Securing a Future that Flows:

Case Studies of Protection Mechanisms for Rivers

WWF

The Nature Conservancy
Protecting nature. Preserving life.

Citation: Moir, K., M. Thieme, and J. Opperman. 2016. *Securing A Future that Flows: Case Studies of Protection Mechanisms for Rivers.* World Wildlife Fund and The Nature Conservancy. Washington, DC.

Acknowledgement of previous report:

This work builds on an earlier report prepared for WWF-Canada: Moir, Korice (March 2012). *On the Wild Side: A jurisdictional review of wild rivers protection legislation and non-legislative initiatives.* WWF-Canada.

Reviewers & Contributors:

Mexico: Sergio Salinas-Rodríguez (WWF-Mexico)
Costa Rica: Emmanuel Boulet (Inter-American Development Bank)
China: Qiaoyu Guo (The Nature Conservancy), Lin Cheng (WWF-China), David Harrison (The Nature Conservancy)
Brazil: David Harrison (The Nature Conservancy), Damian Fleming (WWF-UK), Mariana Napolitano Ferreira (WWF-Brazil)
Norway: Petra Remeta (WWF-Adria), Martina Mlinaric (WWF-European Policy Office)
Sarah Davidson (WWF-US)
Amy Newsock (The Nature Conservancy)

On the cover: A stretch of the Rio Tapajós in Brazil

Introduction

Societies have gone to extraordinary efforts to harness the power of rivers. Dams, levees, diversions, channelization and other alterations provide many benefits including drinking water and energy, water for agricultural and industrial production, flood control, reduction of water-borne diseases, and navigation. These interventions also place considerable pressure on rivers. Large dams modify the natural flow regime, fragment river habitats and alter the delivery of sediments to floodplains and deltas. The large-scale hydropower and water storage projects that began in North America during the 1930s have steadily expanded on a global scale. It is now rare to encounter a major river system that has not been transformed from its natural condition in some way.

Although it is unrealistic to keep all rivers free-flowing, such rivers provide unique benefits. These include migration paths for fish and other species, critical habitats, sediment nourishment to floodplains and deltas, recreational and eco-tourism opportunities, and aesthetic and spiritual values. Natural rivers support productive fisheries and flood-recession agriculture that provide food and livelihoods for hundreds of millions of people globally.

Efforts to protect specific rivers were initiated in the United States to preserve from development the free-flowing nature and scenic beauty of rivers. This inspired other countries to consider ways to balance infrastructure development with the necessity to sustain free-flowing rivers of high value.

The world is now poised to double global hydropower capacity by 2040, along with continued expansion of associated infrastructure in rivers. Expansion will mostly occur in river basins that support high diversity of freshwater species, important remaining fish migrations, and rural communities that depend on food and livelihoods provided by free-flowing rivers[1]. Governments, communities, companies, and conservation organizations are seeking ways to ensure that this development can meet needs for energy and water while maintaining healthy rivers. Given that mechanisms to protect important rivers, or sections of rivers, will be a critical tool to meet this challenge, World Wildlife Fund and The Nature Conservancy initiated a review of existing protection mechanisms.

Canoeing along the Parismina River, Costa Rica

Free-flowing river[a]**:** a river or stretch of river occurs where natural aquatic and riparian ecosystem functions and services are largely unaffected by anthropogenic changes to ***fluvial connectivity*** allowing an unobstructed exchange of material, species and energy within the river system and beyond.
Fluvial connectivity encompasses longitudinal (river channel), lateral (floodplains), vertical (groundwater and atmosphere) and temporal (intermittency) components.

In this white paper, we highlight place-based river protections in three countries, including national legal mechanisms such as river designations in United States and Norway, and environmental water reserves in Mexico. Also included are case studies of other types of mechanisms that have been leveraged to protect rivers, including a species-based reserve in China, national parks in Brazil, and a biodiversity offset in Costa Rica. These diverse examples can serve as models for how countries can protect important rivers over the long term as part of sustainable development.

a Although currently no consensus on definition, this draft definition is from a working group of academic institutions and conservation organizations in the process of conducting an updated global assessment of free-flowing rivers.

Mexico Profile:
Water Reserves
with San Pedro Mezquital Environmental Water Reserve as case study

Page 8

United States Profile:
Wild and Scenic Rivers Designation
with Clarks Fork of the Yellowstone River as case study

Page 4

Case Study:
Reventazón and Parismina Rivers, Costa Rica
Biodiversity Offset

Page 14

Case Study:
Tapajós and Juruena Rivers, Brazil
Protected Areas

Page 12

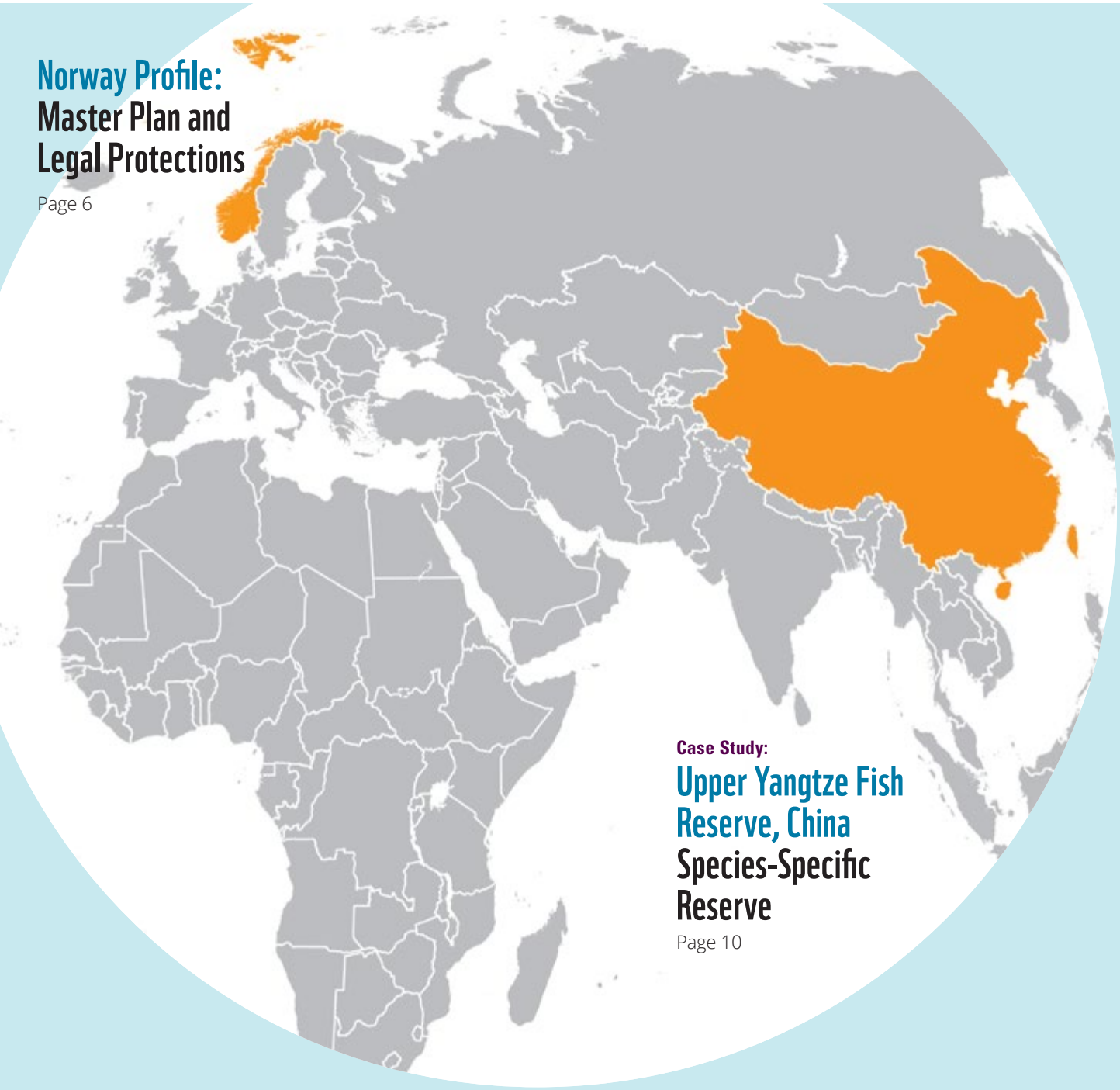
Types of Place-Based Protection Mechanisms[b]

Protected area[c]
A clearly defined geographical space, recognized, dedicated and managed through legal or other effective means, to achieve long-term conservation of nature with associated ecosystem services and cultural values[3].

River designation
A designated river or river segment where certain protections are applied to preserve outstanding values and/or prevent development.

Water reserve
Volume of water allocated to specific uses within a basin context to enhance long-term resiliency and sustainability. An environmental water reserve is the volume allocated from a river for environmental use[4], involving specific protections applied to protect environmental flow.

b Typology adapted from Dudley (2008)[3], building on Abell *et al.* (2007)[2].
c The types presented here are not mutually exclusive – e.g. most of the river-associated place-based protection mechanisms are considered to be protected areas.



Norway Profile:
Master Plan and Legal Protections

Page 6

Case Study:

Upper Yangtze Fish Reserve, China
Species-Specific Reserve

Page 10

Species-specific management or conservation area

Protection applied to a spatially defined area of freshwater to restore, sustain or increase the population of a specific species[3]. In freshwater systems, these reserves are often targeted at particular fish species in order to increase natural fish stocks.

Biodiversity offset[d]

A mitigation strategy aiming to compensate biodiversity impacts through exchange, allowing certain impacts resulting from development activities in or along one river, in exchange for the protection of a similar river or stretch of river in another location[5].

d Although not strictly a place-based protection mechanism, biodiversity offsets can be leveraged in locations where development is due to occur in order to protect or keep other portions of a basin intact.

(c) Fritz Pölking / WWF

A stretch of the Yellowstone River

United States Profile: Wild and Scenic Rivers Designation

with Clarks Fork of the Yellowstone River as case study

The *National Wild and Scenic Rivers Act 1968* enabled the identification and designation of wild, free-flowing rivers and their immediate environments with **outstandingly remarkable values** such as scenic, recreational, geologic, fish and wildlife, historic, cultural, and/or other values worthy of conservation. The United States National Wild and Scenic Rivers System currently protects 12,709 miles of 208 rivers or river segments in 40 states and the Commonwealth of Puerto Rico, representing 0.35% of the nation's rivers[6].

To complement initial efforts to designate specific rivers, a Nationwide Rivers Inventory was created to identify eligible rivers and river segments[7]. To be eligible, a river segment must be generally free-flowing, and the river and adjacent land must possess at least one outstandingly remarkable value[8]. There have been a number of updates to enhance the inventory over time.

According to the Act, there are three types of designated rivers – wild, scenic, and recreational – based on the level of development and accessibility at the time of eligibility[6]:

- **Wild rivers** are free of all impoundments, generally inaccessible, and essentially pristine.
- **Scenic rivers** are in between, more developed than wild but less than recreational, though still largely undeveloped.
- **Recreational rivers** are readily accessible and may have some shoreline development, and some minor impoundments and diversions in the past.

Unique in its approach, the three types allow for a range of rivers to be protected with different levels of restrictions depending on their status and intended use. The Act allows for the continuation of small dams, diversions and other minor structures existing at the time a river is proposed.

Rivers segments may be designated by Congress or approved by the Secretary of the Interior, and can be administered by either federal or state agencies. Other than when a designated river flows on federal land, states generally administer land management. Thus, conflicts can arise between private land use, state laws, and federal goals of maintaining a free-flowing river. Several states have passed their own wild and scenic river statutes which can bolster a federal designation on a river designated at both levels, as well as expand the total length of river protected.

Once designated, the free-flowing condition and essential characteristics of a river that existed at the time of designation are to be preserved, and if possible enhanced, regardless of the type of designation. For federally administered rivers, the designation also establishes a quarter-mile protected corridor on both sides of the river in the lower 48 states, and one-half mile in Alaska.

A wild and scenic river designation prohibits federal licensing of any new hydropower dams and restricts other in-stream activities that could potentially harm a river's values. The goal is not to prohibit the use of the river area, but to preserve its character. The National Wild and Scenic Rivers System also aims to engage river-related stakeholders in collaborative management, including the development of comprehensive river management plans.

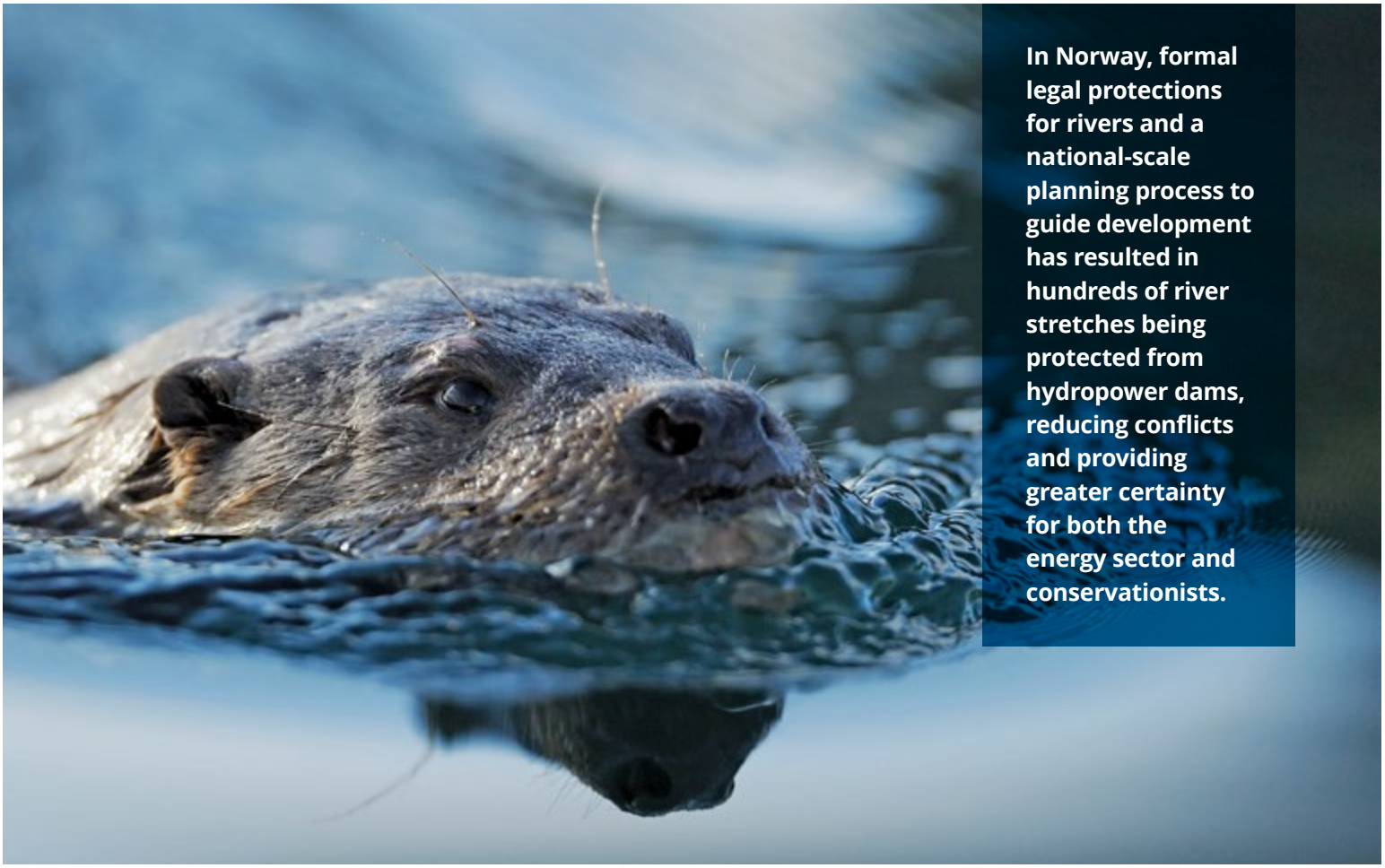
Case Study:
Clarks Fork of the Yellowstone River

The Clarks Fork River is a major tributary of the Yellowstone River. It originates in the Beartooth Mountains north of Cooke City in Montana and flows into Wyoming through a deep canyon, before joining the Yellowstone River in Montana near Laurel. Visitors to Yellowstone National Park travel this beautiful river corridor on the way to the park's entrance.

In 1977, the United States' Forest Service recommended a segment of the Clarks Fork of the Yellowstone River for designation. As part of the Nationwide Rivers Inventory, studies conducted in late 70s and early 80s identified three outstandingly remarkable values – scenic, recreational and historic – for the river[9]. Its scenic qualities include soaring cliffs, deep chasms, dramatic waterfalls, and challenging whitewater rapids, and its recreational features offer opportunities for world-class fishing, paddling, and solitude. Historically, Indigenous Peoples travelled the area on route to the buffalo hunting grounds of the Great Plains.

In the 1980s, Wyoming proposed to build a dam and reservoir for hydropower and irrigation that would have compromised Clarks Forks' outstanding values. Wild river legislation had been considered for the canyon section of Clarks Fork in 1983, but was delayed for further study and consideration of options. However, through the continued efforts of river enthusiasts and conservation organizations rallying for its protection, a 20.5-mile portion within the Clarks Fork Canyon was finally designated as a wild river in November 1990[10].

This designation permanently protected the river and immediate environment from federally licensed dams and other development. As a result, the segment is without major diversions, with little development within the corridor – unlike the entrance ways to some other national parks which have experienced extensive development. While the terrain of the Clarks Fork Canyon would have made widespread commercial development challenging[9], it was the legal designation that guaranteed that the entrance to Yellowstone would remain wild and scenic.



In Norway, formal legal protections for rivers and a national-scale planning process to guide development has resulted in hundreds of river stretches being protected from hydropower dams, reducing conflicts and providing greater certainty for both the energy sector and conservationists.

European river otter (Lutra lutra)

Norway Profile: Master Plan and Legal Protections

Norway relies almost entirely on hydropower for its electricity and most of its large rivers are currently regulated. By the 1970s, approximately half of Norway's estimated hydropower potential had been developed and new hydropower projects began to confront opposition from indigenous groups, environmental organizations and other proponents of non-power values from rivers[11]. As energy demand continued to increase, the government of Norway decided that a project-by-project approach to hydropower development was not capable of producing outcomes that balanced the multiple values of the country's rivers[12].

Norway has a complex legal framework regarding river protection, hydropower licensing and water management. Through multiple legislative actions in the 1970s and 1980s, Norway created a national Protection Plan for Watercourses which, by 1986, had designated nearly 200 rivers or stretches of river for protection, including removal from eligibility for future hydropower licenses[12].

In the 1980s, the government developed a Master Plan for Water Resources (or Hydropower Development) to provide a national assessment of river resources and to rank future hydropower projects with the goal of meeting an energy target with the lowest impacts on other resources, including the environment. The planning process considered only projects deemed to be economically feasible. In addition to energy generation, the Master Plan assessed resources such as fish and wildlife resources, recreation, cultural/historical sites, and other water sectors such as water supply and flood management. Potential impacts on each resource were ranked from -4 (very negative) to +4 (very positive). Based on these rankings, potential projects were then placed into one of three categories: (1) projects eligible for licensing due to

low costs and low conflict with other resources; (2) projects with higher energy costs and/or potential for conflict that were placed into a "reserve" for future consideration; and (3) projects to be removed from consideration due to high costs and/or high potential for conflict.

The Master Plan was approved by the Norwegian legislature in 1985, and was updated in 1988 and 1993. Subsequent revisions merged categories 2 and 3 to expand those projects for which licenses could not be submitted. Projects placed in category 1 may advance to development by following a procedure set up under the legal framework for licensing of hydropower which requires a project-level environmental impact assessment[13].

(c) Wild Wonders of Europe / Magnus Lundgren / WWF

(c) Wild Wonders of Europe / Magnus Lundgren / WWF

Atlantic salmon (*Salmo salar*) in the River Orkla in Norway

In part reflecting categories from the Master Plan, the Protection Plan for Watercourses has now grown to include 389 rivers or parts of rivers representing approximately 25% of Norway's hydropower potential[14]. *The Water Resources Act 2000* made these river protections statutory. In 2003, the Norwegian Parliament also established a system of "national salmon rivers," a designation which prioritizes management and restoration of Atlantic salmon stocks and precludes activities that would harm wild salmon. A total of 52 rivers have received this designation, representing approximately ¾ of Norway's production of wild Atlantic salmon.

Although these various plans and laws delineate where hydropower can be developed and where rivers are protected from this development, the 2005 supplement to the Protection Plan decreed that hydropower projects with a capacity below 10 MW would be exempt from the Master Plan. Licensing for projects between 1-10 MW are reviewed and granted directly from Water Resources and Energy Directorate and those <1 MW are delegated to county authorities[15]. The 2005 supplement also permitted licensing of < 1 MW in protected rivers, but only if the development is not contradictory to any of the protection criteria[16]. Responding to increasing demand, particularly for renewable energy, small dam development has increased with more than 350 hydropower dams of 1-10 MW built on Norwegian rivers between 2001 and 2014[17].

Because of Norway's dependence on hydropower, it has developed a high proportion of its rivers. However, Norway has also formally protected more rivers from hydropower development than any other country. The complex legal framework and regulations that govern river protection in Norway limit some activities that would negatively impact natural values or specific resources such as salmon. Further, Norway has a Master Plan that directs hydropower development toward low-conflict rivers and away from high-conflict rivers..

A view of the San Pedro Mezquital

Mexico Profile: Water Reserves

with San Pedro Mezquital Environmental Water Reserve as case study

In order to safeguard important ecosystems, maintain invaluable ecological services, and adapt to water scarcity in a changing climate, Mexico established a National System of Water Reserves in 2012. This was a collaborative process undertaken by the National Water Commission of Mexico (CONAGUA) in partnership with the WWF-Gonzalo Río Arronte Foundation Alliance, together with the National Commission of Natural Protected Areas. The process involved calculating the water requirements of critical ecosystems, implementing a national standard for determining environmental flows (the water regime provided within a river to maintain ecosystems and their benefits), identifying priorities for conservation, and establishing water reserves.

A ***water reserve*** is the volume of water that is excluded from the total amount to be allocated to various management purposes. It is the legal amount for conservation or restoration of vital ecosystems, including maintenance of the functionality of the water cycle and its environmental services, and as a means of providing a reserve in a changing climate[4]. Specific protections include those that protect environmental flow requirements of a river and its ecosystem.

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 reserve represents a percentage of the mean annual runoff which can be used to buffer climate impacts and help to manage risks[4].

By 2018, reserve decrees are expected to be issued for 189 river basins. The reserve decrees will be supported through policies such as the National Environment Sector Program (2013-2018) and Water and Special Climate Change Programs (2014-2018). Decrees outline conditions for authorizing environmental, social and economic water uses, as well as ensuring environmental flows, ultimately aiming to guarantee water security for the next 50 years.

Case Study:
San Pedro Mezquital River in Mexico

The San Pedro Mezquital is the last free-flowing river in the western Sierra Madre Mountains in Mexico. As the river flows 540 kilometers en route to the Pacific Ocean, the mainstem of the river ebbs and flows depending on the time of year[18].

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 large (200,000 hectare) 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% 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[19].

This Reserve decree outlines three types of reserves: one for domestic use, another for hydropower generation, and the third for the environment. The *Environmental Water Reserve* regulates any water-related infrastructure that is proposed. Therefore, before construction can be authorized, 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 a Reserve include sediment parameters and protection of social resources related to Indigenous People's rights and land (cultural sites), among others.

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. In 2009, non-profit organizations presented a petition to the Secretariat of the Ramsar Convention for the Conservation of Wetlands detailing concerns about how the dam would affect the river and its resources. In September 2014, Mexico's Secretariat of Environment and Natural Resources authorized the Las Cruces dam project with a set of 18 conditions, including that it not violate the Environmental Water Reserve.

Experts, including scientists from local, regional and national universities, representatives from federal agencies, and non-governmental organizations, among others, indicated that the project design and proposed operation would not fulfill 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[20]. Thus, the construction of the dam has been delayed unless it can meet the environmental flows requirements, in addition to the other 17 conditions set out in the decree.

The San Pedro Mezquital Basin is one of six pilots designed to test the effectiveness of implementing water reserves and associated flow regimes[21]. 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.

(c) Michel Gunther / WWF-Canon

Fisherman at sunset in the Yangtze basin

Species-Specific Reserve Case Study:

Upper Yangtze Fish Reserve, China

The upper reaches of the Yangtze River support 267 native fish species, with 118 unique to the region[22]. To protect species richness and mitigate the ecological impacts of the Three Gorges Dam upstream, a series of actions created the National Nature Reserve Areas of Rare and Endemic Fishes of the Upper Yangtze River (Fish Reserve). In 1997, the Sichuan provincial government merged two local protected areas in the Upper Yangtze into a provincial reserve. This was later upgraded to national reserve status in 2000 and renamed in 2005 to what it is today.

The Fish Reserve provides formal protections for three rare fish species (Chinese paddlefish, Dabry's sturgeon, and Chinese high fin banded shark) and dozens of endemic fishes[23]. Regulations of the People's Republic of China on Nature Reserves limit hydropower development within the Reserve, however, maintaining the original boundaries of the reserve has been a challenge.

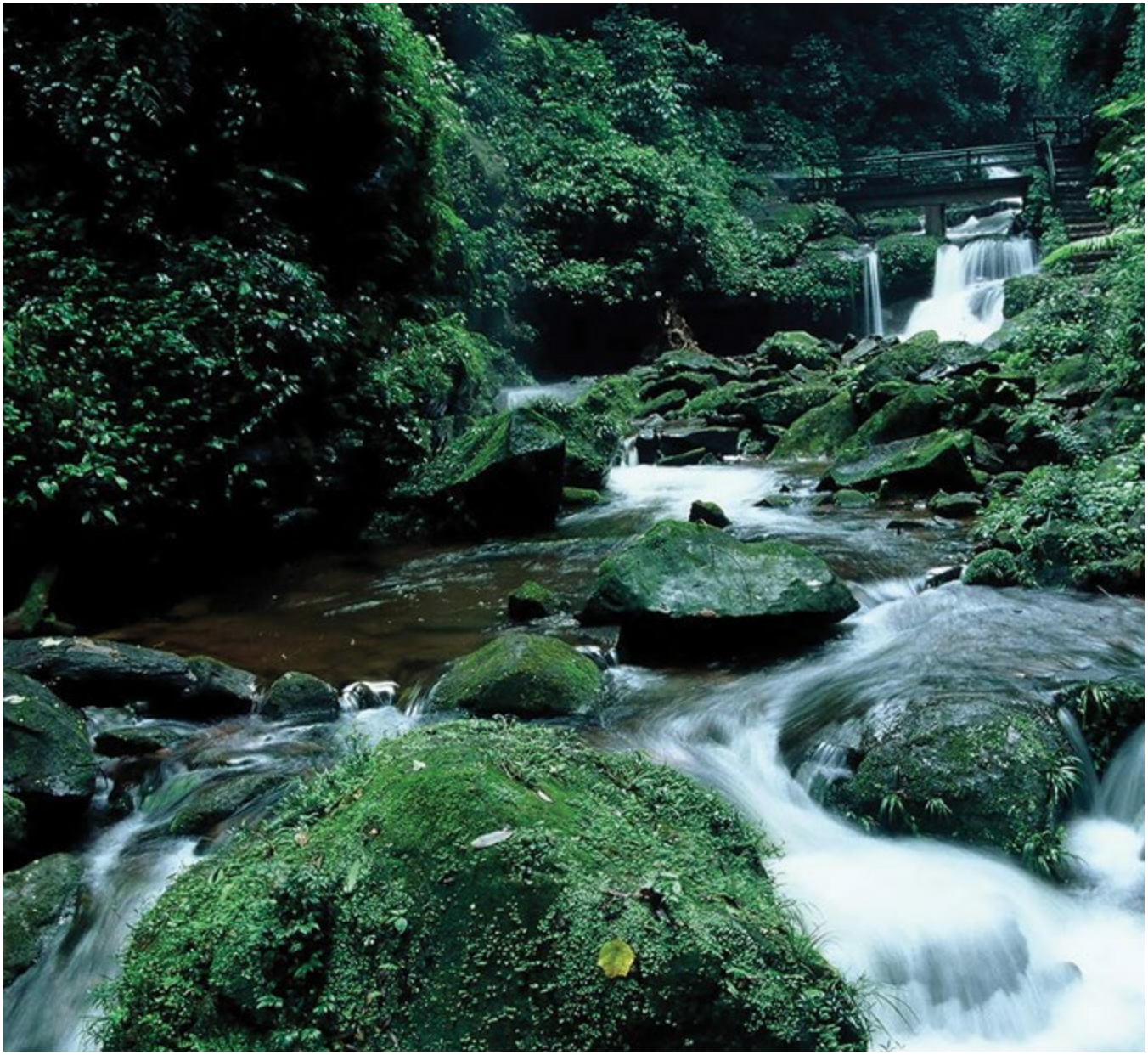
In 2005, the Reserve's boundaries were altered to accommodate a hydropower project on the Jinsha River tributary (the recently completed Xiangjiaba dam). In 2010 the boundaries were adjusted again to accommodate the proposed Xiaonanhai dam. The original proposals for these hydropower projects preceded establishment of the Reserve, creating some confusion and conflicts regarding goals and plans for conservation and development.

In particular, the Xiaonanhai section of the river within the Reserve serves as an 'ecological corridor' for rare and endemic species[24]. The Xiaonanhai dam would have resulted in a physical barrier preventing migratory fish from reaching spawning grounds. Further, by creating a long reservoir in the Reserve, the dam would have negatively affected the reproductive success of fish with eggs that develop while floating. This reproductive strategy requires the moving water of a free-flowing river because the eggs will sink in a reservoir and will not develop. Because the Reserve was established to

protect the last free-flowing stretch of the Upper Yangtze, the Xiaonanhai Dam would have pushed this part of the basin past an ecological 'red line'[25].

In April 2015, the proposed Xiaonanhai dam was stopped by China's Ministry of Environmental Protection in response to environmental concerns[26]. In 2016, President XI Jinping further announced large-scale development would no longer be allowed on the Yangtze River, with environmental protection upgrades as part of a national strategy.

While Xiaonanhai was not built in the Reserve, the fact that its boundaries were adjusted indicates that designation of a reserve is only as strong as the will to maintain that designation. Ultimately, the Chinese government recognized the ecological value of the Fish Reserve and it appears now that it is protected from dam development. However, an upstream cascade will affect the flow regime within the Reserve and maintaining or restoring physical habitat conditions within the Reserve will remain a challenge.



A stretch of the Chishui River, a free-flowing tributary of the Yangtze

(c) naturepl.com / Kevin Schafer / WWF

The Amazon river dolphin, which lives in Brazil's rivers

Protected Areas Case Study:

Tapajós and Juruena Rivers, Brazil

The Amazon Basin contains the world's largest river. A series of 44 dams have been proposed for one of the Amazon's tributaries, the Tapajós River, and several of its own tributaries – the Teles Pires, Jamanxim and Juruena Rivers[27]. If these hydropower projects go through, they are expected to flood Indigenous lands, national parks, and other protected areas.

The São Luiz do Tapajós Dam is one of the proposed dams. At 53 meters high and 7.6 kilometers long, the dam is designed with a hydropower capacity of 8,000 MW. It is also expected to inundate almost 732 km^2 (half the size of the municipality of Sao Paulo). The dam site falls within the boundaries of the Amazonia National Park. Between 2011 and 2012, the Brazilian Congress amended the boundary limits of the Park – moving the boundaries away from the banks of the Tapajós, to allow the São Luiz do Tapajós Dam to proceed[28]. Other protected areas were also amended including the Itaituba (I and II) and Crepori National Forests, and the Tapajós Area of Environmental Protection[27].

However, in the spring of 2016, Brazil's National Environment and Renewable Natural Resources Institute (IBAMA) put the project on hold, suspending its license due to "the infeasibility of the project from the prospective of Indigenous (the Munduruku) Peoples' issues"[29]. This was announced following the release of a report from the federal agency for Indigenous affairs (Fundação Nacional do Índio, FUNAI) advising that 178,000 hectares along the Tapajós River called Sawre Muybu should be demarcated and protected as the traditional Indigenous territory of the Munduruku people, according to Brazil's constitution[30]. It is not clear if this decision is just a temporary set-back to the project, or whether it will proceed once certain legal and regulatory hurdles are cleared. It is also not clear whether the protected area designation (Amazonia National Park) contributed to the decision to suspend the project.

Two other hydropower plants – São Simão and Salto Augusto Dams – that were proposed for the Juruena River, a tributary of the Tapajós, were dropped within the 10-year energy plan for Brazil which was released in 2014. While this represents a postponement of those projects until at least 2023, if the proposals do proceed after that, reservoirs would inundate approximately 40,000 hectares in the Juruena National Park (established in 2006) as well as other state parks and Indigenous territories. In addition to inundating protected areas, the dams would cause the fragmentation of the currently free-flowing Juruena and disrupt fish migration[31].

The story of hydropower development in the Tapajós, including the amendment of national park and other protected area boundaries, underscores that rivers within protected areas may not have durable protection. Long-term conservation of free-flowing rivers in Brazil may require specific designation of protection for a river (i.e., complementary to the protected area status for the surrounding land) or protection via the hydropower planning process, in which certain rivers are removed from eligibility for development.

A stretch of the Rio Juruena in Brazil

A stretch of the Parismina River

Biodiversity Offset Case Study:

Reventazón and Parismina Rivers, Costa Rica

In Limon Province of Costa Rica, two sister rivers – the Reventazón and the Parismina – meet and flow together as one along the coastal plain into the Caribbean Sea. But the two also have very different fates. The Reventazón River has been regulated over the past fifty years via a series of hydropower projects along its mainstream and tributaries. In contrast, the Parismina River, which joins the Reventazón, remains a free-flowing system with its natural ecosystem relatively intact.

Adding to a cascade of dams already along the Reventazón River, a 305 MW hydropower project was constructed and commissioned (2012 to 2016) in its lower reach. Financed in part by the Inter-American Development Bank, the Reventazón Hydropower Project (PHR) included a 130-meter-high dam and an eight-kilometer long reservoir. As the project was built downstream from existing dams along the Reventazón River, its construction and operation were expected to influence the river's ability to support migratory fish species. If left unmitigated, the environmental impacts, including loss of critical habitat and connectivity, would be significant[32].

To offset the impacts of the Reventazón dam, Costa Rica's national power company, Instituto Costarriacense de Electricidad, declared the Parismina River protected in perpetuity[32]. As part of the second phase of the Reventazón project (2016 to 2032), the agreement guaranteed that "artificial modifications, including dams that would block migrations, will be prohibited and that the Parismina's natural flow pattern and its biological integrity will be preserved or restored where required"[33].

The mitigation strategy also includes the establishment and management of a protected area encompassing a 100.5 km

long corridor with 794 hectares allocated as a protection zone and 8178 hectares allocated as a buffer zone[34]. These land protections and management are intended to improve habitat conditions within the Parismina and its riparian corridor.

The Inter-American Development Bank report estimated the offset would cost US$ 2.7 million (2013-15) and US$ 800,000 per year thereafter[35]. This includes a program designed to assess the offset's effectiveness through the monitoring of water quality, biodiversity and habitat health. While the Parismina River offers similar habitats for migratory fish, it is considerably smaller than the Reventazón in terms of width and flow. However, the Parismina is one of the first offsets implemented for a hydropower project, illustrating the potential value of this approach to direct mitigation toward the formal protection of a free-flowing river.

In addition to the offset of the Parismina, in 2015, the President of Costa Rica declared the Savegre and Pacuare Rivers as protected from hydropower development for the next 25 years, as part of a broader national framework for hydropower[36]. Both rivers were selected for their ecological, biological, economic and social importance. The wild Pacuare is 108 km long and supports whitewater rapids that attract tourists from around the world. The protection of these two rivers, together with the Parismina offset, serves as another means to protect wild and free-flowing rivers.

An egret along the Parismina River

(c) Brent Stirton / Getty Images

A winding river in the Amazon rainforest

Conclusions

The world is undergoing a dramatic expansion of dams and other water-management infrastructure[37]. For example, the projected doubling of hydropower capacity means that the world will build as many large hydropower dams in the next few decades as were built in the previous century. While this development often provides economic benefits, dams also change rivers and negatively impact a wide range of other benefits, including the food, livelihood, and cultural values provided by healthy rivers. A wide range of governments, funders, companies and stakeholders are seeking ways to reduce impacts from dam and other infrastructure development, as well as to balance the benefits that come from developed rivers with those from free-flowing rivers.

Although significant improvements have been made in dam design and operation, the most effective way to achieve this balance is through site selection – comprehensive and system-scale planning that directs development toward the most appropriate places and away from the most important or vulnerable rivers or sections of rivers. In recent research, The Nature Conservancy estimates that widespread application of this planning approach could reduce impacts on 100,000 kilometers of river worldwide during the projected expansion of hydropower[1]. In other words, comprehensive planning can allow the world to have significantly more free-flowing rivers while meeting projected energy targets.

System-scale planning identifies rivers or sections of rivers that should be avoided by new development and protected over the long term. To be durable, this approach therefore depends on effective mechanisms to provide this protection. This white paper is the initial summary of findings from a longer research project that WWF and The Nature Conservancy are pursuing. Our findings thus far suggest that a relatively small fraction of the world's nations have formal, legal mechanisms specific to river protection. Additionally, formal designations of other types of protected areas often do not convey durable protection for the rivers within them, as illustrated by the Brazil case study. In parts of the world, such as the Balkan countries in southeastern Europe, a high proportion of proposed new dams fall within the boundaries of formally designated protected areas.

Below we summarize our initial recommendations arising from this research:

1. An expansion of national legal protections that specifically conserve high-value rivers and sections of rivers. The case studies from the United States, Norway, and Mexico provide illustrative examples of mechanisms that other countries can adopt.

2. Strengthening and clarifying the laws governing national parks and other types of protected areas to confirm that rivers within them are not eligible for dam or other infrastructure construction that affects their free-flowing status.

3. Protecting rivers via system-scale planning, licensing and mitigation. Even in the absence of formal protections along the lines of the United States Wild and Scenic Rivers Act, governments have other options for effectively protecting rivers. For example, Norway's Master Plan provides an example of system-scale planning, which identified dozens of rivers that were ineligible for licensing for new dams. Costa Rica has done something similar, though not yet permanently, by removing two important rivers from being eligible for new hydropower development, and has undertaken a mitigation action to protect one river in exchange for hydropower development on another. Funders and government agencies have the ability to undertake system-scale planning as well as requiring offsets for new dam development and using those offsets to permanently protect and manage high-value rivers.

In conclusion, this preliminary review highlights a pressing need for comprehensive system-scale planning for rivers and a range of mechanisms by which countries can protect free-flowing rivers and the values that they provide.

Aerial view of the Kitkajoki River in Finland

References

1. Opperman J, Grill G, Hartmann J (2015) The Power of Rivers: Finding balance between energy and conservation in hydropower development. Washington, D.C., USA: The Nature Conservancy.

2. Abell R, Allan JD, Lehner B (2007) Unlocking the potential of protected areas for freshwaters. Biological Conservation 134: 48-63.

3. Dudley N, editor (2008) Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN.

4. Ramsar Convention (2015) Resolution XX11.12. Call to action to ensure and protect the water requirements of wetlands for the present and the future. Submitted at 12th Meeting of the Conference of the Parties to the Convention on Wetlands.: Convention on Wetlands (Ramsar, Iran, 1971) Secretariat.

5. Business and Biodiversity Offsets Program (2016) Biodiversity Offsets. Accessed April 2016: **http://bbop.forest-trends.org/pages/biodiversity_offsets**

6. United States Fish and Wildlife Service (2016) National Wild and Scenic Rivers System: About the WSR Act. Accessed April 2016: **www.rivers.gov/wsr-act.php**.

7. United States National Park Service (2011) Nationwide Rivers Inventory. Accessed April 2016: **www.nps.gov/ncrc/programs/rtca/nri/hist.html#creation**.

8. Schlueter S, Shetty N, Zvolanek E (2014) A comparison of the old and new: A case study for rebuilding the nationwide rivers inventory. Available at: **https://depts.washington.edu/mgis/capstone/files/2014_1_Schlueter_Shetty_Zvolanek.pdf. University of Washington**.

9. United States Department of Agriculture (2009) Comprehensive River Management Plan for the Clarks Fork of the Yellowstone Wild and Scenic River Accessed April 2016: **www.rivers.gov/documents/plans/clarks-fork-plan.pdf**.

10. United States Fish and Wildlife Service (2016) National wild and scenic rivers system – Yellowstone River (Clarks Fork) – Wyoming, USA. Accessed April 2016: **www.rivers.gov/rivers/yellowstone.php**.

11. Halvorsen ST (1988) The Master Plan for the Management of Watercourses in Norway. Environmentalist 8: 39-45.

12. Huse S (1987) Norwegian river protection scheme: A remarkable achievement of environmental conservation. Ambio 16: 304-308.

13. Knudsen JK, Ruud A (2011) Changing currents in Norwegian hydropower governance?: The challenge of reconciling conflicting interests. Oslo, Norway: Center for Environmental Design of Renewable Energy.

14. Norwegian Water Resources and Energy Directorate (Updated March 15, 2016) Conservation Plan for Waterways. Accessed May 2016: **www.nve.no/vann-vassdrag-og-miljo/verneplan-for-vassdrag/**.

15. Aarrestad K, Hatlen LM (2015) Facts 2015: Energy and Water Resources in Norway. Oslo, Norway: Norwegian Ministry of Petroleum and Energy. Available online: **https://www.regjeringen.no/contentassets/fd89d9e2c39a4ac2b9c9a95bf156089a/facts_2015_energy_and_water_web.pdf.**

16. Kampa E, von der Weppen J, Dworak T (2011) Water management, Water Framework Directive & Hydropower: Issue Paper from Common Implementation Strategy Workshop, Brussels, 13-14 September 2011. Available online: **http://www.ecologic-events.eu/hydropower2/documents/IssuePaper_final.pdf**.

17. Lia L, Jensen T, Stensby KE, Midttømme GH, Ruud AM (2015) The current status of hydropower development and dam construction in Norway. International Journal on Hydropower and Dams 22: 37-43.

18. WWF - Gonzalo Río Arronte Foundation Alliance (2012) The San Pedro Mezquital River: The great unknown. Available online at: **http://d2ouvy59p0dg6k.cloudfront.net/downloads/san_pedro_mezquital_2012.pdf.** Mexico: WWF and Gonzalo Rio Arronte Foundation.

19. Mexico Secretariat of Environment and Natural Resources (2014) Decree of water reserves in the San Pedro Mezquital River Basin. Available online at: h**ttp://reservasdeagua.com.mx/documentos-tecnicos/**.

20. Alfonso AG, Soria-Barreto M, Martinex-Cardenas L (2015) Fishes in the lower San Pedro Mezquital River, Nayait, Mexico. The Journal of Biodiversity Data 11: 1796.

21. Barrios Ordóñez JE, Salinas Rodríguez SA, López Pérez M, Villón Bracamonte RA, Rosales Ángeles F, et al. (2015) National Water Reserve Program in Mexico: Experiences of ecological flow & allocation of water to environment. Washington, DC, USA: Inter-American Development Bank.

Left: Fisherman at sunset in the Yangtze basin

References *Continued*

22. Chang J (2006) Evaluation of rare and endemic fish resources in the upper reaches of the Yangtze River. Report to The Nature Conservancy China Program. Wuhan, China: Institute of Hydrobiology, Chinese Academy of Sciences.

23. He Y, Wang J, Lek S, Cao W, Lek-Ang S (2011) Structure of endemic fish assemblages in the upper Yangtze River Basin. River Research and Applications 27: 59-75.

24. Xiao F (2012) Briefing on Xiaonanhai Dam and its impact on the Upper Yangtze Rare and Endemic Fish Reserve. Accessed April 2016: **www.internationalrivers.org/files/attached-files/xiaonanhai_briefing_fanxiao_small.pdf**.

25. Mang G (2015) Xiaonanhai: The controversial dam on the Yangtze that will not be built. Accessed May 2016: **www.internationalrivers.org/blogs/262/xiaonanhai-%E2%80%93-the-controversial-dam-on-the-yangtze-that-will-not-be-built**.

26. China Ministry of Environmental Protection (2015) Wudongde Approval Letter (includes rejection decision of Xiaonanhai Dam). Accessed April 2016: **www.internationalrivers.org/resources/8698**.

27. WWF Brazil (2016) A conservation vision for the Tapajós Basin. Brasilia, Brazil.

28. Instituto Socioambiental (2012) Unidades de Conservação. Accessed May 2016: **https://uc.socioambiental.org/**.

29. Yale Environment 360 (April 22, 2016) Brazilian officials put a hold on mega-dam project in the Amazon. Accessed May 2016: **http://e360.yale.edu/digest/environmental_officials_brazil_put_hold_on_mega_dam_project_in_amazon/4706/**.

30. International Rivers (April 20, 2016) Press Release: Brazil Suspends Licensing of Controversial Amazon Dam. Accessed May 2016: **https://www.internationalrivers.org/resources/11450**.

31. WWF Brazil (2014) Juruena National Park – Safe for now. Accessed **www.wwf.org.uk/wwf_articles.cfm?unewsid=7339**.

32. Trujillo C, Rodriguez E, Franco Carassale GF, Boulet E, Watkins G, et al. (2012) Reventazón hydropower project:. Environmental and social management report. Costa Rica: Inter-American Development Bank.

33. Inter-American Development Bank (2015) Project snapshot: Hydroelectric project takes unprecedented measures to protect habitat. Accessed May 2016: **www.iadb.org/en/topics/sustainability/project-snapshot-hydroelectric-project-takes-unprecedented-measures-to-protect-habitat,7998.html**.

34. Chaves A, Fallas J, Campos F (2015) Parismina River offset project. Accessed May 2016: **http://previous.espconference.org/downloadattachment/83095/92052/21%20Offset-Parismina-ICE-eng.pdf**.

35. Dixon J (2013) Expanded cost-benefit analysis of the Reventazón hydroelectric project (PHR) in Costa Rica. Washington, DC, USA: Inter-American Development Bank.

36. Inter-American Development Bank (2016) Can we protect our rivers and continue to build hydropower projects? Accessed May 2016: **http://blogs.iadb.org/vivasustainability-en/2016/02/29/bigdams/**.

37. Zarfl C, Lumsdon AE, Berlekamp J, Tydecks L, Tockner K (2015) A global boom in hydropower dam construction. Aquatic Sciences 77: 161-170.

As hydropower and associated infrastructure continues to expand, people are seeking ways to ensure that this development can meet needs for energy and water while maintaining healthy rivers. Given that mechanisms to protect important rivers, or sections of rivers, will be a critical tool to meet this challenge, World Wildlife Fund and The Nature Conservancy initiated a review of existing protection mechanisms. In this white paper, we highlight place-based river protections and case studies from around the world.

For more information, contact:
Michele Thieme: **michele.thieme@wwfus.org**
Jeff Opperman: **jopperman@TNC.ORG**

WWF

The Nature Conservancy
Protecting nature. Preserving life.