10.2989/16085914.2020.1787125.

348 Acreman, M.C. (2016). Environmental flows – basics for novices. *WIREs Water* **3** (5): 622–628. https://doi.org/10.1002/wat2.1160

349 Arthington, A.H., Tickner, D., McClain, M.E., Acreman, M.C., Anderson, E.P., et al. (2023). Accelerating environmental flow implementation to bend the curve of global freshwater biodiversity loss. *Environmental Reviews* **32** (3): 1–27. doi:10.1139/er-2022-0126. https://doi.org/10.1139/er-2022-0126

350 Salinas-Rodríguez, S.A., Barba-Macías, E., Infante Mata, D., Nava-López, M.Z., Neri-Flores, I., et al. (2021). What do Environmental Flows Mean for Long-term Freshwater Ecosystems' Protection? Assessment of the Mexican Water Reserves for the Environment Program. *Sustainability* **13** (3): 1240. https://doi.org/10.3390/su13031240

351 Salinas-Rodríguez et al. (2021). Op cit.

352 Thieme et al. (2023). Op cit.

353 Zarfl, C., Berlekamp, J., He, F., Jähnig, S. C., Darwall, W. and Tockner, K. (2019). Future large hydropower dams impact global freshwater megafauna. *Scientific Reports* **9** (1): 18531. https://doi.org/10.1038/s41598-019-54980-8

354 Zarfl, C., Lumsdon, A.E., Berlekamp, J., Tydecks, L. and Tockner, K. (2015). A global boom in hydropower dam construction. *Aquatic Sciences 77*: 161–170. https://doi.org/10.1007/s00027-014-0377-0

355 Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (2016). *Nature-based solutions to address global societal challenges*. Gland, Switzerland: IUCN.

356 Abell, R., Asquith, N., Boccaletti, G., Bremer, L., Chapin, E., et al. (2017). *Beyond the source: The environmental, economic and community benefits of source water protection*. The Nature Conservancy, Arlington, VA.

357 IPCC. (2023). *Climate Change 2023: Synthesis Report.* Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)] (pp. 35–115). Geneva, Switzerland: IPCC. https://doi.org/10.59327/IPCC/AR6-9789291691647.

358 Butman, D., Stackpoole, S., Stets, E., McDonald, C.P., Clow, D.W. and Striegl, R.G. (2016). Aquatic carbon cycling in the conterminous United States and implications for terrestrial carbon accounting. *Proceedings of the National Academy of Sciences USA* **113** (1): 58–63. https://doi.org/10.1073/pnas.1512651112.

359 Regnier, P., Friedlingstein, P., Ciais, P., Gruber, N., Janssens, I.A., et al. (2013). Anthropogenic perturbation of the carbon fluxes from land to ocean. *Nature Geoscience* **6** (8): 597–607. https://doi.org/10.1038/ngeo1830

360 Shrestha, G., Cavallaro, N., Lorenzoni, L., Seadler, A., Zhu, Z., et al., (2018). Second State of the Carbon Cycle Report (SOCCR2): A Sustained Assessment Report [Cavallaro, N., Shrestha, G., Birdsey, R., Mayes, M.A., Najjar, R.G., et al. (eds.)]. *U.S. Global Change Research Program*, Washington, DC.

361 Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., et al. (2017). Natural Climate Solutions. *PNAS* **114** (44): 11645–11650. https://doi.org/10.1073/pnas.171046511

362 Cook-Patton, S.C., Drever, C.R., Griscom, B.W., Hamrick, K., Hardman, H., *et al.* (2021). Protect, manage and then restore lands for climate mitigation. *Nature Climate Change* **11**, 1027–1034. https://doi.org/10.1038/s41558-021-01198-0

363 Masson-Delmotte, V., Zhai, P., Pörtner, H.O., Roberts, D., Skea, J., et al. (2018). IPCC 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* Cambridge, UK and New York, NY, USA: Cambridge University Press. https://doi.org/10.1017/9781009157940.001.

364 Vigerstol, K., Karres, N., Kang, S., Lilly, N. and Massey-Bierman, M. (2023). *Accelerating adaptation: The promise and limitations of Nature-based Solutions in the race to adapt to increasing floods and droughts.* The Nature Conservancy, Arlington, VA.

365 Lynch, A.J. Cooke, S.J., Deines, A.M., Bower, S.D., Bunnell, D.B., et al. (2016). The social, economic, and environmental importance of inland fish and fisheries. *Environmental Reviews* **24** (2): 115–121. https://doi.org/10.1139/er-2015-0064.

366 Funge-Smith, S. and Bennett, A. (2019). A fresh look at inland fisheries and their role in food security and livelihoods. *Fish and Fisheries* **20** (6): 1176–1195. https://doi.org/10.1111/faf.12403.

367 Karres, N., Kang, S., Aldous, A., Pattison-Williams, J.K. and Masuda, Y. J. (2022). How effective is community-based management of freshwater resources? A review. *Journal of Environmental Management* 323. https://doi.org/10.1016/j.jenvman.2022.116161.

368 Simasiku, E. and Hay, C. (2023). The significance of the Sikunga Fish Protected Area towards fisheries conservation in the Zambezi River, Namibia. *African Journal of Ecology* **61**: 354–367. https://doi.org/10.1111/aje.13118

369 Koning, A.A., Perales, K.M., Fluet-Chouinard, E. and McIntyre, P.B. (2020). A network of grassroots reserves protects tropical river fish diversity. *Nature* **588**: 631–635. https://doi.org/10.1038/s41586-020-2944-y

370 Scanlon, J. and Iza, A. (2003). International legal foundations for environmental flows. *Yearbook of International Environmental Law* **14** (1): 81–100. https://doi.org/10.1093/yiel/14.1.81

371 Forslund, A., Malm Renöfält, B., Barchiesi, S., Cross, K., Davidson, S., et al. (2009). *Securing Water for Ecosystems and Human Well-being: The Importance of Environmental Flows*. Swedish Water House Report 24. Stockholm: Stockholm International Water Institute.

372 McIntyre, O. (2018). Protection and preservation of freshwater ecosystems (Articles 20–23). In: Boisson, L., De Chazournes, L., Moïse Mbengue, M., Tignino, M., Sangbana, K. and Rudall, J. (eds.) *The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: A Commentary*. Oxford University Press.

373 Tarlock, D. and Wouters, P. (2007). Are shared benefits of international waters and equitable apportionment? *Colorado Journal of International Environmental Law and Policy* **18** (3): 523–536.

374 Graham, J., Amos, B. and Plumptre, T. (2003). *Governance principles for protected areas in the 21st century, a discussion paper*. Ottawa, Institute on Governance in collaboration with Parks Canada and Canadian International Development Agency.

375 Borrini-Feyerabend, G., Dudley, N., Jaeger, T., Lassen, B., Pathak Broome, N., et al. (2013). *Governance of Protected Areas: From understanding to action*. Best Practice Protected Area Guidelines Series No. 20, Gland, Switzerland: IUCN.

376 Ibid.

377 Vasilijević, M., Zunckel, K., McKinney, M., Erg, B., Schoon, et al. (2015). *Transboundary Conservation: A systematic and integrated approach*. Best Practice Protected Area Guidelines Series No. 23. Gland, Switzerland: IUCN.

378 WWF. (2009). *Sacred Waters: Cultural Values of Himalayan Wetlands*. Kathmandu, Nepal.

379 Stolton et al. (2014). Op cit.

380 Lewis, A.H., Gottlieb, B., Wilson, B., Sutton, J., Lessmann, J., et al. (2024). Coverage and beyond: How can private governance support key elements of the Global Biodiversity Framework's Target 3? *Frontiers in Conservation Science* **4**: https://doi.org/10.3389/fcosc.2023.1303801.

381 Mitchell et al. (2018). Op cit.

382 Stolton et al. (2014). Op cit.

383 Forest Peoples Programme, International Indigenous Forum on Biodiversity, Indigenous Women's Biodiversity Network, Centres of Distinction on Indigenous and Local Knowledge and Secretariat of the Convention on Biological Diversity. (2020). *Local Biodiversity Outlooks 2: The contributions of indigenous peoples and local communities to the implementation of the Strategic Plan for Biodiversity 2011–2020 and to renewing nature and cultures.* Moreton-in-Marsh, UK: Forest Peoples Programme.

384 ICCA Consortium. Undated. https://www.iccaconsortium.org/discover/

385 Borrini-Feyerabend et al. (2013). Op cit.

386 ICCA Consortium. Undated. https://www.iccaconsortium.org/discover/

387 Stevens, S., Hay-Edie, T., Miranda Larrea, C., Ramos Castillo, A. and Pathak Broome, N. (eds) (2024). *Guidelines for Recognising and Respecting Territories and Areas Conserved by Indigenous Peoples and Local Communities (ICCAs) Overlapped by Protected Areas*. IUCN World Commission on Protected Areas Good Practice Guidelines on Protected and Conserved Areas Series, No. 33. Gland, Switzerland: IUCN.

388 Australian Government. (2023). Australia's Indigenous Protected Area Program. Fact sheet. Department of Climate Change, Energy, the Environment and Water. National Indigenous Australians Agency.

389 Newman, B., Wilson, K.A., Melbourne, J., Mathews, D., Wysong, M. and Iacona, G.D. (2019). The contributions of nature to people within the Yawuru Indigenous Protected Area. *Conservation Science and Practice* **1**: e16. https://doi.org/10.1111/csp2.16

390 Pyke, M.L., Toussaint, S., Close, P.G., Dobbs, R.J., Davey, I., et al. (2018). Wetlands need people: A framework for understanding and promoting Australian indigenous wetland management. *Ecology and Society* **23** (3): 43. https://doi.org/10.5751/ES-10283-230343

391 McGrath, D., Crossa, M., Cardoso, A., Pena da Gama, S. and Almeida, O. (2006). *Developing Community-Based Management Systems for the Amazon Floodplain: Lessons we are learning*. Brasilia: WWF Brazil.

392 Campos-Peres, J.V. and Peres, C.A. (2016). Community-based management induces rapid recovery of a high value tropical freshwater fishery. *Nature Scientific Reports* **6**: 34745. https://doi.org/10.1038/srep34745.

393 Jones, W., Eldridge, J., Silva, J.P. and Schiessler, N. (2007). *Life and Europe's Rivers: Protecting and improving our water resources*. Luxembourg: European Commission.

394 Shahabuddin, G. and Rao, M. (2010). Do community-conserved areas effectively conserve biological diversity? Global insights and the Indian context. *Biological Conservation* **143** (12): 2926–2936. https://doi.org/10.1016/j.biocon.2010.04.040

395 Borrini-Feyerabend, G. and Campese, J. (2017). Self-strengthening ICCAs – Guidance on a process and resources for custodian indigenous peoples and local communities – draft for use by GSI partners. The ICCA Consortium.

396 Acreman, M., et al. (2020). Opcit

397 Thieme, M.L., Rudulph, J., Higgins, J. and Takats, J.A. (2012). Protected areas and freshwater conservation: A survey of protected area managers in the Tennessee and Cumberland River Basins, USA. *Journal of Environmental Management* **109**: 189–199. https://doi.org/10.1016/j.jenvman.2012.06.021

398 Leal et al. (2020). Op cit.

399 Ibid.

400 Dudley, N., Timmins, H.L., Stolton, S. and Watson, J.E.M. (2024). Effectively incorporating small reserves into national systems of protected and conserved areas. *Diversity* **16**: 216. https://doi.org/10.3390/d16040216

401 Acreman, M.C. and Dueñas-Lopez, M.A. (2019) *How effective is protected area designation for the conservation and restoration of freshwater biodiversity?* Final Report to WWF-UK. Wallingford, UK: Hydro-Ecology Consulting Ltd.

402 Desjonquères, C., Gifford, T. and Linke, S. (2019). Passive acoustic monitoring as a potential tool to survey animal and ecosystem processes in freshwater environment. *Freshwater Biology* **65**: 7-19.

403 Greenhalgh, J.A., Genner, M.J., Jones, G. and Desjonquères, C. (2020). The role of freshwater bioacoustics in ecological research. *WIREs Water* **7**: e1416. https://doi.org/10.1002/wat2.1416.

404 Bruce, K., Blackman, R.C., Bourlat, S.J., Hellström, M., Bakker, J., et al. (2022). *A practical guide for DNA-based methods for biodiversity assessment*. Sofia, Bulgaria: Pensoft.

405 Wearn, O.R. and Glover-Kapfer, P.)2017). *Camera Trapping for Conservation: a guide to best practices*. Woking, UK: WWF UK.

406 Cook, C.N., Wardell-Johnson, G. Carter, R.W. and Hockings, M.)2014). How accurate Is the ocal Ecological Knowledge of protected area practitioners? *Ecology and Society* **19** (2). http://www.jstor.org/stable/26269543.

407 Metcalfe, A.N., Kennedy, T.A., Mendez, G.A. and Muehlbauer, J.D.)2022). Applied citizen science in freshwater research. *WIREs Water* **9** (2): e1578. https://doi.org/10.1002/wat2.1578

408 Stroh, P. and Hughes, F.)2010). *Practical Approaches to Wetland Monitoring: Guidelines for landscape-scale, long-term projects*. Cambridge, UK: Anglia Ruskin University.

409 Turak, E., Harrison, I., Dudgeon, D., Abell, R., Bush, A. … De Wever, A.)2016). Essential Biodiversity Variables for measuring change in global freshwater biodiversity. *Biological Conservation* **213** (B): 272-279.

410 Dalton, D., Chaudhary, C., Jungmeier, M., Adams, V., Berger, V., et al. (2024). *A framework for monitoring biodiversity in protected areas and other effective area-based conservation measures: Concepts, methods and technologies*. IUCN WCPA Technical Report Series No. 7, Gland, Switzerland: IUCN

411 Tickner, D. et al. (2020). Op cit.

412 Gurnell, A.M., Gregory, K.J. and Petts, G.E.)1995). The role of coarse woody debris in forest aquatic habitats: Implications for management. *Aquatic Conservation: Marine and Freshwater Ecosystems.* **5** (2): 143-166. DOI:10.1002/aqc.3270050206.

413 Addy, S., Cooksley, S., Dodd, N., Waylen, K. Stockan, J., Byg A. and Holstead K.)2016). *River Restoration and Biodiversity: Nature-based solutions for restoring rivers in the UK and Republic of Ireland*. IUCN National Committee for the UK.

414 SEPA (Scottish Environment Protection Agency). (2009). 2nd edition. *Riparian Vegetation Management: Engineering in the Water Environment Good Practice Guide*. Edinburgh.

415 Graber, B., Singler, A., McClain, S. and Thomas-Blate, J. (n.d.). *Removing Small Dams: A basic guide for project managers*. American Rivers.

416 Lindloff, S. (2000). *Dam Removal: A citizen's guide to restoring rivers*. River Alliance of Wisconsin and Trout Unlimited.

417 Christiansen, T., Azlac, M. and Ivitts-Wasser, E. (2020). *Floodplains: A Natural System to Preserve and Restore.* European Environment Agency, Copenhagen.

418 Serra-Llobet, A., Jähnig, S.C., Geist, J., Kondolf, G.M., Damm, C… Schmitt, R. (2022). Restoring rivers and floodplains for habitat and flood risk reduction: experience in multi-benefit floodplain management from California and Germany. Frontiers of Environmental Science **9**

419 Jackson, M.C., Voulvoulis, N. and Woodward, G. (2018). *Multiple stressors in freshwater ecosystems: biocides and climate change*. Grantham Institute Briefing Paper number 27. London: Imperial College.

420 Bijay-Singh and Craswell, E. (2021). Fertilizers and nitrate pollution of surface and ground water: an increasingly pervasive global problem. SN Applied Sciences **3**: 518

421 Convention on Wetlands. (2021). *Global guidelines for peatland rewetting and restoration. Ramsar Technical Report No. 11*. Gland, Switzerland: Secretariat of the Convention on Wetlands.

422 Convention on Wetlands. (2021). *Restoring drained peatlands: A necessary step to achieve global climate goals,* Ramsar Policy Brief No. 5.

423 Jones, J., Ellison, D., Ferraz, S., Lara, A., Wei, X. and Zhang, Z. (2022). Forest restoration and hydrology. *Forest Ecology and Management* **520**: 120342. https://doi.org/10.1016/j.foreco.2022.120342

424 IPBES. (2023). *Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Roy, H.E., Pauchard, A., Stoett, P., Renard Truong, T., Bacher, S, et al. (eds.). Bonn, Germany: IPBES secretariat. https://doi.org/10.5281/zenodo.7430692

425 Caffrey, J.M., Baars, J.R., Barbour, J.H., Boets, P., Boon, P. et al. (2014). Tackling invasive alien species in Europe: The top 20 issues. *Management of Biological Invasions* **5** (1): 1–20. https://doi.org/10.3391/mbi.2014.5.1.01

426 Stockan, J.A. and Fielding, D. (2017). *Methods for controlling or eradicating aquatic invasive species*. CRW2016_05. Edinburgh: Scottish Government and The James Hutton Institute.

427 Institute of Fisheries Management (2012). *Code of Practice for Freshwater Fisheries Management. Part 1 Salmon and Trout*. Scottish Branch of the Institute of Fisheries Management.

428 Kolipakam, V., Jacob, M., Gayathri, A., Deori, S., Sarma, H, et al. (2022). Pingers are effective in reducing net entanglement of river dolphins. *Nature Scientific Reports* **12**: 9382. https://doi.org/10.1038/s41598-022-12670-y

429 Nelson, R. (2022). Water rights for groundwater environments as an enabling condition for adaptive water governance. *Ecology and Society*, **27** (2). https://doi.org/10.5751/ES-13123-270228

430 Finlayson, C.M., Arthington, A.H. and Pittock, J. (2018). Freshwater ecosystems in protected areas: A synthesis. In: *Freshwater Ecosystems in Protected Areas*. Routledge.

431 Lindloff, S.D. (2001). Restoring rivers through the selective removal of small dams: An American overview and the Wisconsin experience. *The Way Forward on Weirs.* Sydney: Inland Rivers Network.

432 Acreman, M.C. (2016). Op cit.

433 Richter, B.D. and Thomas, G.A. (2007). Restoring environmental flows by modifying dams. *Ecology and Society* **12** (1)

434 O'Connor, J., Stuart, I. and Jones, M. (2017). *Guidelines for the design, approval and construction of fishways. Arthur Rylah Institute for Environmental Research*. Technical Report Series No. 274. Heidelberg, Victoria: Department of Environment, Land, Water and Planning.

435 Thieme, M.L., Khrystenko, D., Qin, S., Golden Kroner, R.E., Lehner, B. et al. (2020). Dams and protected areas: Quantifying the spatial and temporal extent of global dam construction within protected areas. *Conservation Letters* **13**: e12719. https://doi.org/10.1111/conl.12719

436 Lind, L., Maher Hasselquist, E. and Laudon, H. (2019). Towards ecologically functional riparian zones: A meta-analysis to develop guidelines for protecting ecosystem functions and biodiversity in agricultural landscapes. *Journal of Environmental Management* **249**: 109391. https://doi.org/10.1016/j.jenvman.2019.109391

437 Luna Juncal, M.J., Masino, P., Bertone, E. and Stewart, R.A. (2023). Towards nutrient neutrality: A review of agricultural runoff mitigation strategies and the development of a decision-making framework. *Science of the Total Environment* **874**: 162408. https://doi.org/10.1016/j.scitotenv.2023.162408

438 Pennock, D. (2019). *Soil Erosion: The greatest challenge for sustainable soil management*. Rome: FAO.

439 Ahmad, S.K., Hossain, F., Holtgrieve, G.W., Pavelsky, T. and Galelli, S. (2021). Predicting the likely thermal impact of current and future dams around the world. *Earth's Future* **9**: e2020EF001916. https://doi.org/10.1029/2020EF001916

440 Leung, Y., Spenceley, A., Hvenegaard, G. and Buckley, R. (eds.) (2018). *Tourism and visitor management in protected areas: Guidelines for sustainability*. Best Practice Protected Area Guidelines Series No. 27. Gland, Switzerland: IUCN.

441 Wild, R. and McLeod, C. (eds) (2008). *Sacred Natural Sites: Guidelines for Protected Area Managers*. Gland, Switzerland: IUCN.

442 UK Parliament. (2022). *Reducing agricultural pressures in freshwater ecosystems*. Postnote number 661. London.

443 Williams, P., Biggs, J., Stoate, C., Szczur, J., Brown, C. and Bonney, S. (2020). Nature based measures increase freshwater biodiversity in agricultural catchments. *Biological Conservation* **244**: 108515.

444 Bijay-Singh and Craswell. (2021). Op cit.

445 Forestry Commission. (2019). *Managing forest operations to protect the water environment*. Forestry Commission Practice Guide. Edinburgh: Forestry Commission.

446 Acreman, M., et al. (2020). Op cit.

447 Acreman, M.C. and Duenas-Lopez, M.A. (2019). Op cit.

448 Acreman, M., Hughes, K. A., Arthington, A. H., Tickner, D., & Dueñas, M. A. (2020). Protected areas and freshwater biodiversity: A novel systematic review distils eight lessons for effective conservation. *Conservation Letters*, **13**(1), e12684.

449 Hockings, M., Stolton, S., Leverington, F., Dudley, N. and Courrau, J. (2006). *Evaluating Effectiveness: A framework for assessing management effectiveness of protected areas. 2nd edition.* Gland, Switzerland and Cambridge, UK: IUCN.

450 Metcalfe, A.N., Kennedy, T.A., Mendez, G.A. and Muehlbauer, J.D. (2022). Applied citizen science in freshwater research. *WIREs Water* **9** (2): e1578. https://doi.org/10.1002/wat2.1578

451 Brittain, S., Newing, H., de Fátima Cornejo Cardich, A., Ferrari, M.F., Fernández, N.Y.G., et al. (n.d.) Introduction to community-based environmental monitoring: practical guidance for monitoring of natural resources by Indigenous Peoples and local communities. Transformative Pathways and Forest Peoples Programme.

452 Dudley, N., Buyck, C., Furuta, N., Pedrot, C., Renaud, F. and K. Sudmeier-Rieux (2015). *Protected Areas as Tools for Disaster Risk Reduction. A handbook for practitioners*. Tokyo and Gland, Switzerland: Ministry of Environment Japan and IUCN.

453 Neugarten, R.A., Langhammer, P.F., Osipova, E., Bagstad, K.J., Bhagabati, N. et al. (2018). *Tools for measuring, modelling, and valuing ecosystem services*. Gland, Switzerland: IUCN.

454 Ivanić, K-Z., Stolton, S., Figueroa Arango, C. and Dudley, N. (2020). *Protected Areas Benefits Assessment Tool + (PA-BAT+): A tool to assess local stakeholder perceptions of the flow of benefits from protected areas*. Gland, Switzerland: IUCN.

455 Schröter, M., Zanden, E.H., Oudenhoven, A.P., Remme, R.P., Serna-Chavez, H.M., et al. (2014). Ecosystem services as a contested concept: a synthesis of critique and counter-arguments. *Conservation Letters* **7**: 514–523. https://doi.org/10.1111/conl.12091

456 Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., et al. (2016). Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences* **113**: 1462–1465. https://doi.org/10.1073/pnas.1525002113

457 Franks, P. and Small, R. (2016). *Social Assessment for Protected Areas (SAPA). Methodology Manual for SAPA Facilitators*. London: International Institute for Environment and Development.

458 Booker, F. and Franks, P. (2019). *Governance Assessment for Protected and Conserved Areas (GAPA)*. London: IIED.

459 Stolton, S., Dudley, N. and Hockings, M. (2021). *METT Handbook: A guide to using the Management Effectiveness Tracking Tool (METT). Second edition guidance for using METT-4*. Gland, Switzerland: WWF.

460 Convention on Wetlands. Undated. Ramsar Site Management Effectiveness Tracking Tool (Resolution XII.15). Gland, Switzerland: Ramsar Convention on Wetlands.

461 Stolton et al. (2021). Op cit.

462 Ivaníc et al. (2020). Op cit.

463 Franks et al. (2018). Op cit.

464 Booker and Franks. (2019). Op cit.

465 https://iucn.org/resources/conservation-tool/iucn-green-list-protected-and-conserved-areas

466 Shoal and Equilibrium Research. (2021). *Conservation Assured River Dolphin Standards*. Report for WWF International.

467 UNESCO, ICCROM, ICOMOS and IUCN. (2023). *Enhancing Our Heritage Toolkit 2.0: Assessing Management Effectiveness of World Heritage Properties and Other Heritage Places*. Paris, UNESCO.

468 https://smartconservationtools.org/

469 Meyers, D., Bohorquez, J., Cumming, T., Emerton, L., Heuvel, O.v.d., et al. (2020). *Conservation Finance: A Framework*. Conservation Finance Alliance. https://doi.org/10.13140/RG.2.2.14186.88000

470 Ibid

471 Credit Suisse. (2014). *Conservation Finance: Moving beyond donor funding towards an investor-driven approach*. WWF and McKinsey & Company.

472 Meyers et al. (2020). Op cit.

473 https://www.thegef.org/what-we-do/topics/global-biodiversity-framework-fund

474 Leung et al. (2018). Op cit.

475 CBD. (2001). *Mobilising Funding for Biodiversity Conservation: A user-friendly training guide*. Montreal.

476 Eagles, P.F.J., Baycetich, C.M., Chen, X., Dong, L, Halpenny, E., et al. (2009). *Guidelines for planning and management of concessions, licenses and permits for tourism in protected areas, Tourism planning and management program*, University of Waterloo, Ontario, Canada.

477 The Nature Conservancy. (2024). *Nature Bonds Project Toolkit*. Arlington, VA.

478 Linden, L., McCormick, S., Barkhorn, I., Ullman, R., Castilleja, G., et al. (2012). A Big Deal for Conservation. *Stanford Social Innovation Review*. https://ssir.org/articles/entry/a_big_deal_for_conservation

479 Cabera, H., Planitzer, C., Yudelman, T. and Tua, J. (2021). *Securing Sustainable Financing for Conservation Areas: A Guide to Project Finance for Permanence*. Amazon Sustainable Landscapes Program and WWF.

480 Baghai, M., Miller, J.R.B., Blanken, L.J., Dublin, H.T., Fitzgerald, K.H., et al. (2018). Models for the Collaborative Management of Africa's Protected Areas. *Biological Conservation* **218**: 73–82. https://doi.org/10.1016/j.biocon.2017.11.025

481 Smith, S., Rowcroft, P., Everard, M., Couldrick, L., Reed, M., et al. (2013). *Payments for Ecosystem Services: A Best Practice Guide.* London, UK: DEFRA.

482 Wunder, S. (2005). *Payments for Environmental Services: Some nuts and bolts. CIFOR Occasional Paper No. 42.* Bogor, Indonesia: CIFOR.

483 Salzman, J., Bennett, G., Carroll, N., Goldstein, A. and Jenkins, M. (2018). The global status and trends of Payments for Ecosystem Services. *Nature Sustainability* **1** (3): 136–144. https://doi.org/10.1038/s41893-018-0033-0

484 https://waterfundstoolbox.org/

485 Porras, I. and Steele, P. (2020). *Making the market work for nature: How biocredits can protect biodiversity and reduce poverty*. London, UK: IIED.

486 Biodiversity Credit Alliance. (2023). *Understanding Biodiversity Credits.* https://www.biodiversitycreditalliance.org/

487 ValueNature. (2023). *Our Credits*. ValueNature. Available at: https://valuenature.earth/#credits.

488 Fitzsimons, J.A., Stolton, S., Dudley, N. and Mitchell, B. (2024). Clarifying 'long-term' for protected areas and Other Effective area-based Conservation Measures (OECMs): Why only 25 years of 'intent' does not qualify. *PARKS* **30** (1): 89–93.

489 Fitzsimons, J.A., Partridge, T. and Keen. R. (2024). Other effective area-based conservation measures (OECMs) in Australia: Key considerations for assessment and implementation. *Conservation* **4** (2): 176–200. https://doi.org/10.3390/conservation4020013

490 Porras and Steele. (2020). Op cit.

491 Ducros, A. and Steele, P. (2022). *Biocredits to finance nature and people: Emerging lessons*. London, UK: IIED.

492 NatureFinance. (2023). *The Future of Biodiversity Credit Markets: Governing High-Performance Biodiversity Credit Markets*. Geneva: Switzerland: NatureFinance.

493 BBOP (Business and Biodiversity Offsets Programme). (2012). Standard on Biodiversity Offsets. BBOP, Washington, DC. https://www.forest-trends.org/bbop/resources/

494 Deutz, A., Heal, G.M., Niu, R., Swanson, E., Townshend, T., et al. (2020). *Financing Nature: Closing the global biodiversity financing gap*. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability.

495 Pope, J., Morrison-Saunders, A., Bond, A. and Retief, F. (2021). When is an offset not an offset? A framework of necessary conditions for biodiversity offsets. *Environmental Management* **67**: 424–435. https://doi.org/10.1007/s00267-020-01415-0

496 DeFries, R.S., Fanzo, J., Mondal, P., Remans, R. and Wood, S.A. (2017). Is voluntary certification of tropical agricultural commodities achieving sustainability goals for small-scale producers? A review of the evidence. *Environmental Research Letters* **12**: 033001. DOI 10.1088/1748-9326/aa625e

497 EcoLabel Index. (n.d. a) *Ecolabel Index is the largest global directory of ecolabels, currently tracking 456 ecolabels in 199 countries, and 25 industry sectors*. Ecolabel Index. http://www.ecolabelindex.com/.

498 EcoLabel Index. (n.d. b). *Salmon-Safe.* https://www.ecolabelindex.com/ecolabel/salmon-safe.

499 Stolton, S., Timmins, H. and Dudley, N. (2021). *Making Money Local: Can Protected Areas Deliver Both Economic Benefits and Conservation Objectives?* Technical Series 97. Montreal: Secretariat of the Convention on Biological Diversity.

500 Boshoven, J. (2018). *The Nature of Conservation Enterprises: A 20-year retrospective evaluation of the theory of change behind this widely used approach to biodiversity conservation*. Washington, USA: USAID.

501 Zander, K.K., Austin, B.J. and Garnett, S.T. (2014). Indigenous peoples' interest in wildlife-based enterprises in the Northern Territory, Australia. *Human Ecology* **42** (1): 115–126. https://doi.org/10.1007/s10745-013-9627-3

502 Stolton et al. (2021). Op cit.

503 Fredrickson, B. and Mott Lacroix, K. (2017). Wild and scenic rivers into the next 50 years: Lessons from the re-watering and restoration of fossil creek. International Journal of Wilderness 23 (2): 16–21.

504 Muehlbauer, J., LeRoy, C., Lovett, J., Flaccus,, K., Vlieg, J. and Marks, J. (2009). Short-term responses of decomposers to flow restoration in Fossil Creek, Arizona, USA. Hydrobiologia 618 (1): 35–45. https://doi.org/10.1007/s10750-008-9545-3

505 Marks, J., Haden, G., O'Neill, M. and Pace, C. (2010). Effects of flow restoration and exotic species removal on recovery of native fish: Lessons from a dam decommissioning. Restoration Ecology 18 (6): 934–943. https://doi.org/10.1111/j.1526-100X.2009.00574.x

506 Fredrickson, B. and Mott Lacroix, K. (2017). Op cit.

507 Meulenbroek, P., Egger, G., Trautner, J., Drescher, A., Marlene, R., et al. (2020). The river Vjosa – A baseline survey on biodiversity, potential impacts, and legal framework for hydropower development, (pp. 180). https://doi.org/10.5281/zenodo.4139640

508 UNEP. (2023). Decision no.155, dated 13 March 2023 on the declaration of the natural ecosystem of the Vjosa river as National Park, category II. https://leap.unep.org/en/countries/al/national-legislation/decision-no-155-dated-13-march-2023-declaration-natural-ecosystem

509 Patagonia Works. (2022). Albanian government and Patagonia join forces to establish Vjosa National Park. www.patagoniaworks.com/press/2022/6/13/albanian-government-and-patagonia-join-forces-to-establish-vjosa-national-park#

510 Sovinc, A. (2021). Protection study of the Vjosa River Valley based on IUCN protected area standards. Belgrade, Serbia: IUCN.

511 Kharadze, K. and Salukvadze, E. (2022). Protected areas and remarkable features of inorganic nature. In: Bolashvili, N. and Neidze, V. (eds.) The Physical Geography of Georgia. Geography of the Physical Environment. Cham, Switzerland: Springer.

512 Grosser, C., Barjadze, S. and Maghradze, E. (2021). Trocheta ariescornuta n. sp. (Annelida, Hirudinida: Erpobdellidae) – a new cavernicolous leech from Motena Cave, Georgia. Ecologia montenegrina 44: 32–43. https://doi.org/10.37828/em.2021.44.5

513 BirdLife International. (2022). Important Bird Areas factsheet: Reserva Nacional Laguna Torca. http://datazone.birdlife.org/site/factsheet/reserva-nacional-laguna-torca-iba-chile

514 Publimicro. (2023). Auspicioso comienzo de año, anuncia la CONAF, para ejemplares de cisne de cuello negro, en la Reserva Nacional Laguna Torca en Curicó. https://publimicro.cl/auspicioso-comienzo-de-ano-anuncia-la-conaf-para-ejemplares-de-cisne-de-cuello-negro-en-la-reserva-nacional-laguna-torca-en-curico/

515 CONAF. (2022). Laguna Torca National Reserve. www.conaf.cl/parques/reserva-nacional-laguna-torca/

516 Borrini-Feyerabend, G. and Dudley, N. (2005). Elan Durban… Nouvelles perspectives pour les Aires Protégées à Madagascar. Gland, Switzerland: IUCN, WCPA and CEESP..

517 Saunders, D.L., Meeuwig, J.J. and Vincent, A.C.J. (2002). Freshwater protected areas: Strategies for Conservation. Wiley for Society for Conservation Biology 16 (1): 30–41. https://doi.org/10.1046/j.1523-1739.2002.99562.x.

518 Pacaya-Samiria. (2022). The Reserve. www.pacayasamiria.com.pe/the-reserve

519 Bodmer, R., Fang, T., Puertas, P., Antunez, M., Chota, K. and Bodmer, W. (2014). Impacts of Climate Change on Wildlife Conservation in the Samiria River Basin of the Pacaya-Samiria National Reserve, Peru. https://picernefoundation.org/wp-content/uploads/2018/08/Samiria-Annual-Report-20143.pdf

520 Zurita-Arthos, L.H. (2015). The impacts of the extractives on biodiversity, ecosystem services and conservation prioritization: Management options in the Andes and western Amazon. University of London, King's College (United Kingdom) ProQuest Dissertations Publishing. 10176896.

521 Sassen, M. and Wan, M. (2005). Biodiversity and local priorities in a community near the Ivindo National Park Makokou, Gabon. Report. CIFOR.

522 European Wilderness Society. (2019). A Victory for Mura River. https://wilderness-society.org/a-victory-for-mura-river/.

523 Mohl, A., Beckmann, A, Figeczky, G., Soutter, R. and Schneider-Jacoby, M. (2011). Mura-Drava-Danube UNESCO Trans-Boundary Biosphere Reserve. WWF. https://wwfint.awsassets.panda.org/downloads/danube_drava_mura_factsheet.pdf.

524 Biosffer Dyfi Biosphere. (n.d.). UNESCO Biosphere Reserve. https://www.dyfibiosphere.wales/dyfi-biosphere-wales

525 Griffith, H.V., Wade, A.J., Lavers, D.A. and Watts, G. (2020). Atmospheric river orientation determines flood occurrence. Hydrological Processes 34: 4547–4555. https://doi.org/10.1002/hyp.13905

526 McKinley, E., Harvey, R., Ballinger, R.C., Davidson, K., Griffin, J.N. and Skov, M.W. (2022). Coastal agricultural landscapes: Mapping and understanding grazing intensity on Welsh saltmarshes. Ocean and Coastal Management 222: 106128. https://doi.org/10.1016/j.ocecoaman.2022.106128

527 Natural Resources Wales. (2021). Know your river – Dyfi: Salmon and trout catchment summary. https://cdn.cyfoethnaturiol.cymru/media/694881/accessible-dyfi-kyr-2021-completed1.pdf

528 Borrini-Feyerabend, G., & Kothari, A. (2008). Recognizing and supporting indigenous and community conservation–ideas and experiences from the grassroots. CEESP/WCPA briefing note, 9.

529 Dudley, N. and Stolton, S. (eds.) (2022). Best Practice in Delivering the 30x30 Target (1st ed.). The Nature Conservancy and Equilibrium Research..

530 Coast Fund. (2020). 2020 Annual Report. https://coastfunds.ca/wp-content/uploads/2021/04/Coast-Funds-Annual-Report-2020-2.pdf

531 International Rivers, Earth Law Center and The Cyrus R. Vance Center. (2020). Rights of Rivers: A global survey of the rapidly developing Rights of Nature jurisprudence pertaining to rivers.: https://www.earthlawcenter.org/river-rights

532 Constitutional Court of Colombia. (2016). River Atrato Decision (English), Dignity Rights Project, Delaware Law. Harmony with nature UN. http://files.harmonywithnatureun.org/uploads/upload838.pdf

533 Vargas-Chaves, I., Rodríguez, G.A., Cumbe Figueroa, A. and Mora-Garzón, S.E. (2020). Recognizing the Rights of Nature in Colombia: The Atrato River case. Jurídicas 17: 13–41. https://doi.org/10.17151/jurid.2020.17.1.2

534 River Management Society for the Durable Rivers Protection Coalition. (2022). Rights of the Atrato river in Colombia.

535 Earth Law Center. (2017). The importance of the Atrato River in Colombia gaining Human Rights. www.earthlawcenter.org/blog-entries/2017/5/the-importance-of-the-atrato-river-in-colombia-gaining-legal-rights.

536 Rai, K.R.K. (2013). Comparative studies on lentic environment of Mai Pokhari, Ilam and Kechana jheel wetland ecosystems, Jhapa, Nepal (with reference to bottom dwelling fauna). Nepalese Journal of Biosciences 1: 32–36. https://doi.org/10.3126/njbs.v1i0.7467

537 Rai, S. (2009). Some Chlorophycean Algae from Maipokhari Lake, Ilam, East Nepal. Journal of Natural History Museum 24 (1): 1–8. https://doi.org/10.3126/jnhm.v24i1.2228

538 Pradhan, N. and Heimstad, R. (2016). Diversity and local status of bryophytes in Mai Pokhari of Ilam district, east Nepal. Journal of Natural History Museum 30: 39–46. https://doi.org/10.3126/jnhm.v30i0.27402

539 Kafle, G. and Savillo, I.T. (2009). Present status of Ramsar sites in Nepal. International Journal of Biodiversity and Conservation 1 (5): 146–150.

540 WWF. (2009). Op cit.

541 Mandal, R.A., Jha, P.K., Krakaue, N., Jha, A. and Lakhankar, T. (2017). Assessing cost effective management options of Eichhornia crassipes in ecotourism Ramsar sites, Nepal. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems 7 (2): 79–83.

542 Visitteo. (2022). Kuda's Bridge – The Legend of Love. Visitteo. https://visitteo.com/kudas-bridge/

543 Pelivan, A. (2004). Zrmanja, Krka, Cetina i Njihovi Pritoci. Donja Lomnica: Ekološki Glasnik.

544 Schäfer, T. (2019). Legal Protection Schemes for Free-Flowing Rivers in Europe. Brussels, Belgium: The Nature Conservancy.

545 Worthington et al. (2022). Op cit.

546 Deinet et al. (2024). Op cit.

547 Dam Removal Europe. (2018). 3,300 km of free-flowing river. Retrieved from: https://damremoval.eu/3300km-of-free-flowing-river/

548 European Commission. (n.d.). Natura 2000 Award: Improving the Pärnu River Basin for its Migratory Fish. https://environment.ec.europa.eu/topics/nature-and-biodiversity/natura-2000-award/meet-natura-2000-heroes/improving-parnu-river-basin-its-migratory-fish_en

549 World Fish Migration Foundation. (2018). Annual Report. Connecting Fish, Rivers and People. https://worldfishmigrationfoundation.com/wp-content/uploads/2019/11/annual-report.pdf

550 European Commission. (n.d.). Op cit.

551 Rewilding Europe. (2019). Estonia's massive dam removal efforts highlight benefits of river restoration. https://rewildingeurope.com/news/estonias-massive-dam-removal-efforts-highlight-benefits-of-river-restoration/#

552 WHSRN. (2022). About WHSRN. https://whsrn.org/about-whsrn/

553 FC. (2022). Argentina: Protecting shorebirds at Laguna Mar Chiquita. https://icfcanada.org/our-projects/projects/argentina-mar-chiquita-mapping.

554 Alfonso, A.G., Soria-Barreto, M. and Martinex-Cardenas, L. (2015). Fishes in the lower San Pedro Mezquital River, Nayait, Mexico. The Journal of Biodiversity Data 11: 1796. https://doi.org/10.15560/11.6.1797

555 WWF – Gonzalo Río Arronte Foundation Alliance. (2012). The San Pedro Mezquital River: The great unknown. Mexico: WWF and Gonzalo Rio Arronte Foundation. http://d2ouvy59p0dg6k.cloudfront.net/downloads/san_pedro_mezquital_2012.pdf.

556 Mexico Secretariat of Environment and Natural Resources. (2014). Decree of water reserves in the San Pedro Mezquital River Basin. http://reservasdeagua.com.mx/documentos-tecnicos/.

557 Barrios Ordóñez, J.E., Salinas Rodríguez, S.A., López Pérez, M., Villón Bracamonte, R.A. and Rosales Ángeles, F. (2015). National Water Reserve Program in Mexico: Experiences of ecological flow and allocation of water to environment. Washington, DC, USA: Inter-American Development Bank. https://publications.iadb.org/en/national-water-reserves-program-mexico-experiences-environmental-flows-and-allocation-water

558 IUCN & WCMC. (2011). Rwenzori Mountains National Park Datasheet. http://world-heritage-datasheets.unep-wcmc.org/datasheet/output/site/rwenzori-mountains-national-park/

559 World Heritage Datasheets. (2011). Rwenzori Mountains National Park. http://world-heritage-datasheets.unep-wcmc.org/datasheet/output/site/rwenzori-mountains-national-park/.

560 IUCN. (2020). Rwenzori Mountains National Park - 2020 Conservation Outlook Assessment. https://rris.biopama.org/sites/default/files/2020-12/Rwenzori%20Mountains%20National%20Park%20-%202020%20COA%20-%20en.pdf

561 Surenkhorloo, P., Buyanaa, C., Dolgorjav, S., Bazarsad, C. O., Zamba, B., Bayarsaikhan, S., & Heiner, M. (2021). Identifying riparian areas of free flowing rivers for legal protection: Model Region Mongolia. Sustainability, 13 (2): 551. https://doi.org/10.3390/su13020551.

562 Koning, A. A., Perales, K. M., Fluet-Chouinard, E., & McIntyre, P. B. (2020). A network of grassroots reserves protects tropical river fish diversity. Nature, 588(7839), 631-635.

563 IUCN WCPA. (2022). Case Studies on Existing and Potential OECMs Categorised by Type of Resource Use (Terrestrial and Marine). Presentation.

564 India OECM. (n.d.) Kadwa Kosi Floodplains, Bihar. www.india-oecm.in/Files/Categories/Kadwa_Kosi_Floodplains.pdf

565 National Parks.FI. (2022). Activities in Isojärvi National Park. www.nationalparks.fi/isojarvinp/activities.

566 Mundy, V. (2022). Ukraine's 'hero river' helped save Kyiv. But what now for its newly restored wetlands? The Guardian. 11th May.

567 Ibid.

568 Schmidt, B. (2023). Defensive rewilding: Where military and environmental protection overlap. RUSI. www.rusi.org/explore-our-research/publications/commentary/defensive-rewilding-where-military-and-environmental-protection-overlap

PROTECTED AREA AND OECM DEFINITIONS, MANAGEMENT CATEGORIES AND GOVERNANCE TYPES

IUCN defines a protected area as:
A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

The definition is expanded by six management categories (one with a sub-division), summarised below.

Ia Strict nature reserve: Strictly protected for biodiversity and also possibly geological / geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values.

Ib Wilderness area: Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.

II National park: Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.

III Natural monument or feature: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.

IV Habitat/species management area: Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.

V Protected landscape or seascape: Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected areas with sustainable use of natural resources: Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims.

The category should be based around the primary management objective(s), which should apply to at least three-quarters of the protected area – the 75 per cent rule.

The management categories are applied with a typology of governance types – a description of who holds authority and responsibility for the protected area. IUCN defines four governance types:

Type A. Governance by government: Federal or national ministry/agency in charge; sub-national ministry or agency in charge (e.g. at regional, provincial, municipal level); government-delegated management (e.g. to NGO).

Type B. Shared governance: Transboundary governance (formal and informal arrangements between two or more countries); collaborative governance (through various ways in which diverse actors and institutions work together); joint governance (pluralist board or other multi-party governing body).

Type C. Private governance: Conserved areas established and run by individual landowners; non-profit organisations (e.g. NGOs, universities) and for-profit organisations (e.g. corporate landowners).

Type D. Governance by Indigenous peoples and local communities: Indigenous peoples' conserved areas and territories – established and run by Indigenous peoples; community conserved areas – established and run by local communities.

The Convention on Biological Diversity defines an "other effective area-based conservation measure" (OECM) as:
A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values.

This covers three main cases:

1. **Ancillary conservation** – areas delivering in-situ conservation as a by-product of management, even though biodiversity conservation is not an objective (e.g. some war grave sites).
2. **Secondary conservation** – active conservation of an area where biodiversity outcomes are only a secondary management objective (e.g. some conservation corridors).
3. **Primary conservation** – areas meeting the IUCN definition of a protected area, but where the governance authority (i.e. community, Indigenous peoples' group, religious group, private landowner or company) does not wish the area to be reported as a protected area.

For more information on the IUCN definition, categories and governance types, see Dudley (2008). *Guidelines for applying protected area management categories*, which can be downloaded at: https://doi.org/10.2305/IUCN.CH.2008.PAPS.2.en

For more on governance types, see Borrini-Feyerabend et al. (2013). *Governance of Protected Areas: From understanding to action*, which can be downloaded at https://portals.iucn.org/library/node/29138.

For more information on OECMs, see Jonas et al. (2023) *Site-level tool for identifying other effective area-based conservation measures (OECMs): first edition*, which can be downloaded at: https://doi.org/10.2305/WZJH1425



INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
Tel: +41 22 999 0000
Fax: +41 22 999 0002
www.iucn.org
www.iucn.org/resources/publications