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WORLD RIVERS REVIEW

INSIDE

Special Focus: Biodiversity

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Saving the World's Rivers: What Must Be Done?

By C. A. Sullivan, D. Dudgeon, et al.

Flying across any continent today confirms that the world's rivers are dominant features in the landscape, and are places where humans and animals gather to reap the many benefits and services they provide. Rivers of all sizes all over the world have underpinned the process of human development. As we progress into the twenty-first century, this development process must now be reassessed. Across the world, we have mismanaged and in some places almost destroyed the core ecological fabric on which river health – and indeed our own survival – depends. Human-caused stressors now endanger the biodiversity of 65% of the world's river habitats, putting thousands of aquatic wildlife species at risk.

One of the most comprehensive studies of global rivers to date has examined human stressors on all the major rivers of the world. This study, published in September 2010 in the journal *Nature*, evaluated the state of the world's rivers by taking into account the major "ecological insults" we impose upon them. The 23 threat factors used in this analysis all have well-documented impacts on human water security and aquatic biodiversity. These were grouped according to their effects on river ecological health and biodiversity, and on human water security. Each of these threats was weighted separately, which is important since the effects of a factor such as nitrogen pollution on fish, for example, are not the same as its consequences for human water security.

Using geo-referenced global databases jointly developed by the team, the combined impact of these multiple threat factors can be displayed graphically, demonstrating global conditions across the 99 million km^2 of major river basins included in the study.

Our study found that vast areas across both the developed and developing world arrive at similarly acute levels of imposed threat to their freshwater resources. Sources of degradation in many of the developing world's most threatened rivers bear striking similarities to those of rivers in similar condition in wealthy countries. However, the highly engineered solutions practiced by industrialized nations, which typically emphasize treatment of the symptoms rather than protection of resources, not only often prove too costly for poorer nations, but appear also to do little to secure healthy river systems.

The reliance of wealthy nations on costly technological remedies to overcome their water problems and deliver

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SPECIAL FOCUS ON BIODIVERSITY

Biodiversity the world over is threatened by changes to rivers. These Great One-horned Rhinoceroses live in India's Kaziranga National Park, which is threatened by dams planned in the Brahmaputra River Basin. Photo courtesy UNESCO

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Commentary

SWIMMING WITH STURGEON

Several years ago I picked up the morning newspaper and came across one of those stories that forces you to sit down, breathe deep, and read on. No, it wasn't the latest inter-governmental report on climate change forecasts nor a numbing reminder that the global economy is extinguishing species at an average clip of 200 per day. It was an article about Green Sturgeon.

When I lived in Russia as a young man, I'd come to know this ancient and mysterious creature mostly through their roe, and their lore: a fish without bones (having taken a different evolutionary path from bony fish a long time before the dinosaurs stopped roaming the Earth), longer than an outstretched Olympic swimmer, reaching sexual maturity and the end of a natural life at about the same time as you and me.

As a dam-removal activist in California, I'd come to learn of the green sturgeon's anadromous habits (birth and spawning in freshwater, getting big in oceans and estuaries), of its finicky reproductive patterns (they can wait many years until ideal spawning conditions are found), and of the highly threatened existence of the "Distinct Southern Population" that plies the waters of Oregon and California.

I had become, well, emotionally involved with the species in 2006 when we located and photographed a pair of sturgeon on the Yuba River circling in the plunge pool of an impassable dam. Scientists, who admittedly know little about this enigmatic and elusive fish, informed me at the time that there were likely only be a couple dozen spawning-aged green sturgeon that utilize the whole of the Sacramento River and her tributaries. We went ahead and gave "our" Yuba sturgeon nicknames, knowing full well they wouldn't stay there long.

So to read in the newspaper that morning in 2007 that ten (10!) adult green sturgeon had been crushed in the gates of a diversion dam on the upper Sacramento River was a blow to my mind and my heart. "Did we really just lose nearly half of the remaining spawning population for this river?" I asked myself. "Were the two that we had come to know on the Yuba among the dead?"

The subject of biodiversity is ultimately one about relationships more than statistics. The statistics are indeed grim: we're losing species at 1,000 times the normal rate and these losses are most pronounced in riverine ecosystems.

Yet it's the inter-relationships between species that create resilience in a community – an ecological community as well as our human community. As Janine Benyus, a pioneer in the field of bio-mimicry, points out, "Life creates conditions conducive to life." It is this fecundity and species richness that has propelled the evolution of life on Earth, and which created such a diverse and hospitable place for humans to find their niche, enmesh within the web of life, and to become what we call today "indigenous."

As a species, we've obviously crafted lifeways that are undoing a couple billion years of interdependent planetary evolution, a process of diversification of life that really ramped up after the last extinction climax 65 million years ago. The irretrievable loss of the Yangtze River *baiji* dolphin or the extinction of a third of all wild salmon runs on dammed rivers throughout the US West are just the most charismatic examples of shredding the safety net that supports our own existence and viability.

We're losing life forms that have the ability to nourish us, keep our water clean, produce breathable air and fertile soil, and ultimately make our planet the amazing place it is.

If we don't protect our biological richness and diversity, we undercut the re-generative capacity of the Earth, we undermine the prospect of life creating the conditions conducive to life.

This is one of the reasons why International Rivers – and you as a supporter of our work – are so important in this zeitgeist. We are defending the Earth's lifelines: protecting aquatic biodiversity while simultaneously lending our muscle and smarts to changing an often fool-hearty and pernicious economic development model that persists in under-valuing healthy ecosystems and the protection of biodiversity.

At International Rivers, we'll continue to make our stand arm in arm with resistance movements throughout the global South, to give space for the necessary redesign of human systems to meet our needs in a way that enhances and regenerates the planet's biological diversity. The alternative is to take our chances swimming with the sturgeon.

Jason Rainey

Why We Shouldn't Dam the Mekong

Biological Treasure Trove is World's Most Productive River

By Zeb Hogan

The Mekong River is still a relatively healthy, natural, free-flowing river. It is one of the most biodiverse rivers on Earth (in terms of freshwater fish). Most of its habitats and connections between habitats are still intact. Remarkably, the Mekong is still capable of producing 2.6 million tons of fish a year, despite fishing pressures from millions of people who depend on the river for sustenance. That makes it the most productive river in the world.

The Mekong is also home to many species of giant fish. It's unclear why so many species of giant fish occur in the 2,700-mile (4,350-kilometer) river, which runs from southern China to Vietnam. Certainly part of the answer is the river's size: Large rivers have more space and more food to accommodate larger fish.

Another part of the answer may lie in the productivity of the Mekong River Basin ecosystem, including the floodplains and flooded forests that provide an abundant source of food for many species of fish during the rainy season.

The hydropower dam planned on the Mekong River in Xayaburi Province, northern Laos, is a threat to the survival of the wild population of Mekong giant catfish. Under threat are the suspected spawning locations for many species of fish. The Xayaburi Dam is the first lower Mekong River mainstream dam to enter a critical stage of assessment. The four Mekong nations are expected to make a decision on the dam by January. The other dam closest to being approved is Don Sahong. The Sahong channel is the most important migratory pathway in Southern Laos.

One of the largest fish in the world, the Mekong giant catfish can reach 10 feet (3 meters) long and weigh up to 650 pounds (300 kgs). It is one of the most endangered fish in Southeast Asia. It is listed on the IUCN Red List of Threatened Species as Critically Endangered. This is a culturally important and charismatic species. As a vulnerable Mekong endemic, the giant catfish symbolizes the ecological integrity of the Mekong River. Thus, the protection of this species is an important part in the sustainable management of the Mekong River Basin.

Almost all of the information that we have about this species – that the Mekong giant catfish is highly migratory, seems to need specific cues to spawn, cannot reproduce in reservoirs, and probably spawns in northern Thailand and in Laos – suggests that the Xayaburi Dam and other Mekong dams will have serious negative impacts.

The same is true of other species of Mekong giants: We know very little about the ecology of these species, but what we do know suggests that they need healthy, free-flowing rivers to survive.

Without further study, it's highly likely that mainstream dams will drive at least one, if not all, of these species to extinction. We've seen something similar happen on the Yangtze, where the two largest species are in grave danger after major dam construction (one, the Chinese paddlefish, may already be extinct).

Other threats to the Mekong's megafish include over-harvest, habitat degradation and invasive species. Up to 80% of Mekong giant fish are at risk of extinction.

Way Forward

There are several actions that would help ensure the survival of the giant fish species of the Mekong, including:

• **Maintaining connectivity between rearing grounds and spawning habitat:** Many species of Mekong fish have complex life cycles that involve long-distance migrations. Maintenance of migratory pathways is crucial. Existing fish passage technologies cannot handle the massive volume of fish migrations, which can reach up to three million fish per hour at peak migration times.

• **Healthy flows for a healthy, productive river:** Both the fish and the fisherfolk of the Mekong are adapted to the natural cycle of dry season/rainy season. Flows often cue fish to migrate or spawn and the high flows of the rainy season open up vast habitats for feeding fish. Likewise, local people have invented all manner of ingenious ways of catching fish, and most of these methods are adapted to a specific site, flow, and time of year. If dam projects proceed, it will be critical to design dams in concert with an environmental flows management plan that allows for the most natural river flows possible. Implementation of such a plan will need upfront funding and long-term commitments.

• **Regulation and monitoring of harvest:** Over-harvest is a serious threat to the Mekong's largest, longest-lived, and most vulnerable species. Mekong giant catfish, "dog-eating" catfish, and giant barb are extremely rare, with only 5-10 adult fish caught per year. In areas with heavy fishing pressure (and that includes virtually the entire Mekong Basin), catch of the largest fish must be regulated to ensure their survival. Lessons from other parts of the world indicate that relatively slow-growing large-bodied fish cannot sustain heavy fishing pressure indefinitely.

• **Research and decision-making based on research:** Research on the ecology and conservation status of giant fish is urgently needed in the Mekong River Basin. The "dog-eating" catfish is a case in point. We know almost nothing about it and yet it is undoubtedly one of the largest, rarest, and most vulnerable fish in Southeast Asia. It's likely that at least 100 times more research is being done on salmon in the US Pacific Northwest than on fish in the Mekong, but the consequences of losing the Mekong's fish are 100 times more significant in terms of biodiversity and potential impact to livelihoods.

Giant catfish. Photo: Zeb Hogan

Zeb Hogan is an assistant professor in the Department of Natural Resources and Environmental Science at the University of Nevada. He leads the Megafishes project (megafishes.org), an effort to protect the world's largest freshwater fishes.

China's Rich Natural Heritage Under Threat

By Songqiao Yao

Zhou Dequn

Dr. Zhou Dequn *is a professor at Kunming University of Science and Technology and guest professor at Virginia Tech. He worked for The Nature Conservancy from 2004-09 and is currently on the editorial board for the journal* Plant Pathology & Quarantine. *His expertise includes ecology, fungal diversity and conservation biology. We talked to him about China's biodiversity crisis.*

WRR: What is known about biodiversity losses in China's rivers?

ZD: Currently, our knowledge is relatively limited and mostly focuses on research and active monitoring of a few key rivers. For example, the Institute of Hydrobiology at the Chinese Academy of Sciences in Wuhan has long been researching and monitoring the hydrobiology of the Yangtze River. They also established a comprehensive database of China's inland aquatic organisms. However, as a whole, our inland rivers are suffering from severe losses of biodiversity.

For instance, aquatic organisms living in our largest inland river, the Yangtze, are facing severe challenges due to the rapid development of economic zones along the Yangtze River, which has directly caused the decline of biological resources. Many species are endangered or have already become extinct. Due to overdevelopment and pollution along the Yangzte River, the Chinese River Dolphin, which was under first-class state protection, has essentially disappeared.

There is a serious lack of conservation measures and a shortage of funding to protect other aquatic species. According to an expert from Changjiang Fishery Resources Managing Committee, there used to be more than 1,100 species in the Yangtze, including more than 370 fish species, over 220 zoobenthos (organisms which live on the riverbed), and hundreds of aquatic plants. The Yangtze is also home to many rare fish species and wild animals. But currently these resources are declining dramatically and many species are facing extinction. For example, the "Water Panda" (Chinese river dolphin) and the "King of Freshwater" (Chinese paddlefish) can hardly be seen. The famous Reeves' Shad has not been seen for many years. "Living fossils" such as the Chinese sturgeon have also rapidly decreased in numbers and at an even faster pace. The juvenile fish recruitment numbers for the famous four major Chinese carps (the herrings, grass carps, chubs and bigheads) has rapidly decreased since 2003.

WRR: What is known about the impacts of the Three Gorges Dam on biodiversity?

ZD: It is baffling to me that when we were initially constructing the Three Gorges Dam, we didn't learn from the experiences of developed countries that built fish ladders for migratory fish. When we were making these decisions, we didn't consult with any experts or organize any public hearings. The dam has blocked the migratory routes that the fish need in order to reproduce. The number of rare aquatic animals, such as the Chinese river dolphin, Chinese paddlefish, the Chinese and Yangtze sturgeons, cowfish, and mullets has decreased drastically. As a result of the strategy to "transform rivers to lakes," many fish that are used to living in the rapids are gradually migrating upstream. This has led to ecosystem changes in the entire Yangtze River.

The dam has also had a major impact on fisheries. When Three Gorges started impounding water, the water level of Dongting Lake dropped by 1-2 meters. Poyang Lake was once full of sauries, but now they are nowhere to be found. During this year's rare summer droughts, thousands of fishermen along the water basin have been left with empty nets.

WRR: Describe the "biodiversity-scape" in the Three Parallel Rivers basin.

ZD: The Three Parallel Rivers World Heritage Site is home to the upper reaches of three famous rivers in Asia: the Jinsha (Yangtze), the Lancang (Mekong) and the Nu (Salween) rivers. These rivers run parallel north to south and pass through 3,000-meter deep valleys and 6,000-meter high icebergs and snowy peaks. This is China's most biodiverse region.

The Three Parallel Rivers region is home to more than 210 families, 1,200 genera and 6,000 species of vascular plants – 20% of all higher plants in China. Among these, 40% are endemic to China and 10% are endemic to the Three Parallel Rivers region. This region has the most plant species per unit area in the world. Given the complex geological history of the region, old and new species co-exist here, making it home to some of the world's most famous plant species.

Snub-nosed monkey. Photo: Wikimedia Commons

Today, this region is home to 77 kinds of rare and endangered animals, such as snub-nosed monkeys, antelopes, snow leopards, black-necked cranes, and 33 kinds of nationally protected plants, as well as 500 kinds of medical plants. The Yunnan Snub-Nosed Monkey is the most iconic mammal in the World Heritage Site. This genus is very important among all primates. On the level of development, it is in a special category between old world monkeys and apes. It has a very high research value as it helps us understand human evolution. It is also one of the 25 most endangered primates in the world, and should be viewed as a national treasures.

To accurately predict the impact that the extinction of these precious species may have on this region's ecosystem is difficult because the consequences are often felt along very long time

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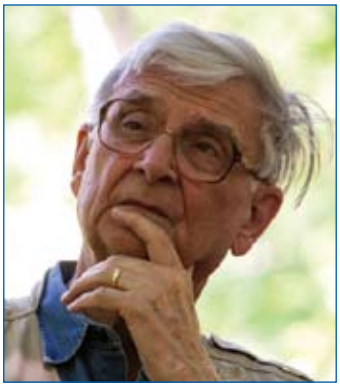
Sweating the Small Stuff

*Renowned biologist **E.O. Wilson** grew up exploring the swamps and river bottom forests of Mobile, Alabama. Now in his 80s, his long and distinguished scientific career has included 40 years at Harvard and two Pulitzer Prizes. We talked to him about the biodiversity crisis.*



E.O. Wilson

WRR: How important are the planet's freshwater species to life on earth, and how are they faring?

EOW: Freshwater systems harbor a large part of Earth's biodiversity; and meter for meter, their species are even more endangered than those in terrestrial ecosystems. Rivers and their watersheds also service downstream land ecosystems and the species in those systems.

WRR: Why do the "little creatures" matter in the big scheme of things?

EOW: Take away all aquatic animals over 100 grams in weight and a system would be seriously impaired. Take away all animals and microorganisms under one gram in weight and the ecosystem would die, and almost immediately.

WRR: What do we lose when we lose a species?

EOW: We lose a genetic code built up by strenuous natural selection to a particular niche over thousands to millions of years. In some cases the extinction is of a "keystone species," so some other species will tumble with it.

In reality, we don't know 90% of what we're losing, because we've only discovered about 10% of the planet's species. When we're trying to stabilize the environment – trying to stop ecosystems from collapsing in the face of global warming or big dams or whatever – we really need to know what's in each of these habitats. We need then to move ecology way ahead of where it is today, really make it a much bigger priority.

WRR: What is the most important thing we need to do to address biodiversity loss?

EOW: Scientists have the knowledge and the technology to staunch biodiversity loss. What we don't have is public understanding of the problem – and the enormous extra benefits to humanity available by studying and saving the rest of life. Therefore, the key is education. ●

China's Heritage *continued from page 4*

scales. Perhaps the impact of species extinction can best be described by "the butterfly effect": a butterfly in the Amazon can cause a tornado in Texas by just flapping its wings.

WRR: What is unique about the Nu River ecosystem?

ZD: In the Three Parallel Rivers region, the Nu River valley represents the most important biological corridor. Damming the Nu would erase the most mysterious and visually stunning river valley before its value can be fully recognized and researched.

The Nu River is located at the canyon of the Hengduan Mountain Range. The completely vertical climatic belt created positive conditions for the growth of animals and plants. Due to these reasons, the Hengduan Mountain Range is one of the most important among the 17 biodiversity conservation regions in China. In addition, the Nu River's rich water resources have given birth to tens of millions of people from various ethnicities.

There are countless aquatic species that depend on the Nu, including more than 50 kinds of fish in Yunnan province alone, and about 20 unique species. In 2001, Kunming Institute of Zoology at the Chinese Academy of Sciences and a fish exploration team from the California Academy of Sciences caught the biggest eel in the world, the Yunnan Manli Eel, in the middle reaches of the Nu River. This eel travels more than 1,500 kilometers between the Nu River and the Indian Ocean. A large number of amphibians, reptiles and aquatic mammals (such as otters) also call the Nu mainstream and its tributaries home. These animals have become interdependent as they coevolved during the formation of the valleys and rivers. They also carry information about the geological and natural history in the entire East Himalayan region.

WRR: What is being done in this watershed to protect biodiversity?

ZD: On the government level, the emphasis on biodiversity is growing. The Nujiang prefecture government has expressed that it will increase and strengthen public advocacy around ecosystem protection and biodiversity conservation. The government is strengthening the protection and management of biodiversity resources in its own prefecture and should provide more support to the departments of environmental and natural protection, to better adapt to the needs of modern biodiversity conservation management. The government should also construct a Nu Biodiversity Protection Base and public education centers.

Academics have been closely monitoring the biodiversity of the Nu River. The Chinese Academy of Sciences, other national and Yunnan universities, international conservation organizations such as The Nature Conservancy, and some domestic environmental organizations have done comprehensive research on different aspects about the biodiversity in the Nu valley and have taken different protection measures. However, there needs to be comprehensive and in-depth research done for the entire river basin.

Thanks to non-governmental environmental organizations, the Nu River hydropower controversy in 2003 and 2005 launched the dam project to national attention. Because of the work of organizations such as Green Earth Volunteers and Green Watershed, central government suspended the Nu River hydropower project. For the first time in China. the voice and activities of domestic non-governmental organizations directly influenced the decision-making of the central government. Right now, there is no consensus around whether the Nu should be developed for hydropower or not. However, the activities of the Chinese environmental organizations represent an important step forward toward the social modernization of China. ●

Freshwater Biodiversity in India's "Hottest Hotspot" in Peril

By Shaji C P

India's Western "Ghats," which means "river landing stairs" in Hindi, is a mountain range from which numerous rivers and streams flow. These waterways provide sustenance for the moist and fertile lands that surround them. The rivers are also home to diverse fish species, many of which are found only in these rivers. The Western Ghats is the world's most heavily populated Biodiversity Hotspot, and its rivers provide approximately 400 million people with drinking and irrigation water, and electricity generated through hydropower.

A recent IUCN "Red List" publication on freshwater biodiversity in the Western Ghats describes the crisis of biodiversity loss in the region. The assessment confirms that the river-rich Western Ghats is a globally significant center of biodiversity warranting urgent conservation strategies.

The Western Ghats run for 1,600 km parallel to the west coast of India and are divided into eight riverine regimes. From a biodiversity point of view, the Western Ghats is one of the eight "hottest hotspots" of the world's 34 biodiversity hotspots. While the earliest dams were built downstream for irrigation, hydropower dams started devouring the upper forested catchments later on. Flows have been diverted and beautiful waterfalls, like the Jog, reduced to trickles. Dams upstream have impacted downstream water needs, fishing livelihoods, ecological functions, and led to deep saline ingress in delta farmlands. Presently a number of controversial dams – including the Gundia, Athirappilly, Pooyamkutty, Kalu and Shai, Dandeli and others – are at different stages in the planning and approval process. They are also being opposed by peoples' movements.

A faunal and floral analysis of the biogeographic zones underscores the richness of the life in this region. Approximately 175 species of amphibians (130 endemics) and 290 freshwater fishes (189 endemics) have been reported from these most ancient mountains of the world. Of the 212 freshwater molluscs reported from India, 77 are found in the Western Ghats. Roughly 608 aquatic plant species are reported from this eco-region.

Most of the Western Ghats streams have torrential flows in the upper catchments. Almost all the torrential streams at an altitude of 1500-2000m harbor several species of aquatic insects in their specialized microhabitats. Their life cycles get disrupted when these niches are submerged by dams. The food spectrum of several fishes consists of aquatic insects and their larvae. Alteration of flows due to dams in turn changes the diversity and density of aquatic insects, directly impacting fish populations and leading to disruption of entire ecosystems.

The IUCN report affirms that dams and diversions are the major impediments altering the river hydrology, consequently changing the habitat and making it less suitable for the survival of many specialized life forms. A study on dams in the region reveals a staggering 871 dams constructed by the year 2000, including 13 mega-dams and 34 large dams, which have submerged substantial riparian zones and prime evergreen forests.

Mining and quarrying have boomed in the Western Ghats during the past two decades, which is another menace to biodiversity. Water quality has changed considerably and large-scale sediment deposition has prevented the algal growth in the streams near the mines, disrupting the entire web of life. IUCN estimates that 6% of fishes, 5% of molluscs and 4% of plants are threatened due to mining and energy production.

In addition, residential and commercial developments, agriculture and aquaculture, and invasive alien species play a significant role in the depletion of the biodiversity of aquatic ecosystems of the Western Ghats.

The rivers and wetlands of the Western Ghats support 174 species of dragonflies. Photo: K.A. Subramanian

The IUCN Red List further reveals that 12 freshwater fishes, 6 molluscs and 4 dragonflies are critically endangered and 53 species of freshwater fishes and 4 molluscs are endangered. An urgent policy and legal level intervention and awareness campaign are necessary to save the rivers and conserve riverine biodiversity in this important region.

IUCN puts forward some suggestions that are crucial for the very survival of biodiversity in the long run. Several species in the region are poorly documented due to lack of expertise and scarcity of information. The taxonomic inventories and monitoring of river systems deserves a high priority in the conservation agenda. The compilers of the Red List also recommend habitat restoration involving pesticide control, preservation of unique habitats like Myristica swamps, prevention of flow modifications, etc. which are apt in the present scenario. The study recommends to avoid large dams where unacceptable impacts to freshwater species are predicted.

One strong, novel and feasible recommendation is the prioritization of the Key Biodiversity Areas with the involvement of local communities to address the conservation issues based on the outcome of the Red List 2011. These areas are proposed to legally ensure the conservation of diversity while catering to the needs of stakeholders. Establishing Key Biodiversity Areas with appropriate management plans and regulatory mechanisms seems to be a promising approach to curb the onslaught of dams and restore aquatic ecosystems.

The rivers in this "hottest of hotspots" are struggling to reach the seas. Aquatic species are facing habitat fragmentation and degradation from dams and other threats, often disappearing even before they have been recorded. More dams are in the pipeline. Ecological restoration of the remaining river catchments with due legal protection, and reviving flows in already dammed rivers, is urgently needed to preserve the remaining biodiversity of Western Ghats rivers. ●

The author is a fisheries scientist working on Western Ghats rivers. Contact him at: shajibarb@gmail.com

Learn more about the IUCN assessment: http://tinyurl.com/5tzh36

India's Community Fish Sanctuaries Protect Wild Fish and Rivers

By Parineeta Dandekar

As elsewhere around the globe, native freshwater fish diversity in India's rivers is declining rapidly. About a third of the approximately 650 fish species found in India are threatened. Crucial reasons for this decline are destruction of habitats through dams and barrages, pollution, and exploitive fishing practices.

Dams in India have converted flowing rivers into reservoirs, which have a profoundly different hydrological character than rivers to which indigenous species have adapted to. Species like Indian shad, carp and catfish have been severely affected by these changes. Rivers and reservoirs are now dominated by exotic fish like Tilapia, silver carps, grass carps, and African catfishes, which tolerate high pollution and static water levels.

Waitarna Fish Sanctuary. Photo: Parineeta Dandekar

A flowing river provides numerous habitats for a variety of fish. Different fish species are found in niches like riffles, runs, deep pools, riparian stretches, floodplains, and estuaries. Fish require flood pulses and drought signals as spawning cues. Temperature and light penetration are also important factors for their sustenance. Dams and barrages change all of these factors. Adding insult to injury for native fish, dams are stocked with exotic species by the Irrigation and Fisheries Departments. These fish compete with the local fish species. Only external fishing contractors benefit from the process.

A positive light in this dark picture are some gems of community conservation which protect not only rare native fish species, but entire riverine habitats through simple, participatory measures. Today, these community conserved fish sanctuaries are some of the very few places where we can see native fish and undisturbed river stretches. Most of these are temple sanctuaries, and have been managed for centuries by devotees of riparian temples. These small temple sanctuaries are nestled along river banks in many states of India. More than 35 have been documented, and new sanctuaries are being set up by local communities. There is an urgent need to conserve these important bastions of biodiversity from the impacts of new upstream dams and pollution.

A snapshot of some of these sanctuaries:

Shringeri Fish Sanctuary (Tunga River, Karnataka) was established nearly 1200 years ago. This sanctuary teems with endangered *Sahyadri Mahseer* fish, and supports nearly 38 fish species. Devotees offer puffed rice to huge schools of fish, and worship them as the 'Meen avatar' of Lord Vishnu. Catching these fish is supposed to be a crime. Significantly, no modifications have been made on the river banks by the temple authorities, so that the natural river morphology is maintained. The area receives no formal protection.

Chippalgudde Matsya Dhama (Tunga River,Teerthahalli) hidden in a tangle of Western Ghat forests, protects 4 kms of the Tunga River. Temple authorities and riparian communities manage the stretch. The tiny stretch protects more than 27 species of fish; significant species include the endangered *Mahseer* and *Puntius pulchellus,* the only indigenous herbivorous fish in India. The place receives no formal protection.

Shishisla Matsya Teertha (Kapila/Kumardhara River, Dakshin Kannada) was declared a protected area in 1930. This sanctuary supports more than 18 fish species. In 1996, the river stretch was accidentally poisoned with pesticides and all fish in the sanctuary died. This gave rise to Matsya Hitharakshan Vedike, an informal organization that looks after the protection and management of fish. The villagers were shaken by the death of their sacred fish and built a fish memorial to commemorate them. Since then, fish populations have been rising.

Temple fish sanctuaries are found all over the country. This author recently recorded a fish sanctuary on River Waitarna in Western India, which is sandwiched between two dams and is experiencing severe hydrological stress. A number of river bank temples in India had thriving fish sanctuaries a few decades back, but have been impacted by reductions in the quality and quantity of water. Such is the fate of our rivers today.

Management of Fish Sanctuaries

Temple fish sanctuaries are not the only answer to protecting dwindling fish diversity. The reasons for decline of fishes (like dams or pollution) are too often outside the control of the managers of the fish sanctuaries. However, these areas are an important tool in conserving fish species and riverine stretches, and should receive official protection. Their potential to link communities in a strong river basin network should be recognized. Existing dams should be required to allocate environmental flows to protect these sanctuaries, and new dams affecting the sanctuaries should be scrapped.

Protecting these areas will not only aid fish but can act as a bridge in protecting important free-flowing riverine stretches. We have very few pristine river stretches and native fish left and it is our responsibility to protect these for the world around us and our future generations. ●

Experience from Thailand shows that Fish Sanctuaries help in fish conservation. Buddhist monks in Thailand have established more than 100 fish sanctuaries. Many villages along the Salween on the Burma-Thailand border have protected parts of rivers and creeks as fish sanctuaries. In Lao PDR, deep water pools in the Mekong have a number of sanctuaries which are protected through local customary laws and religious and animistic beliefs.

The Ecological Mysteries of Latin America's Rivers

By Monti Aguirre

Latin America's watersheds are rich in biodiversity, yet it is remarkable how much we don't know about the ecology of these rivers. Aquatic and terrestrial species interact in still-mysterious ways, their relationships dependent on rivers' patterns of flood and drought, of slow and fast currents, of sediment deposit and wetlands and mangroves creation.

With the disruption of healthy riverine ecosystems from deforestation and damming, scientist's opportunity to understand and appreciate these interactions is rapidly disappearing. Yet, plans to dam most Latin American rivers are proliferating like an infestation of termites.

We interviewed a few key scientists working in the area to reflect on the work they do, and the challenges they see. Here is what they told us.

This tropical ladyslipper orchid only grows on limestone along streams at the base of the eastern Andes, in Ecuador and Peru. Photo: Lou Jost

On Extinction and Orchids

American botanist *Lou Jost* works as a mathematical ecologist, plant biogeographer and conservation scientist. A fellow of the Population Biology Foundation in Ecuador, he is also one of the world's top orchid hunters. In the past decade, Dr. Jost discovered 60 new species of orchids and five other new plant species.

Extinction is the worst crime that humans can inflict on nature. Once a species is gone, it can never come back, and its unique genetic information, accumulated during millions of years of evolution, is erased from the planet. Luckily most water projects do not commit this ultimate crime, but when a project comes along that does put the survival of a species at risk, the world should react.

The animals and plants most vulnerable to this kind of extinction are the species found only in one river and nowhere else in the world. This kind of local endemism is relatively rare.

However, in the eastern Andes of Ecuador, where I live, the hydroelectric projects planned for the Upper Rio Pastaza and for its tributary, the Rio Topo, threaten several locally endemic species. The Abitagua Dam will affect the only place in the world where the orchid *Epistephium lobulosum* has been found. This mysterious plant was discovered in 1959.

An even more mysterious plant, the critically endangered *Myriocolea irrorata,* is endemic to the Rio Topo. The extinction of such a distinctive species is a crime even worse than the extinction of a species that has other close relatives. None of this apparently matters to the Ecuadorian government, which has made a conscious decision to approve all hydroelectric projects in the country.

What happens when these species disappear? We really don't know. The *Epistephium* orchid on the Rio Pastaza is so rare that it probably plays no role in the local ecosystem, but it nevertheless represents a significant segment of evolutionary history, with unique features and biochemistry that we know nothing about. The *Myriocolea,* on the other hand, is locally abundant along the Rio Topo, and may well be part of an intricate set of relationships with other organisms. Because it has no close relatives, its biochemistry may be very interesting, but again we know nothing about it.

When we destroy these unique species and their associated ecosystems, we throw away their evolutionary secrets forever. We are like ignorant people burning books before we have even learned to read them. No civilized society would dream of massive government-supported public book-burnings these days. Why then do we so freely destroy the much more remarkable, irreplaceable works produced by nature and evolution?

Mysterious Catfish

Peruvian ichthyologist *Norma Salcedo* works at the Grice Marine Laboratory, College of Charleston in South Carolina. Much of her field experience is in the tropical Andes.

For the past 10 years I have been working on a group of armored catfishes commonly known as "rubbernose plecos." These fish only live in highlands, like the slopes of the Andes, where the turbulence of the waters and the low temperatures make the water very oxygenated, where the slope is not too high (otherwise it is salmon territory), not too low (where the sediment is too fine and the oxygen low). These fish feed by rasping the algae that grow on the surface of rocks in regions where cold water runs very fast, so fish diversity is not very high. This fragile ecosystem, known as the tropical Andes, is the largest, most continuous one they inhabit.

There is so much we don't know about the fish I study! How far do they migrate? Do they migrate at all? How do they reproduce? All the species in this genus depend on well-oxygenated, coarse bottom streams and rivers, as they use their mouths to attach themselves to the rocks. Little is known about the hydrology of these regions and how it correlates with the aquatic fauna in it.

Continued Opposite

Aquatic invertebrates are very good indicators of water quality. Think about it: larvae and adults of beetles, butterflies, mayflies, dragonflies, gnats, horse flies – all these feed the vertebrate fauna and pollinate plants. In other words, the whole forest depends on the water and the organisms in it at different levels.

I have worked mainly in higher elevation regions, the regions known as cloud forests. The water in the streams comes from the melting of the snow in the high peaks. The whole forest depends on the water in one way or another. The evaporation of this water keeps the vegetation moist. Fish, of course, live in it. Other vertebrates, like birds and mammals, drink the water and feed on organisms that grew using the water in the streams and rivers. So, it is all connected.

Migration and Dams

Bill McLarney is an aquatic biologist working with Costa Rican nonprofit organization Asociacion ANAI, which has pioneered some of the world's most successful and highly participatory community based development initiatives in tropical zones. Dr. McLarney has dedicated many years to work hand in hand with the inhabitants of Costa Rica's Talamanca region, a UNESCO World Heritage Site and Biodiversity Hotspot.

In Mesoamerica we know very little about key river species. For example we don't have a complete life history for any of the fish and shrimp species of La Amistad International Park, a World Heritage Site shared by Costa Rica and Panama. And what we do know, we fail to place in the context of a dynamic system. We fail to recognize that the change we choose to make at one point on the river changes the river over its entire length.

The threat to La Amistad has become more serious with the disclosure of multiple dam plans on the Atlantic slope of the La Amistad area in Costa Rica.

Diadromes (fish and shrimp which migrate between fresh and salt water) are a mechanism for transporting organic matter between the continental mass and the sea. The water also performs this function, in a downstream direction, but only diadromous animals transport organic matter back upstream in their bodies. Extermination of diadromous fish and shrimps from the upper reaches of streams in the La Amistad area would effectively remove most of these "bioturbators," resulting in greater retention of accumulated sediments at high altitudes, with unpredictable but significant effects on sedimentation patterns, channel dynamics and biotic interactions both within and downstream of the World Heritage Site.

Certain species are more sensitive to certain stresses, and so will be the first to be lost when those stresses occur. Often a loss of species doesn't harm or even get noticed by anybody, other than those few of us who care about species for their own sake (and of course the other species that depend on it). What is scary is when we grossly alter ecosystems, as when we dam a river across a migratory route.

Rivers and forests are a continuum, and if you change the composition of the riverine fauna, you change the forest. And vice versa. The changes can only be partially predicted, and mainly on a case-by-case basis.

In the Caribbean National Forest in Puerto Rico, when *Atyid* shrimp were eliminated from rivers above dams, the river got wider and eroded into the forest. *Atyids* burrow constantly in the rocky substrate, in search of food and shelter. In so doing, they mobilize sediments that are carried downstream. Researchers in Puerto Rico demonstrated that sites without *Atyids* tended to accumulate sediments, whereas sites with *Atyids* flushed them. Filling of pools with sediment naturally results in water expanding to the sides, thus stressing stream banks during high flows. There are lots of other effects, too, especially related to processing of leafy detritus, and changes in algal cover. Similar effects have been attributed to *Loricariid* catfish in Panama, Sicydium gobies in Costa Rica, and others.

This *Brycon hilarii* was collected at its typical habitat, a piedmont river of the upper Amazon basin in Peru. These fish are important dispersers of tree seeds. Photo: Max Hidalgo

The central point is that mucking around with central elements of ecosystems is risky business.

The idea behind Environmental Impact Assessments (EIAs) is a good one and would work well if we as a society made decisions based on rational discussions. In the real world, they are usually treated as merely a formality in the licensing process. If I have to build a dam, I am required to hire a consultant to do an EIA. Do you suppose that consultant doesn't know who signs his check? If the consultant is a good one, he may offer alternatives leading to a less damaging project, but he is not going to say "Don't build the dam, society will be better off without it." Even if we had some sort of independent review body for EIAs, we don't have a rational or democratic process in place for dealing with such a review. More often than not the projects which get seriously proposed are heavily favored by the governments in question and the ultimate decision is made by a very few people. In my experience, the chief value of EIAs is that debate over them can buy time.

Migration and Seed Dispersers

Flavio Lima is an ichthyologist at the University of Sao Paulo in Brazil. He has worked on the natural history and conservation of South American freshwater fishes since 1993.

I have worked with the taxonomy of several groups of South American freshwater fishes, especially the large characid fishes, the genera *Brycon*.

Brycon are middle- to large-sized fishes whose preferred habitat range from small forested rivers at headwater areas to large rivers with extensive floodplains in lowland areas. The larger species living on large rivers undertake long-range migrations to the spawn areas and are extremely prolific, large females being able to release almost a million eggs in a single reproductive bout.

The genus *Brycon* is the most widespread fruit-eating fish lineage of the Neotropics. *Brycon* species are actually omnivores that ingest a broad range of food items, including smaller fish, and occasionally even terrestrial vertebrates as frogs and rats. Predominantly their diet consists of terrestrial vegetal matter, most notably fruits and seeds. It has been assumed that *Brycon* species are important seed dispersers of trees in large periodically flooded forests of the Central Amazon, and they

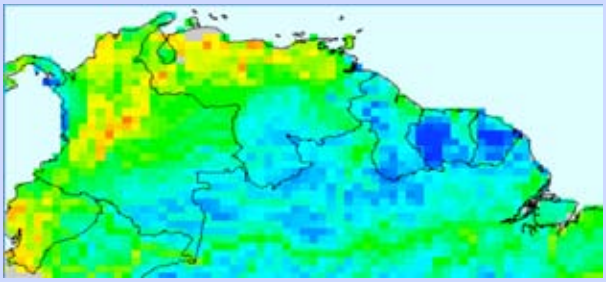
Continued on page 15

water services does little to abate the underlying threats, producing a false sense of security in industrialized nations, while perilous water insecurity in the developing world still remains a major global problem. In addition, lack of comparable investments to conserve biodiversity, regardless of national wealth, help to explain accelerating global declines in freshwater species.

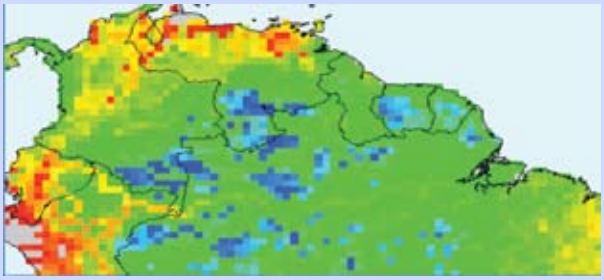
The state of the Amazon

So far, the huge scale of the Amazon has helped it to resist the pressures from human development, although these are clearly beginning to encroach, as illustrated by the higher level of Human Water Security threat within the basin. The severity of these pressures is clearly demonstrated in the coastal areas of several of the riparian countries, where areas of high human population densities are also those where freshwater biodiversity is most threatened. With over 100 dams planned for the Amazon basin, it is clear that the reasonably healthy state of the river will not last long, unless more stringent measures are taken to reduce such high human pressure.

Amazon



Biodiversity Threat



Adjusted Human Water Security Threat

Red is highly threatened.

The situation in Venezuela also provides a useful illustration, where the Grand Savanah in the south of the country faces little threat to human water security, and also to biodiversity. In contrast to this, the coastal plain of that country, which represents a continuous ribbon of development, reflects high levels of threat to both humans and biodiversity. In the Orinoco basin, for example, urbanization, canalization of rivers, oil exploitation, conversion of wetlands and loss of river habitats are all bringing about degraded river conditions ranking among the worst in the world. This highlights the need for more effective environmental governance in the face of rapid development and industrialization.

Threats across Indian sub-continent

Most people in the Indian sub-continent face a high level of water security threat. While this has been mitigated to some extent by infrastructure in the Indus, Ganges and other river basins, high levels of threats to humans remain. Unfortunately, these efforts to improve human conditions though the development of dams and large irrigation schemes have created high levels of biodiversity threat in most rivers of the region. In Sri Lanka and Bangladesh, in contrast to India and Pakistan, the level of human water security threat is higher than the threat to biodiversity. This situation reflects the relatively lower levels of river fragmentation and land conversion in those countries.

The case of Rwanda

One of the smallest, most densely populated countries in Africa is Rwanda. There is no doubt that human population density is a major factor impacting on the world's rivers. As demonstrated in the three main rivers systems in Rwanda, this takes the form of overcrowding and degradation of riparian areas, mismanagement of solid waste, uncontrolled runoff, and lack of strong legislation to regulate all forms of water pollution. The Kagera (originating in Burundi), is one of the most important rivers in Rwanda. It is the largest tributary to Lake Victoria, flowing along the border between Rwanda and Tanzania. Our analysis has shown that human wellbeing is threatened in this river basin by the lack of water and sanitation services. In addition to the severe health impact this has, especially on children, the deterioration in water quality directly impacts on river health and freshwater biodiversity. Fortunately, the Kagera River also flows along the edge of the Kagera national park, which affords some protection, and this is evident from the lower threat intensity for biodiversity in the eastern part of Rwanda.

In the case of the Razizi River, hydropower dams have caused downstream impacts on the river and its biodiversity. Since more hydropower projects are planned for the region, government officials should take action to ensure that all possible aspects of their construction and operation are fully examined before any decision is made on their implementation. Deteriorating river health also characterizes the Kagitumba River, which flows through some heavily populated areas. As in many other parts of the country, impacts from agriculture, mining and deforestation have affected this river and its biodiversity. To make matters worse, across Rwanda and in other parts of sub-Saharan Africa, anticipated increases in large-scale irrigated agriculture associated with 'land-grabs' by outside investors is likely to exacerbate drainage-basin degradation, raising concern over the future of river health across the region.

What can be done?

Our study revealed that there are very few places in the world where rivers can be described as healthy. Even regions distant from human populations have been impacted by human actions, for example through atmospheric deposition of pollutants.

Overcoming this global crisis of water insecurity for both humans and biodiversity requires deliberate prevention of impairment rather than simply offsetting threats once they arise. It is more cost-effective to ensure that river systems are not impaired in the first place. This could be accomplished through better land use planning and management, better irrigation techniques and emphasis on protecting ecosystems and all the life forms within them.

In the few areas of the world where threats to both human water security and biodiversity are low, the best strategy for any future development would be to ensure that natural capital is protected, and ecosystems remain intact. Across the developed world, existing human water security infrastructure will require continuous upgrading to protect biodiversity while retaining existing human water services. In developing countries, it is vital that we ensure that the establishment of human

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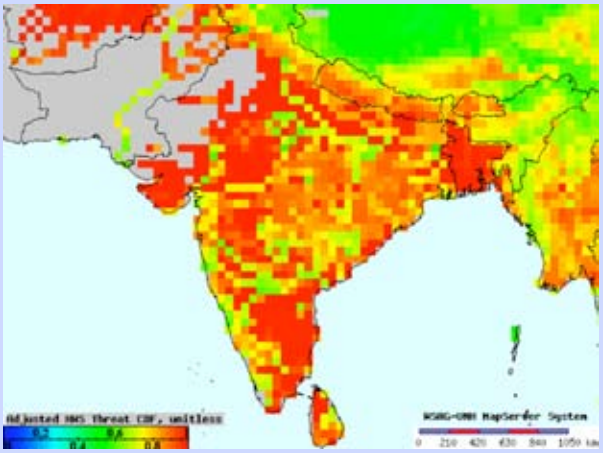
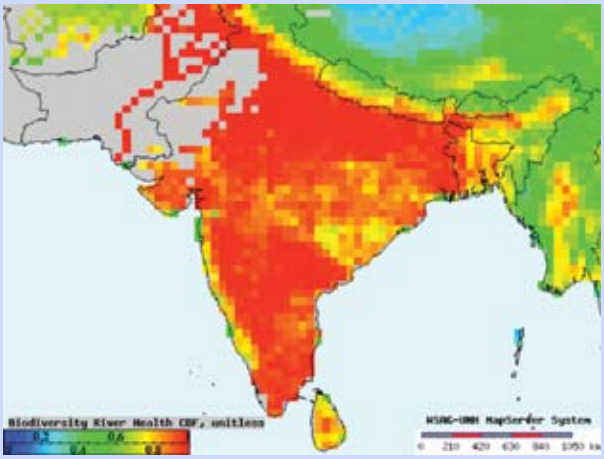
India



Adjusted Human Water Security Threat



Biodiversity Threat

Red is highly threatened.

water security is not achieved at a cost to freshwater biodiversity. This challenge will require both technical innovation and political commitment, possibly best met through an approach known as "Integrated Water Resource Management" (IWRM). IWRM should be promoted even at the international scale (despite the manifest difficulties of establishing the management authorities that would be required for this). Local communities should also be encouraged and enabled to become more involved in river basin management processes. Almost all the world's major rivers run through more than one country, and river basin commissions and international water legislation should be established and strengthened in all parts of the world, with an emphasis on transparency and public participation.

Within the public arena, efforts should be made to promote greater understanding of how individual actions affect river health. Farmers should be encouraged to leave buffer strips along riverbanks, and wetlands should be protected and preserved rather than drained for agricultural use. River connectivity should be re-established, and wetland and floodplain conversion avoided, so that the river and its floodplain remain linked. In many places, impacts of bad practice are exacerbated by the effect of atmospheric pollution, carrying mercury and other pollutants across continents, transporting them from power station smokestacks in countries where environmental regulations are weak. This highlights the need for improved water and environmental governance, not just globally, but at all scales.

At the more local scale, detailed habitat monitoring and species inventories are needed, and there is much scope for benefits to be gained from the establishment of conservation corridors which include river systems. Ecosystem services provided in river basins must be identified and publicized widely, and their values quantified and captured in decision-making processes. Clearly, the value of the world's rivers is immeasurable, but unfortunately, recognizing the monetary worth of the resources provided by rivers is too often the necessary push humans need to take action to better preserve and manage these valuable systems. However, it must be recognized that monetary interests of some stakeholders may be incompatible with those of others, and thus non-monetary metrics are also needed to support decision-making. The time has come to recognize that the increasingly scarce resources associated with healthy river systems will increase in value over time, not decrease.

Land management and land-use planning is also vital, and local governments in particular have a key role to play here. Recognizing and rewarding the value of good practice in agriculture and land management can be achieved through a system of payments for ecosystem services, and such approaches can provide the win-win situation of supporting regional development through payments for better environmental stewardship. When considering water infrastructure, options that would do the least harm to riverine health and biodiversity should be prioritized. Given the extent, prevalence and intensity of deterioration of the world's rivers, we must have zero tolerance for further ecosystem degradation, even if the monetary costs are high.

Those involved in managing a nation's water resources should be provided with training on how infrastructure developments can impact river systems, and financial resources must be made available to enable them to implement best practices. Within the decision processes associated with river development, much more emphasis must be placed on ecological values, and a systems approach should be taken to ensure a holistic assessment is made.

There is no doubt that a radical change is needed in the way humans interact with rivers. In most of the world's rivers, similar threats and stressors are operating, and human impacts are negatively influencing river ecosystems and their biodiversity. We must treat the causes, and not just the symptoms of this degradation. Urbanization, industrial and agricultural development, and river habitat modification have all reached a pandemic level, and the interaction of multiple stressors often causes unintended consequences within river basins. These problems can be addressed by streamlining institutions involved in water management, supporting the development of integrated datasets, putting in place more effective legislative frameworks, and providing adequate funds for implementation and enforcement.

Ultimately, if these measures can be achieved, it may just be possible to refocus the development trajectory so that a more balanced relationship between humans and global river ecosystems can be found, before it is too late. ●

**The full list of authors includes S. E. Bunn, P. M. Davies, M. O. Gessner, S. Glidden, P. Green, P. B. McIntyre, A. Prusevich, C. Reidy Liermann, C. J. Vörösmarty. Coming from a range of countries, institutions and disciplines, they have all worked for many years on issues relating to river health and development, and as a result have a truly global perspective on this vitally important issue. This article is based on "Global threats to human water security and river biodiversity," Vörösmarty et al, 2010, Nature, vol. 467, no. 7315. Learn more about the study here: www.riverthreat.net*

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Broken Rivers, Broken Policies: Where To From Here?

By Grace Mang

Rivers need to be "unbroken" to maintain healthy habitats. Dams proposed for the Amazon, for example, would fragment the river in ways that would harm the region's rich tapestry of life.

Freshwater biodiversity is in a state of crisis. Recent efforts to protect and sustainably manage freshwater ecosystems have done little to offset the consequences of decades of human exploitation of rivers: large dams, water pollution and over-extraction. While the sources of water pollution can be found and stopped and over-extraction by irrigators can be curtailed, the consequences of building large dams across rivers are largely irreversible. Large dams permanently fragment riverine ecosystems by isolating species (both fish and mammals), interrupting the exchange of nutrients between ecosystems, and cutting off migration routes between feeding and spawning sites. At the ecosystem level, the cumulative impacts increase the vulnerability of entire ecosystems to other threats, such as climate change.

The severe consequences of large dams are well known, yet every year more rivers are dammed. Given the urgency and severity of the threats to rivers, the current set of policy tools are surprisingly short-sighted, and are mainly directed toward mitigating the negative impacts of dams rather than equipping us with the tools to protect and sustainably utilize healthy rivers. In the policy space, comparatively much more work has gone into environmental flows methodology and its application to existing or proposed dams, compared with developing policy to protect vital ecosystems or to design hydropower projects that do less harm to rivers. There are, however, three policy approaches that could be effective in protecting rivers and their biodiversity if we can muster sufficient political will to implement them. They are the landscape approach to protected areas; utilizing ecosystem services methodology in hydropower development decision-making, and whole-basin dam removal policies.

Landscape Approach to Protected Areas

A landscape ecology approach to river and watershed management requires that protected areas must be comprehensive, adequate and representative. Rather than carving out discreet no-go zones for development while allowing projects to go ahead that lead to badly degraded river systems, this policy approach prioritizes ecological integrity first and foremost. A landscape approach requires that a network of regional-scale ecosystems be protected; that sufficient levels of each ecosystem are included to make protected areas ecologically viable and to maintain the integrity of populations, species and communities, and that the protected areas encompass variability of habitat within ecosystems.

While a compromised example, China's Upper Yangtze Rare and Endemic Fish Nature Reserve was created to protect important remaining freshwater ecosystems and high-priority conservation areas. The reserve was originally intended as compensation for the Three Gorges Project and in recognition that the Yangtze River is home to around a third of all fish species in China, of which half are found nowhere else in the world. At the time of its creation in 1996, the reserve was a 400-kilometer corridor, which acted as a virtual no-go zone for hydropower development.

Over time, the environmental policy for the protected area has been compromised by the government's desire to build large dams on the Upper Yangtze. In early 2011, the boundaries of the fish reserve were changed to accommodate new proposed dams such as Xiaonanhai. More than 22 kilometers of the Yangtze River have been removed from the protected area and 73 kilometers of protected areas were re-classified as a buffer zone, for "experimental development." The failure of the protected area to prevent plans for large dams such as Xiaonanhai demonstrates the basic limitations of any policy approach, which ultimately relies on the will of the government to realize the stated objectives.

Ecosystem Services

The practice of valuing nature's services is not technically a policy approach but represents a tool for assessing whether a proposed dam is viable based on the cost of the dam to the environment. Ecosystem services are functions performed by ecosystems that lead to desirable environmental outcomes, such as air and water purification, land fertilization, drought and flood mitigation, and climate stabilization. Compared to an environmental impact assessment, the ecosystem services methodology enables a monetary value to be put on the environmental impacts so they can be compared with any purported revenue or economic benefit estimated to come from the project.

A study conducted by a group of Chinese scientists from the Coastal and Ocean Management Institute of Xiamen University found that for each of three proposed dams examined in the Jiulong Watershed in Southeast China, more than 90% of the environmental cost of the dam (in monetary terms) was attributed to biodiversity loss. They found that in the case of the Tiangong Hydropower Project, once the environmental costs were offset against the benefits from the dam, the project was only marginally cost effective. The studies also found the dams were unprofitable under China's current power tariff structure, as the cost to ecosystem services equated to about three-quarters of the on-grid power tariff.

A 2002 study of a proposed Kano River irrigation project in arid northern Nigeria that would have diverted water from the large Hadejia-Nguru wetland predicted that every 1,000 cubic meters of water used on the irrigation scheme would generate net economic benefits of four US cents (taking account of the costs of constructing and operating the project). But the net economic benefits of traditional uses of the floodplain (an estimated 10 million people use the wetlands for rice farming, grazing, fisheries and other eco-

Continued on page 15

Where Rivers Flow, Biodiversity Grows

Kierán Suckling *founded the US-based Center for Biological Diversity in 1989. The highly successful Center uses science, law and creative media to protect species on the brink of extinction, primarily in North America. Kierán talked to us about the Center's work and the importance of biological diversity to humans and the planet.*

Kierán Suckling

WRR: What inspired you to focus on biodiversity?

KS: When I was at university, I was working on a doctoral dissertation looking at both the extinction of species and the extinction of languages. There's a clear but not well-understood link between the two – the areas of highest biodiversity also have the highest language diversity, and the same forces are killing off both. I had a summer job surveying owls in New Mexico for the US Forest Service, and I became so entranced by owls that I quit school and started the Center.

WRR: How do rivers figure into the Center's work?

KS: Rivers figure very prominently in our work, because it's all about the water – that's where all species great and small congregate. And of course water is a critical resource that humans also desperately need. River systems are not only the zone of our highest biological diversity, but also of the greatest human endeavors, which is a recipe for an extinction crisis. So we put a lot of work into trying to protect rivers.

We've had a lot of success through the Endangered Species Act (ESA) approach. We don't have many laws that actually protect the rights of rivers, but there are lots of laws in the US to protect imperiled plants and animals. To protect a river, one of the most powerful things you can do is try to protect species associated with them. One of the primary tools we use is to get a "critical habitat" designation under the ESA. We've gotten 10,000 miles of Western US rivers protected this way, as part of efforts to help preserve habitat for raptors, plants, fish. We've recently launched a campaign to protect the endangered aquatic species of the US Southeast, whose waterways have gotten less attention than Western rivers. We had our first victory there in October, when US Fish and Wildlife issued an initial positive decision to list 404 riverine species as endangered in this region.

WRR: You've written, "Since European settlement, more than 120 freshwater species in North America have vanished forever." What have we lost?

KS: We've lost incredible species that would have made our modern lives much richer. Here in the US Southwest, we no longer have river otters, for example – they went extinct more than 50 years ago. They were not only charming, interesting animals, but also the top riverine predator. Our rivers have suffered tremendously because of this loss.

We've also lost many native trout and salmon all across the country, which were part of ecological and cultural heritage. Humans evolved with these species in an environment of great biological diversity, and when we wipe out that diversity, we suffer a loss that is hard to grasp, but is quite profound.

WRR: We have many partner activist groups working in places where the loss of a not-so-charismatic species may be considered a small price to pay for a big dam that promises to bring electricity or water to a poor nation. Generally, these activists are also working without strong legal protections. Any advice for them?

KS: One of the important advances in the past 20 years was the Convention on Biological Diversity, which protects biological diversity from exploitation for commercial use. It was signed by virtually all developing nations, and its passage was a big victory for developing nations. So it would be really ironic for dam-building southern nations to start chipping away at their own biodiversity with major dam-building schemes. We've had enough time to learn about the many downsides of the Western development model. A smart response is to find another development path to prosperity, one that doesn't sacrifice biodiversity and the environment.

It's very tough to work in nations that don't have legal protections for endangered species or rivers. I would urge groups to use their ongoing campaigns to call attention to what will be lost, and to press for laws that will help prevent the loss of species and protect healthy, functioning ecosystems.

You also need a diversity of tactics, and even a diversity of groups with different perspectives working together. More interaction between the traditional environmental groups and the social justice groups could lead to creative campaigns, for example.

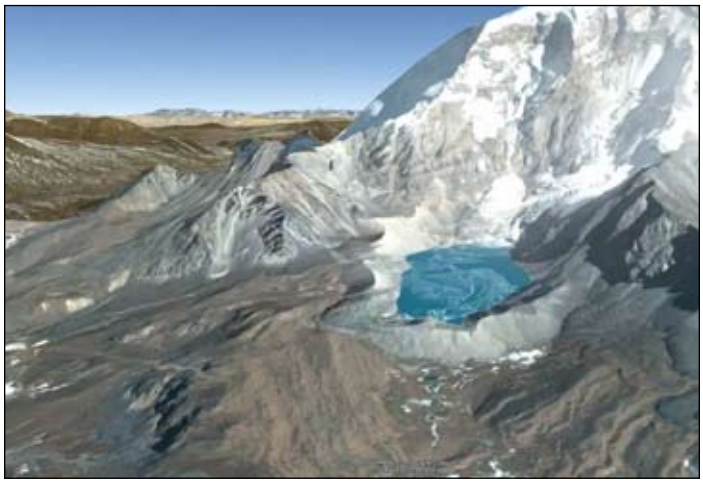
WRR: What change would you make to laws that protect endangered species?

KS: Our species-protection laws are designed to protect a minimum viable population of a particular species. We are not managing for abundance, which is what we need for ecosystems to work properly. A lot of species are being protected at levels that prevent them from going extinct, but not at levels sufficient to do their jobs in the ecosystem. For example, most woodpecker species are not on the brink of extinction, but they exist at such low numbers they can't eat enough tree-damaging insects to fulfill their ecological role. Now our western forests are in trouble. And in the East Coast, horseshoe crab levels have dropped enormously, though they're not going to go extinct any time soon. The crab eggs were a huge food source for the Red Knot, a migratory bird that is now endangered due to vastly less food available to it.

Ultimately, if we can protect and restore our rivers, we'll find that most of our other environmental problems get fixed along the way. Logging, mining, grazing, pesticides, overpopulation, the extinction crisis … they all intersect where the waters flow. It doesn't matter whether you live in a desert or a rainforest, you have to focus on keeping rivers full and healthy. ●

News Briefs

by Kate Ross



Dams in the climate-challenged Himalayas are risky business. This image is from our new Google Earth tour, "Wrong Climate for Damming Rivers" (view it at: www.internationalrivers.org)

Climate change threatens Himalayan glaciers

The primary source of the Brahmaputra River, the Jima Yangzong glacier in Tibet, is retreating at an alarming pace due to the effects of climate change. If nothing is done, the giant river may run dry in another 50 years, according to Chinese scientist Dr. Yang Yong. Furthermore, if the earth continues to warm at the current rate, other glaciers located at the same height will also disappear within a few decades. Already, nearly 1,000 sq km of Himalayan glaciers has disappeared (from a total area of about 5,000 sq km).

According to UN climate-change experts, the melting of the Himalayan glaciers threatens 1.3 billion people living downstream with increased floods and drought. Glacier melting can cause massive floods that will carry glacial debris to the lower part of the river, creating safety problems for dams. Rapid melting of the glaciers in the Himalayan region will at first increase the volume of water in rivers, causing widespread flooding, and later leading to declining river levels, causing massive environmental problems throughout western China, Nepal and Northern India. If nothing is done about the soaring global temperature, then the Brahmaputra and other Himalayan rivers flowing through Northeast India could stop flowing within five decades. Hundreds of dams are proposed for the Himalayas.

Learn more about why it's the wrong climate for damming rivers. Take our new Google Earth tour and explore topics such as reservoir emissions, dam safety, and adaptation while visiting real case studies in Africa, the Himalayas and the Amazon: www.internationalrivers.org/en/node/6928.

Dams drown California history

On the fiftieth anniversary of one of California's largest dams, emotions still run high among the thousands of residents of Trinity Center, Stringtown and Minersville whose towns and homes were flooded by the Trinity Dam, local papers report. A pioneer town, Trinity Center used to be a major stop on the way from San Francisco to Portland, but all that remains now is an underwater ghost town. Former resident Mary Hamilton, who was in her twenties when the town was forced to evacuate, says "it's like a death…Nobody wanted this." According to residents, virtually everyone opposed the dam, and yet their protests were not heard.

The government paid property owners for their land, but residents had no recourse if they didn't want to leave. "They took the best pastureland you could imagine," Lyn Scott of Trinity Center, a young man at the time, told the *Trinity Journal*. "Dad thought that was thievery."

Lake Shasta holds a similar story; built in the late 1930s and early '40s it now contains the town of Kennet in its murky depths. Residents of Kennet originally refused to leave their homes as the dam was being built, but when water starting coming up to their door, they had no choice. Historians agree that the flooding of these towns marks a loss of a microcosm of the California story.

Wikileaks reveals CDM flaws in India

Damming evidence against the international greenhouse-gas emissions-trading system – the Clean Development Mechanism (CDM) – has called into question the legitimacy of credits being used to support hundreds of projects already constructed and proposed in India. The CDM, first established under the Kyoto Protocol, allows rich countries to offset some of their carbon emissions by investing in climate-friendly projects in developing countries. Projects that are verified receive certified emission reductions (CERs) – carbon credits which can be bought and sold, and count toward rich nation's carbon reduction targets. A recent diplomatic cable published on the Wikileaks website reveals that most of the CDM projects in India should not have been certified, as they do not reduce emissions beyond those that would have been achieved without foreign investment.

These revelations imply that "millions of tons of claimed reductions in greenhouse gas emissions are mere phantoms," says Eva Filzmoser, program director of CDM Watch, a Brussels-based watchdog organization.

India currently accounts for 15% of CERs expected by 2012. A total of 112 million CERs have been issued so far to Indian projects, the equivalent of 112 million metric tons of CO_2. If all of these CERs are false, this would be equivalent to allowing 26.5 coal-fired power plants to continue polluting in Europe.

Take action for rivers on March 14!

It's not too early to plan for 2012. Let us know what you'll be doing for your river at dayofaction@internationalrivers.org.

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nomic activities) were calculated to be $32 per 1,000 cubic meters of water – 800 times greater than using the water for irrigation.

While price is only one factor that should affect decision-making, the aim of utilizing ecosystem service methodology is to get the price closer to being "right," so that better decisions about whether dams should be built can be made.

Dam Removal Policies

Dam removal is perhaps the most dramatic approach examined, but unlike the ecosystem services methodology or the landscape protected area policy, this approach only seeks to address problems of already fragmented river systems.

Dam removal policies have evolved from a dam-by-dam approach to the watershed scale. Restoration efforts are now being prioritized or planned at the ecosystem scale in areas such as the United States, Europe and Australia. One example is the Penobscot River in Maine, where more than 1,000 miles of river habitat will be restored in the coming years. The catchment scale plan seeks the removal of two dams and the decommissioning of a third dam, while at the same time increasing energy production at other dams on the tributaries to compensate for any lost capacity. The Penobscot River Restoration Trust, which is coordinating the project, hopes to see migratory fish species such as salmon, sturgeon and bass increase by as much as 500% once the dams are removed. Colin Apse, the Nature Conservancy's Deputy Director of Fresh Water Science, says, "I hope this project inspires energy planners to place dams in locations that are least disruptive to key processes, like migration, and to operate them in ways that maintain all of nature's key services. The best thing you can do to make an ecosystem more resilient is to keep it together."

Policy Challenges

The reality is that the current set of policy tools and approaches for protecting global freshwater systems from the impacts of dams are neither inspiring nor innovative. In fact, from a policy perspective, we are unprepared to answer fundamental questions, such as "Can the ecology of rivers can support large-dam development?" The development and testing of promising frameworks, such as the Ecological Limits of Hydrological Alteration framework (a tool for assessing and managing environmental flows across large regions), indicates that scientists and policy makers are working hard come up with new ways to better manage the world's rivers. However, without the political will to protect biodiversity, all policy tools are prone to failure. One recent example is the Lao government's determination to dam the Mekong Mainstream, despite the recommendations of a Strategic Environmental Assessment of the Lower Mekong River to place a 10-year moratorium on dam development on the Lower Mekong River. The current threats to the Upper Yangtze Rare and Endemic Fish Nature Reserve are also created by the desire of the Chinese government to place energy needs above the health of the river system.

It will take our collective political will to drive the policy innovations needed to protect rivers and the life they support. With large dam proposals currently slated for important and largely uncompromised river systems such as the Mekong and Irrawaddy River in Southeast Asia, the Amazon in Latin America, and the Congo in Africa, the need for a renewed global promise to protect rivers and their inherent biodiversity is urgent. ●

Latin America *continued from page 9*

probably also play a similar role in riverine ecosystems all over their geographical range.

Species of *Brycon* were always considered to be good indicators of healthy aquatic ecosystems due to their dependence of good-quality water, riparian forest and natural flow regimes. They can certainly be thought of as "canaries in the coal mine."

Fishes living in rapids all over South America should be considered indicators of the quality of aquatic ecosystems. Species belonging to all these families are expected to decline substantially or even disappear completely if the pace of disturbance of the riverine ecosystems of South America proceeds unabated, especially in regard to the building of large dams.

The *Brycon vermelha* are endemic from small coastal river systems from eastern Brazil that have historically suffered from deforestation, siltation, and pollution. More recently, damming has become an additional, ultimate impact to affect these species. The conservation status of these species is really a matter of high concern. For example, a hydroelectric dam is currently being built at the core area of occurrence of *Brycon vermelha,* at a river stretch of the Rio Mucuri, a small coastal drainage of eastern Brazil – in spite of the fact that this fish is considered officially threatened with extinction in Brazil since 2004.

In my experience of several years observing how Environmental Impact Assessments (EIA) are made and what benefits they produce, they fail almost completely in serving any purposBut-conservation. At best, they provide an opportunity to make good samples of areas that were poorly known previously. Even those opportunities are commonly lost, however, because the specimens collected are not adequately preserved or never sent to zoological/natural history scientific collections.

Also, EIAs often are biased to views palatable to the contractors of the study, and too often omit or de-emphasize a project's impacts. For example, the recent EIA for the Belo Monte Dam barely mentioned that there are two fish species officially considered as threatened. These are only known from the stretch of the Rio Xingu, which will have its flow dramatically reduced if the project is built. And this is only the tip of the iceberg, since we barely know the fish diversity and natural history of the area, and the EIA has done very little to change this situation. In fact, our knowledge of fish diversity and ecology is extremely out of pace with the environmental disturbance predicted to happen due to the construction of several dams, both small and large, all over Brazil.

To provide adequate conservation measures, it would be fine if we already possessed the current level of knowledge on South American freshwater fishes. But we are 50-60 years delayed in this scientific quest, and no doubt we are going to pay dearly for this, with possibly hundreds of species vanishing before anything can be done for their conservation. In my view, only a huge change in mentality, a change in the economic and development paradigm, as the one now being asked by groups all over the world, can avert this gloomy prediction from taking place. ●

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Volunteer of the Month

Carly Patterson joined International Rivers as a volunteer in August while researching the Sweetwater Project, a personal exploration of freshwater issues in California. Since then, she has helped us create a master list of globally planned dams, which will be featured in our new Google Earth video, *Wrong Climate for Damming Rivers*. An avid traveler, Carly has followed her love of free-flowing rivers to Latin America, Eastern Europe, and Asia, and is excited to continue supporting the health of rivers and river communities worldwide.

Burma Government Suspends Megadam

By Katy Yan

On September 30th, the President of Burma, Thein Sein, suspended what would have been Southeast Asia's biggest hydropower project, the US$3.6 billion Myitsone Dam. The president attributed the unprecedented move as an effort to "respect the will of the people." The project was being built by a Chinese developer, and nearly all the dam's 6,000 megawatts of power was to be exported to China.

The cancellation rewards more than five years of struggle by villagers, activists, scholars, and scientists in Burma. While it may come as a surprise to many – including the developer, China Power Investment – the success of this campaign is a testament to the depth of opposition to the project within Burma, which included important figures like the pro-democracy leader Aung San Sui Kyi.

The Irrawaddy River, which flows through the heart of Burma, supports one of the world's most biodiverse – and vulnerable – river basins. The river feeds millions with its ample fisheries and rich delta, known as Burma's rice basket. The Myitsone Dam is sited on the headwaters of the Irrawaddy River, which is currently undammed, and would have created a reservoir the size of Singapore. If built, 12,000 ethnic Kachin people would be relocated and up to 20,000 would be affected by its construction and operation.

Since the suspension, work at the site has stopped and Chinese workers have begun returning to China. One of the lessons from this suspension has been the need for overseas companies to seriously engage with civil society critics from host countries.

Despite the suspension, the movement to protect Burma's resources continues to rage. A string of Chinese-funded dam cascades are in the works for Burma's rivers, including the Salween, along with other controversial projects like the Shwe Gas transnational oil and gas pipeline. The Myitsone project is part of a seven-dam cascade that represents an almost US$2 billion investment from China. If built, the cascade would impact millions of people downstream, including members of several ethnic groups.

According to the Kachin Development Networking Group, while construction has stopped at the Myitsone site, survey work and security restrictions for local residents continue. Activists and local communities are now calling for a complete cancellation of the project. How the government responds will be the true test for whether it's ready to follow the will of its people over that of its powerful neighbor. ●

For an analysis on China's role, see: internationalrivers.org/node/6907