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contents

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Cover art by Prabha Mallya

The late novelist David Foster Wallace, in his now-famous graduate commencement speech, narrates the following story: "There are these two young fish swimming along, and they happen to meet an older fish swimming the other way, who nods at them and says, "Morning, boys, how's the water?" And the two young fish swim on for a bit, and then eventually one of them looks over at the other and goes, "What the hell is water?""

This parable could apply equally to us - city-dwellers. If ever there was a thing we took for granted it would be water. Our connection to this precious commodity, our awareness of it, begins and ends at the mouths of the taps in our homes and workplaces. We know little of the impossible journeys it makes to get there - Where does it come from? How far does it travel? What happens to it along the way? It is only when our taps run dry that we reflect on these questions. It is only then that we wonder about the other lives that are touched by the water we finally use.

This volume of CC is about these other lives, lives whose connections to fresh water are more direct, more immediate, than ours. In an entirely unplanned way, many of the pieces in the issue are about conflict (maybe a reflection of the precarious state of our freshwater resources): between aboriginals and river ecologists in Australia, between the state and fisherfolk in Assam, among multiple stakeholders along the Ganges in north India. But there are bright sides to this volume as well: a photo-essay on the creatures of the Agumbe monsoon, a piece on the bizarre natural history of axolotls, and an interview about a unique fish count conducted in Vembanad every year.

We hope you enjoy this issue of CC. It is best consumed with a tall, refreshing glass of water.

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Agumbe monsoon: How water transforms the landscape

Monsoon takes on a whole new meaning when you find yourself in the highest rainfall zone in the Western Ghats – the second highest rainfall zone in India. Agumbe, a wonderfully forested region in western Karnataka, "the king cobra capital of the world", receives an average of 7640 millimeters of rainfall a year and a record of 4500 millimeters in a single month.

With the coming of the monsoon and the first showers, one witnesses a miraculous transformation of the landscape —a change that occurs in more ways than can be perceived by a casual observer. At first, the thirsty laterite soil seems to absorb every drop of water. But the rain is incessant, and soon every little ditch, depression and trench is converted into a water body. Dry streams, reduced to a series of interspersed pools and rocks in the summer months, begin to trickle and then flow. Rivulets course through plantations and forests, rapidly feeding streams and rivers. As the rivers begin to flow, cascading over weathered rock, fallen trees and dry banks, it sets in motion countless processes of revival, birth, growth, life and death.

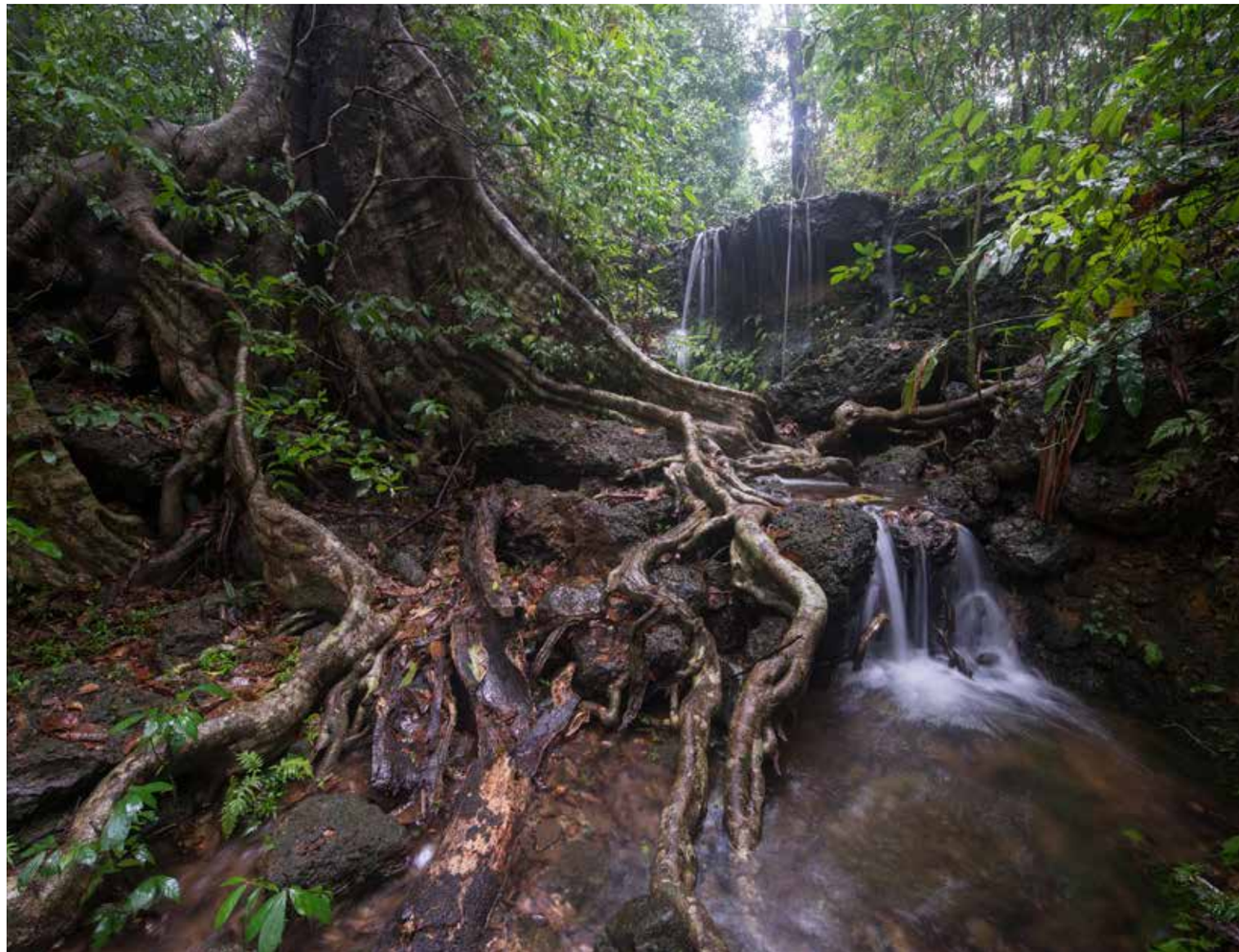

photo-essay Tasneem Khan and Umeed Mistry

Water and moisture have profound effects on germination, breeding, nesting, spawning, metamorphosis, feeding, and movement of organisms. From bacteria to birds, snails to reptiles, frogs to fish, arthropods to otters and everything in between, there is an evident burst of activity. The scene seems straight out of a Hollywood action flick.

Large numbers of toads cluster together in an event of explosive breeding, often forming mating balls. The result of this mass mating is evidenced the next morning with long strings of eggs entangled in vegetation, carpeting the edges of puddles and muddy pools.

Up in the trees, the Malabar gliding frog (*Rhacophorus malabaricus*) also joins in the mating frenzy. These incredibly well-camouflaged amphibians don't venture down to the pools of water on the ground. They are tree-dwellers, and prefer to conduct their business up in the canopy. Their carefully designed foam nests are built strategically above puddles and ditches, within which a number of small off-white eggs are laid. The newly-hatched tadpoles will fall into the waters below to live out the first stage of their lives as entirely aquatic animals before making their way back to the trees as adults.

When the rivulets from the forest empty into the low-lying meadows a dramatic change can be witnessed, sometimes over a period of just a few hours. Who would have imagined that these flat tracts of agricultural land and grassy meadows could be transformed overnight into thriving aquatic systems? With the first flooding of these grasslands, creatures, that one wouldn't usually expect in such areas - like the catfish - suddenly appear.

Over 280 species of fish have been documented from the streams and rivers of the Western Ghats. The health of these freshwater systems is vital to the health of all these fish species and a multitude of mammals, crustaceans, birds, insects and plants.

All these creatures, witnessed over a few days of magical rain-driven transformation, are linked to the water and the coming of the monsoons. Their lives beat to the rhythm of the rain.

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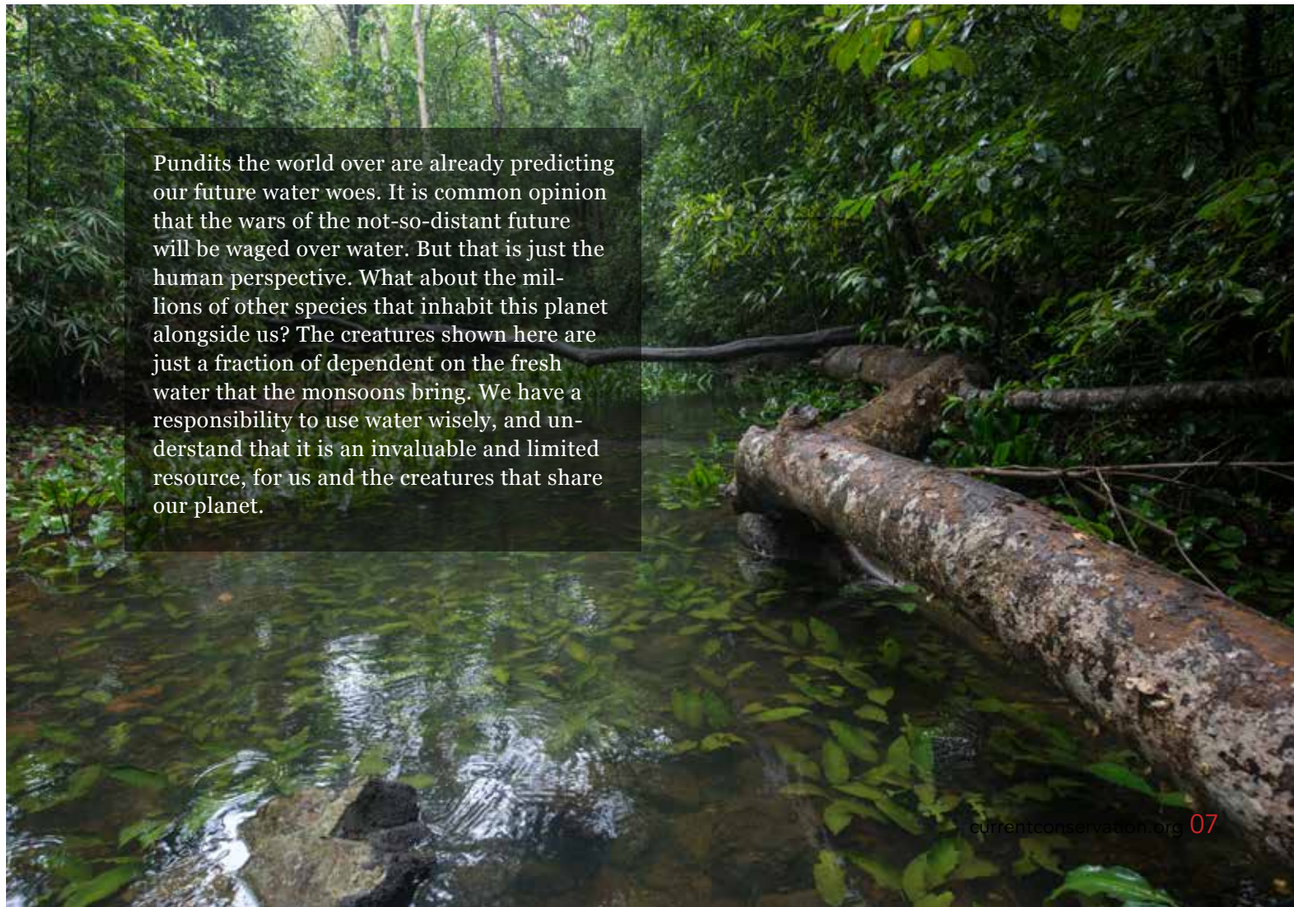
Current Conservation is grateful to YES BANK & SAEVUS / NATURAL CAPITAL AWARDS for permission to use these images.



Pundits the world over are already predicting our future water woes. It is common opinion that the wars of the not-so-distant future will be waged over water. But that is just the human perspective. What about the millions of other species that inhabit this planet alongside us? The creatures shown here are just a fraction of dependent on the fresh water that the monsoons bring. We have a responsibility to use water wisely, and understand that it is an invaluable and limited resource, for us and the creatures that share our planet.

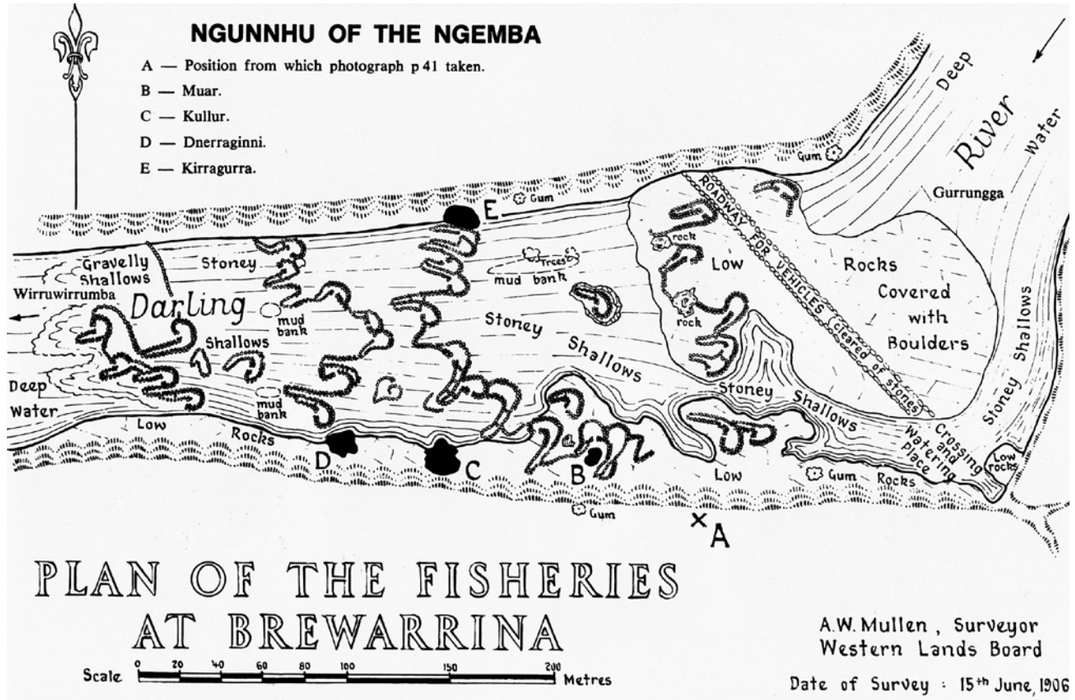
Crisis on the Darling: Understanding conflict between aboriginal people and ecologists

Prabha Mallya

Australian rivers are in crisis, with reduced flows from massive irrigation pumping and extinctions of native species accelerating at frightening pace. The crisis is particularly severe on the many reaches of the Darling and Murray Rivers, which drain the east and north of the continent, joining and emptying into the sea on the southern coast. This is Australia's longest and most productive freshwater system and its importance cannot be overstated. Conservationists have been outspoken in their demands that these rivers be restored to health through a range of measures including major reductions in the extractions allowed for agricultural irrigation. This call has been encapsulated in the phrase 'environmental flows' which signals the ecologists' demand that restoration of flows and overall health of the rivers is essential for their biodiversity—and indeed for our survival.

This debate over river health has also been where aboriginal voices have been heard most strongly. Aboriginal people have been demanding not only 'environmental' but 'cultural flows', which they argue must be recognised as essential to this threatened river system. The Murray and Lower Darling Rivers Indigenous Nations collective (MILDRIN), for example, on the rivers' lower reaches, has called for the recognition of cultural flows in the national context of both the Native Title cases on river rights, (which partially recognised aboriginal people's pre-invasion property rights in common law) and the legalisation of tradable private property in water. This call for the recognition of an aboriginal interest in the river is not new. It draws on the centrality of water to traditional philosophies and social life as well as economies, but it also reflects responses and interactions to the changes caused by two centuries of settler land management.

It might be expected that ecologists and aboriginal defenders of rivers would be in complete agreement. After all, the need to recognise 'Traditional Ecological Knowledge' or TEK is now a standard requirement of all natural resource management guidelines. Yet relations between ecologists and aboriginal people in Australia have often been less than smooth—in fact they have often been in open conflict. This paper will consider a local case study on the upper Darling system: the Brewarrina Native Fisheries, known in local aboriginal languages as Ngunnhu and in colloquial aboriginal English as 'The Rocks' or 'The Fisheries'.



Adapted from NSW Surveyor A.W. Mullens' 1906 careful survey drawings of Ngunnhu by Peter Dargin, who added the key to the river rock names in his leaflet: *Aboriginal Fisheries of the Darling-Barwon Rivers*, Brewarrina Historical Society, Dubbo, 1976. Note the damage already done to the 'Rocks' area to create a vehicle roadway across the river bend.

This site, like all river stretches of the Darling, has rich aboriginal traditions of embedded stories told about, and through, the landforms and flows of the river. Ngunnhu is unusual, however, because of the fish traps. The Brewarrina fish traps were a complex network of rounded pens, extending 500 metres around the bend of the Barwon River where Brewarrina now stands. There are many other stone fish traps in the long Darling River system but none are so long or so well-placed as Ngunnhu. These Brewarrina traps are an extraordinary feat of engineering, reflecting deep knowledge of the river's behaviour in drought and flood as well as showing painstaking, stone-on-stone construction methods. The stone pens were laid out in a matrix along a length of the river in which the bed falls steeply at the same time as it bends. This ensured that no matter how low or high, fast or slow, the river was running, at least some of the pens would be underwater and so able to entice the fish in and then trap them, leaving them swimming safely but unable to find the small downstream opening through which they had entered. The high productivity of the traps meant they could feed many people, so they were the subject of elaborate protocols ensuring neighbouring peoples had rights to the river in times of drought. The traps were the focal point of large ceremonial gatherings, which brought together not only people from the three language groups adjacent to the river, but often people from country which was far more distant from the river. No matter how long the ceremonies took, the traps ensured that many hundreds of people could be fed well for weeks at a time.

One of the major sustained concerns of the aboriginal people has been about the physical damage to the structures and living ecologies of the rivers. The remaining section of this paper will focus on the pressures which were brought to bear by the aboriginal people on aquatic ecologists when they tried to build a new fishway across the weir.

Brewarrina aboriginal communities have continuously stressed their concerns about damage to the river. This is a concern arising partly from settler disregard for the sacred story and partly from concerns about the settler's weir – built in the early 20th Century to store water for the town in an area of unpredictable rainfall. The weir site was chosen to enhance an already deep part in the river, but its effect was both to obscure the deep area and to submerge more stone traps of the Ngunnhu itself. Furthermore, its concrete wall completely obstructed the natural movement of fish upstream to spawn. Each season after the weir was built, native fish would be found in massive numbers trapped below the weir, floundering and gasping as they crowded and died in attempts to move upstream. To address this glaring problem, government authorities had built a 'fishway' or 'fish ramp', a geometric set of rising concrete steps which protruded downstream from the wall on the northern, shallow, side of the river. Fish had never used this path to swim upstream—they had always chosen the southern—deeper—side of the river. So the fishway was poorly positioned, but in any case, its construction blasted even more of Ngunnhu's pens apart, causing more physical and symbolic damage. Aboriginal fears were heightened even further after the expansive 1974 flood which had allowed European carp (*Cyprinus carpio*), initially introduced in southern ponds of the river as an ornamental fish, to escape into the main river system. The species spread rapidly all the way up the length of the system, at least into its major streams. The carp, although widely eaten throughout Asia, are viewed with disgust by Aborigines and settlers alike, deemed inedible because of their taste, their distinctive odour and their many fine bones.

The general aboriginal distress about the impact of the weir has been continuous. Aboriginal people mounted a campaign for a greater say in the management of the river as a heritage resource. Les Darcy, a Ngiyampa man who grew up on the river, was an early director of the Cultural and History centre located at the Fisheries. He led the campaign for the Centre to have a role in managing the fabric of the Fisheries themselves, both as a

heritage structure and as a productive resource. In this 1996 interview, he reflected on his concerns about the river at Brewarrina, demonstrating that, for him, the weir was just one aspect of the severe impact which European settlement and western irrigated agriculture had made on the river:

> *...It's a shame we can't live the same way [as when I was young]. But there's no more reeds, there's trees all over the river falling in. The European carp have got it beat. I don't think the irrigation has helped one little bit. Neither have the weirs... I often comment about building the weir at Brewarrina Rocks. They put a weir where it's been 60 miles of water running in any man's time. It'd never been known to get dry, its the deepest part of the Darling River, so why put a weir where the deepest part of the Darling River is? Why put a weir at all? It's a terrible way of ruining a river.*

Les was scathing about the building of that first fish ramp which was not only 'on the wrong side' of the river but then...

> *...they had to dynamite rocks for at least 50 yards to make a waterway for the fish to come up, and the fish want their natural course. ... It shows you the thought and intelligence that went into the building of the weir at Brewarrina.*

Now, Les said, the failure of the first fish ramp meant 'they're thinking they've got to put it on the other side.' But for him, the weir and the first fish ramp had already demonstrated that 'expert' government authorities did not understand the ecology of the river and therefore should not be trusted with any more decisions at all.

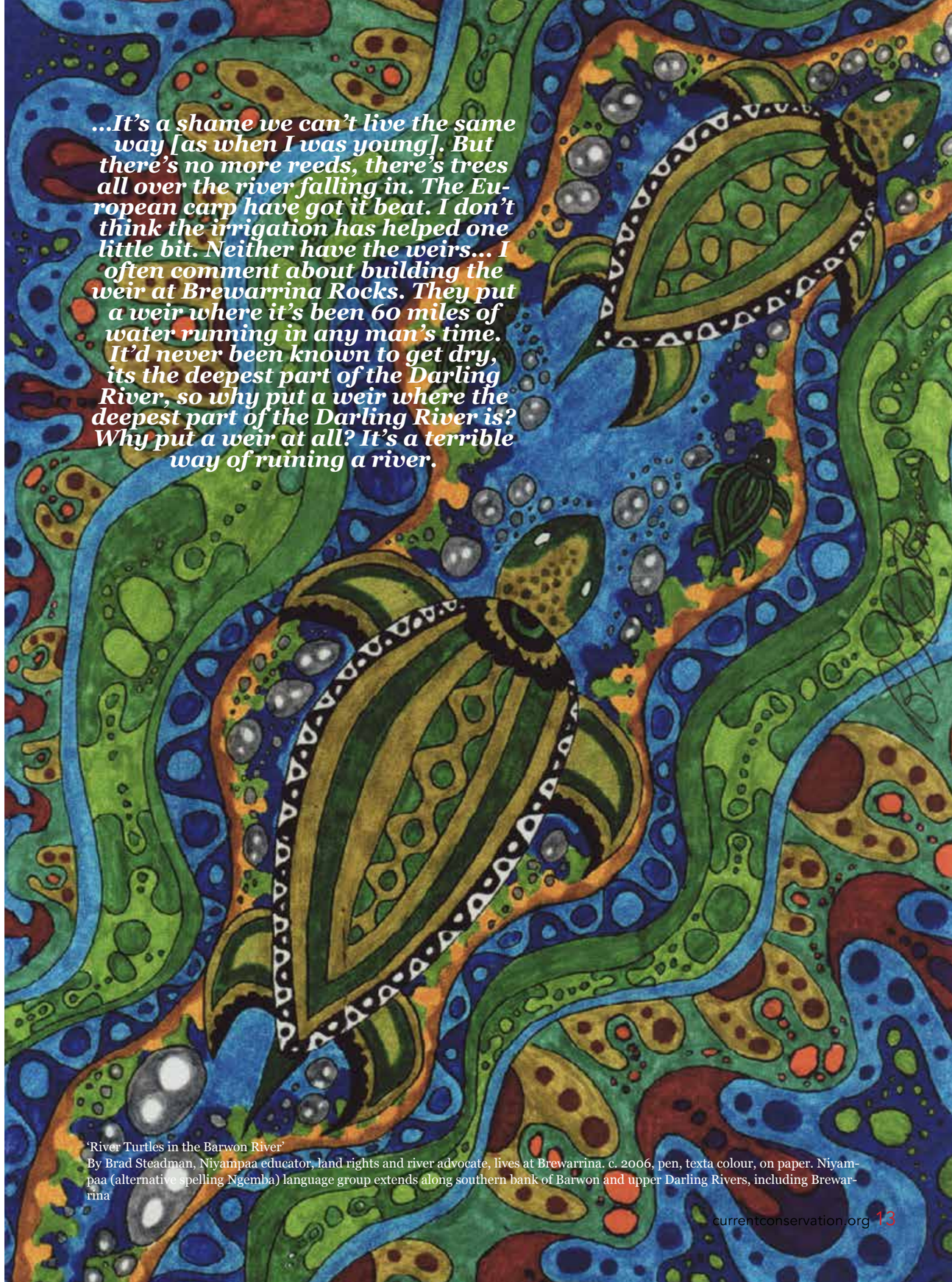
Brewarrina Aboriginal Fish Traps c. 1900.
http://www.environment.gov.au/system/files/pages/ba18eab5-1a30-4f5d-afod-d3f555f56b83/files/national-heritage-brewarrina.pdf
Original is by Henry King (1870 to 1923), commercial photographer, Sydney. The King collection is held in State Library of NSW: 1 album (54 p.) : 105 ill., sepia ; 26 x 41 cm. DSM/F572.9901/ K

The grim concrete channel leading up to the weir on the far side of the river was ugly, but that was the least of its problems: as Les had pointed out, its failure to allow fish to swim upstream was sadly visible. Concerns about both weir and fishway gained even more momentum when, after big floods in 1974 and 1976, a long drought began, which continued from 1997 until at least 2009. This has made the dominance of carp in the river a common grievance among fishermen, graziers and irrigators, who were otherwise seldom on the same side of any argument.

Aboriginal demands for restoration of fishing resources and a reversal of the damage done by the weir have struck a responsive chord in the New South Wales (NSW) Department of Primary Industry (DPI) which manages freshwater rivers. At Brewarrina, there has been an intense debate about whether and how a new fish way might be constructed. The government has finally recognized the damage done by weirs, as DPI spokesman David Cordina explained:

> *Native fish need to migrate short and large distances upstream to spawn, find food sources and redistribute. Barriers to fish passage, such as the Brewarrina weir, prevent this migration and as such, weirs are listed as one of the main factors that have contributed to the decline in native fish numbers in the Murray-Darling Basin. Native fish numbers are now estimated to be at just 10% of pre-European settlement.*

The most contentious discussions have been around the impact that a new fishway might have on Ngunnhu, the Fisheries. DPI announced in October 2009 that a final agreement had been reached after what its spokesperson, ecologist David Cordina, said was extensive consultation, to build a 'reverse rock-ramp fishway' which would be on the southern side of the river and would lie entirely within the existing pool of the weir, that is upstream of the remaining, exposed pens. Cordina continued:



'River Turtles in the Barwon River'
By Brad Steadman, Niyampaa educator, land rights and river advocate, lives at Brewarrina. c. 2006, pen, texta colour, on paper. Niyampaa (alternative spelling Ngemba) language group extends along southern bank of Barwon and upper Darling Rivers, including Brewarrina

This represents a big win for the native fish of the Barwon River and the integrity of the Ngunnhu, or aboriginal Fishtraps, adjacent to the weir. The Ngunnhu, located immediately downstream of the weir is regarded as one of the most important cultural heritage sites in NSW, and as such every effort was taken to ensure the proposed fishway would only enhance their value.

Yet aboriginal concerns persisted. In letters sent to the Federal and the NSW Ministers for the Environment early in 2010, members of long-standing families in the Brewarrina aboriginal community expressed reservations about the agreement. They did so in terms which aligned with concerns of the past, but in ways which also reflected emerging technologies and new practical expressions for these old problems.

Firstly, these letters broached the question of effective recognition of aboriginal people as owners. They expressed frustration at the claim by DPI to have consulted widely, when the Government department had made extensive use of computer generated digital media tools like GPS mapping and animated projections in the consultative process. The view of the letter writers was that this had in effect removed the real decision-making power from an aboriginal community which remained educationally and technologically disadvantaged. This consultation, they wrote, had not used a form of communication which would have allowed meaningful participation in decision making by the broadest number of the local community.

Secondly, the letters expressed concern that the sacred nature of the Fisheries and its precinct had not been adequately recognised in the Government plan, which focused on the fish traps themselves rather than the wider area around the Fisheries. The letter writers argued that, apart from the general disturbance of construction, the government proposal would require the importation of many tonnes of rock from other locations, introducing an alien substance into a sacred landscape, which would again undermine the integrity of the site.

Finally, the letters expressed deep skepticism that NSW DPI could in fact prevent its new fishway from contributing yet more damage to the Fisheries, to the river banks and to the fish themselves. The letters stressed the many damaging outcomes which have already resulted from the settlers' long interference with the stones of the fishtrap pens for a causeway, in the building of the weir itself and the original fishway – yet none of these damaging impacts had been predicted at the time by the engineers who built them. Why should aboriginal people believe now, the letters asked, just because of a sheaf of computer projections, that the engineers were in any better position to predict the outcome of what appeared to be yet another major intervention in the river's flow? The letter writers held grave concerns, based soundly, it would seem, on past evidence, that interventions in the river would do more harm than good.

Ngunnhu is, in many ways, an exceptional site: a waterscape of high productivity and complex human design and engineering, demanding recognition of aboriginal people's knowledge of and successful harvesting of natural resources. Yet, at the same time as it demonstrates human ingenuity, it is embedded within a creation narrative of ancestral power over water, land and living species. The varying flows across its rocks are productive both in food species—for humans and birds—and in the complex stories of creation and continuing interaction between people and

New fishway on southern side of river, rising in steps to the level of the weir pond. NSW Public Works Department: http://www.publicworks.nsw.gov.au/riverina-western/Brewarrina-fishway

the more-than-human world. Aboriginal expressions of concern about Ngunnhu—the place, the river and its flow—show this interaction of both pre-invasion 'tradition' and post-invasion historical change. This interaction is typical of disputes about river health along this long river system, feeding into the sensitivity with which aboriginal people respond to conservation initiatives.

Why should aboriginal people believe now, the letters asked, just because of a sheaf of computer projections, that the engineers were in any better position to predict the outcome of what appeared to be yet another major intervention in the river's flow?

The new Fishway at Brewarrina has at last been completed. It is on the southern side—the Brewarrina side—of the river, and it looks extremely beautiful. Rather than the brutalist concrete geometries of the old fishway, the new one is a rising arrangement of stones, echoing the design of Ngunnhu itself.

But does it do the job everyone wants it to do? Does it allow native fish to swim upriver to spawn? Fish can no longer be seen gasping as they crowd together in frustration below the weir in the way they used to. The ecologists are cautiously optimistic, monitoring the fishway carefully, waiting to see if there are signs of regeneration among native species. Aboriginal community members have mixed views—many remain skeptical, reserving their judgement to see how the fishway works in drought as well as in rainy seasons. The long undertaking of the planning and then the construction of this fishway is testament to the changes which have taken place—not only in the river but in the relations between aboriginal owners and settlers. Ecologists have had to recognise aboriginal people as owners of the river in ways which have never occurred before. The beneficiaries in this still fragile negotiation, it is to be hoped, will also be the riverine species who may finally find their way upstream.

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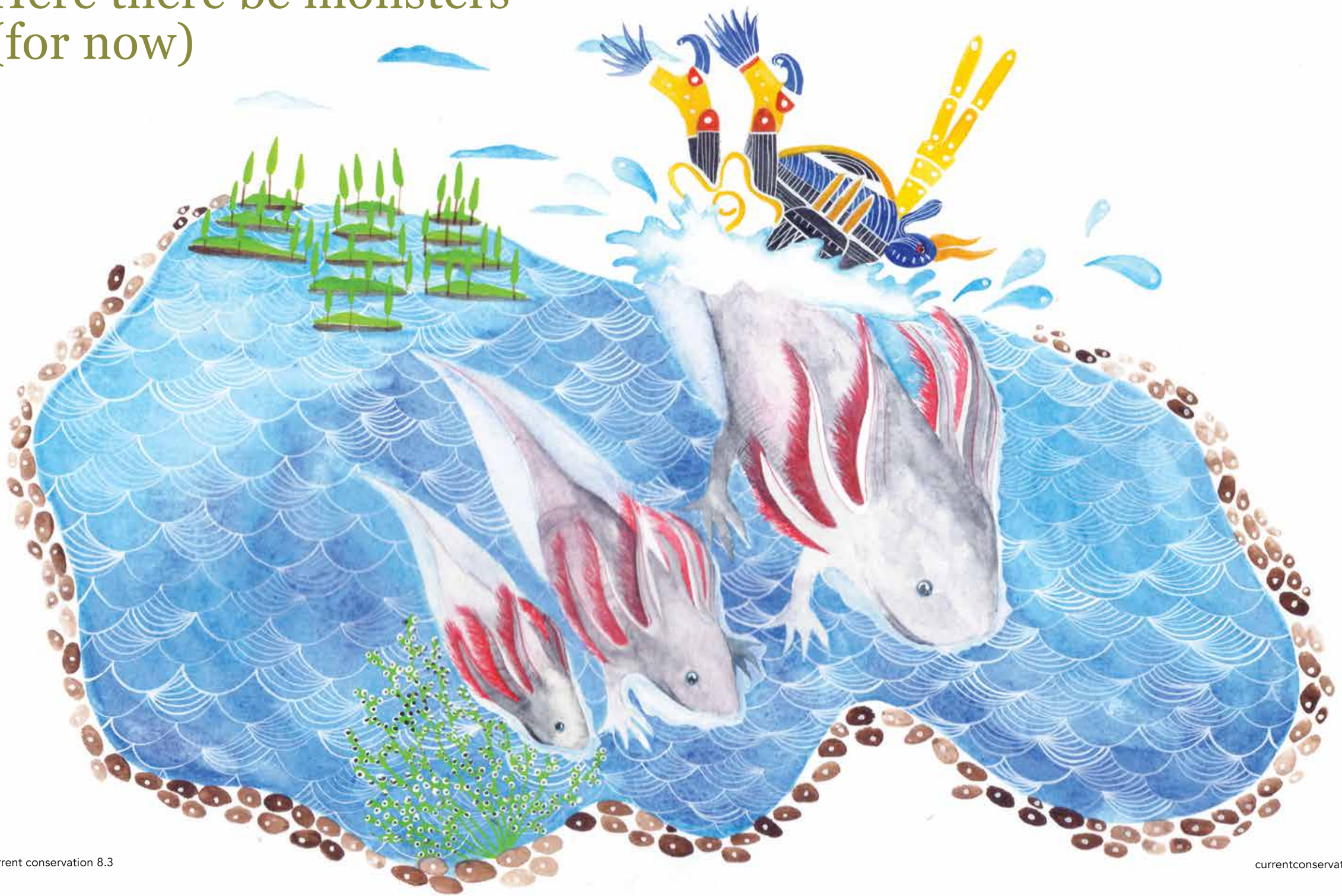
Here there be monsters (for now)



Kalyani Ganapathy

Ambystoma mexicanum is a species with many names. In addition to its Latin binomial, it goes by "Mexican salamander," "Mexican walking fish," and "axolotl"—the last of which is a Nahuatl word that translates, dramatically, as "water monster". Whatever you choose to call it, *A mexicanum* is a fascinating animal with an unusual life history that may one day help medical researchers develop improved techniques for treating traumatic injuries, and potentially even increase human lifespan. Yet, ironically, although abundant in laboratories and collections around the world, the axolotl is critically endangered and may soon be declared extinct in the wild.

Although axolotls have a long history of being used as food and medicine in the New World, they were not known in Europe until the mid-19th century, when specimens were sent from Mexico City to the Jardin des Plantes in Paris. There, the zoologist Auguste Dumeril began studying the unusual characteristic that makes the axolotl so interesting to modern scientists: *paedomorphism*, or the maintenance of juvenile physical features into adulthood.

Like the majority of its fellow amphibians, the axolotl begins its life as an aquatic larva. Feathery gills, splayed around the animal's face like a lacy Elizabethan ruff, allow it to extract oxygen from water. The axolotl also sports unlidded eyes, small limbs, and a pronounced fin running along its spine and onto its thick tail—traits that are common in all larval amphibians. These characteristics, along with the animal's large size (axolotl larvae can be up to 46 cm long), give it the appearance of a giant tadpole from an alien world.

Unlike tadpoles, however, the axolotl does not usually undergo a full metamorphosis, the process through which typical amphibians prepare themselves for emerging from the water and transitioning into a terrestrial life. The axolotl does not lose its gills or tail, or grow larger limbs to help it move onto land and navigate through the undergrowth. Instead, it experiences what is called *neoteny*, or delayed development: it keeps its larval traits and simply continues to expand until it reaches full size and sexual maturity at approximately 18-24 months of age. After this, the axolotl looks and behaves the same for the remaining decade or so of its life.

Thanks to the work of Dumeril and his successors, we now know that axolotl neoteny is at least partly caused by a deficit of thyroid stimulating hormone. This chemical tells the thyroid gland when it is time to produce thyroxine—a different chemical that regulates metabolic activity and, therefore, the body's transition into adulthood. Thyroxine production is dependent on the axolotls' ability to consume adequate levels of iodine, a commodity that is generally scarce in their habitat—(sometimes, especially when these animal breed at high densities, larvae obtain their dietary iodine requirement by consuming other larvae). An additional hindrance to metamorphosis may be the coldness of the water in which axolotls live, since low temperatures reduce the efficacy of thyroxine. While these conditions cumulatively favour the lifelong retention of juvenile traits, it is biologically possible for axolotls to undergo metamorphosis and seek a terrestrial existence—as has been observed in their geographical neighbour and close relative, the Plateau tiger salamander (*A velasci*). This is uncommon in the wild, but can be stimulated easily in captivity by an injection of iodine or thyroxine. Although this might seem like an extravagant parlor trick, it has been integral to studies of what is, perhaps, the defining feature of axolotls: their healing ability.

If an axolotl is cut, its wound will heal over without producing a scar. If it suffers a trauma to part of a limb, it can repair the damage and eventually regain normal function. However, what is truly amazing about the axolotl is that, given enough time, it can completely regrow entire structures, including tails, legs, and even parts of its brain. Further, if organs are transplanted from one axolotl to another, the recipient will readily integrate the foreign components and eventually use them as if they were its own. Because these "talents" are most pronounced before an axolotl undergoes metamorphosis, researchers are particularly keen to understand how, why and when exactly the shift to adulthood makes healing more difficult. This information has obvious implications for both human and veterinary medicine, especially for a range of injuries that previously meant lifelong disability, paralysis, or certain death.

Faldrian

Wild-type axolotl

If an axolotl is cut, its wound will heal over without producing a scar. If it suffers a trauma to part of a limb, it can repair the damage and eventually regain normal function. However, what is truly amazing about the axolotl is that, given enough time, it can completely regrow entire structures, including tails, legs, and even parts of its brain.

Although axolotls are special for their remarkable ability to recover from trauma, the neoteny that facilitates this trait has been observed in a number of other species. A survey of the natural histories of neotenic organisms suggests that the characteristic may be at least partly linked to habitat: Neoteny is particularly common in environments where it is difficult or dangerous for aquatic juveniles to make the transition to terrestrial habitats—especially those where the animals need to locate scarce resources while navigating rough terrain and avoiding desiccation.

This is an apt description of axolotl habitat—the high-altitude Laguna Alchichiga region located to the southeast of Mexico City. The area once boasted five lakes, or *lagunas* (Chalco, Texcoco, Zumpango, Xaltocan, Xochimilco), that sustained generations of Mesoamerican cultures. The two freshwater lakes, Chalco and Xochimilco, were a useful source of water for both humans and their crops; the Aztecs used these bodies of water to create a system of *chinampas*, or "floating gardens", in which a series of drainage channels were interspersed with small plots of arable land that could be used to grow food crops.

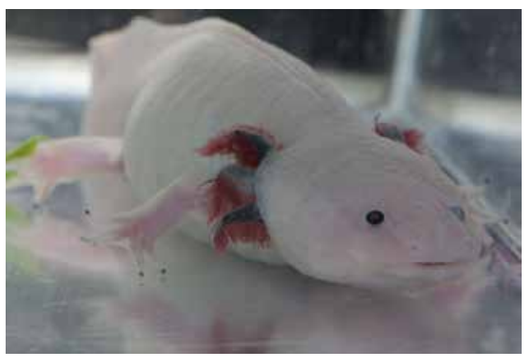
Even before the appearance of humans, the Alchichiga region was a challenging place for the axolotl to live. Water temperatures fluctuate greatly, dropping as low as 6°C and soaring to as high as 20°C; the lakes experience intermittent periods of flooding and drought; and there are a number of terrestrial and aerial predators ready to snatch

- Habitat: Mexico's high-altitude Lake Xochimilco and Lake Chalco (formerly), in waters ranging from 6-20°C
- Size: can range from 15-46 cm, but typically 23-30 cms long; weight is approximately 55-225 g.
- Diet: Carnivorous diet consisting of invertebrates such as molluscs, crustaceans, insects and small fish
- Reproductive activities: Males release packets of sperm into the water; these are then collected by females so that they can undergo internal fertilization and produce eggs; eggs are attached to aquatic vegetation and gestate for 2-3 weeks prior to hatching
- Lifespan: 10-15 years (both in the wild and in an aquarium)

up any axolotls that venture onto land. Life only became more difficult once the Aztecs and their successors settled the area. Because axolotls were considered a delicacy—reportedly tasting like eel—they were regularly hunted for food; their fat was also processed into a syrup that could be used as a nutritional supplement. Perhaps most catastrophic to the axolotl was the drainage of Lake Chalco to prevent flooding and facilitate the expansion of Mexico City and its suburbs. Lake Xochimilco was similarly reduced, leaving the dwindling axolotl population to eke out an existence in the few freshwater ditches and pools that remain in the Alchichiga area.

Recent surveys suggest that wild axolotls occupy no more than 10 km² of fragmented and degraded habitat. The water in these areas is often polluted by chemicals, sediments, and microorganisms. Even where it is clean enough to foster growth of vegetation on which axolotls can secure their eggs, the water may still be home to other dangers such as invasive fish (including carp and tilapia), that eat young axolotls and their prey. As a result of these challenges, axolotl numbers have decreased markedly in recent years—in 1998, surveyors located nearly 6,000 individuals per km²; over the next decade, the number dropped to 1,000 and then to 100; in January 2014, researchers could find no axolotls at all.

Despite these trends, axolotl conservationists are not ready to give up on this unique salamander. In addition to its bizarre appearance and regenerative powers, the axolotl also boasts a connection to the Aztec god of deformations and death. Thus, while it may not be the cutest or cuddliest of organisms, it is undeniably striking, memorable, culturally relevant, and strangely charismatic—a combination of traits that may allow it to function as a flagship species for conservation throughout the Alchichiga region.



Henry Muhlpfordt

Axolotl in the laboratory

Perhaps most promising is the fact that Lake Xochimilco, a popular tourist destination, has received international recognition through both the UNESCO list of World Heritage Sites (1987) and the Ramsar Convention (2004). The axolotl was recently chosen as the figurehead for a Darwin Initiative project aiming to educate Xochimilco visitors about the lake's ecosystem and its economic and ecological benefits. Among other initiatives, the project included wildlife surveys, guide-training workshops for the boatmen who punt thousands of visitors around the canals on large flat-bottomed boats (trachineras), and efforts to help artisans establish souvenir-selling businesses. A field station situated along the shore of Lake Xochimilco provides space for both education about, and scientific study of, axolotls and other wildlife that share their wetland habitat. Visitors may not be able to see free-ranging axolotls, but they can view some of the many live specimens that are kept there in aquaria for research and breeding purposes.

In the future, some of those captive animals may be used to re-establish axolotl populations in the wild—but only if two conditions are met. First, the habitat needs not only to be restored, but also protected; if it is not, the axolotls are unlikely to survive and successfully reproduce because they will have no environment in which to do so. Second, conservationists must work to ensure that only healthy individuals are released. The latter goal may sound easier to achieve than the former, but "health" is a complex issue that encompasses not only disease but also genetics and behavior. Captive breeding can inadvertently select for particular traits that may not be favourable—or may even be actively harmful—in the wild. Preliminary genetic work has suggested that captive-bred axolotls have lower levels of genetic diversity, which means that they may be less able to respond to environmental pressures such as those associated with human disturbance and climate change. Additionally, variations in size, survival, reproductive output, and even colour can prevent successful mating between individuals from different populations of captive axolotls, and between captives and their free-living brethren. The urgency of establishing wild populations of axolotls cannot be overstated. Already, some captive axolotls have shown signs of losing some of their regenerative capacities over many generations, suggesting that robust wild populations are needed to keep this species viable over the long term.

Perhaps most promising is the fact that Lake Xochimilco, a popular tourist destination, has received international recognition through both the UNESCO list of World Heritage Sites (1987) and the Ramsar Convention (2004). The axolotl was recently chosen as the figurehead for a Darwin Initiative project aiming to educate Xochimilco visitors about the lake's ecosystem and its economic and ecological benefits.

Right now, the future is very uncertain, but there are glimmers of hope. In February 2014, in an unexpected and happy turn of events, biologists from Mexico's National Autonomous University spotted two wild axolotls in Xochimilco. The animals could not be caught for use in captive breeding programs, but perhaps they will reproduce in their native waters. To facilitate this and other conservation interventions in the Alchichiga region, an international team of researchers met recently in Mexico to write an updated axolotl action plan. Their management recommendations, due to be released by the end of 2014, will usher in the next phase of axolotl conservation efforts—that, hopefully, will allow us to one day add "survivor" to the long list of names used to describe this remarkable species.

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Two failed states: politics, access and institutions in Gangetic river fisheries

Spoorthy Murali

The life of a fisher-boatman on the Ganga River is hard. Seven years ago, an old fisherman had touched his sun-singed forehead and told me, "There are many wrinkles, but no future. Depending on river fishing in the Ganga and her tributaries for eking out our livelihood has become a curse today. We used to be the masters of the river, now we are scavengers. How would you feel if you got robbed almost every day when you returned from work?" The physical hardship apart, he explained, they had to feed whole families from the poor fishing returns, while facing threat to life and risk of robbery. They begged for an answer to the question: "How did we, the fishers to whom tradition bequeathed the fruit of the Ganga waters, reach this state?"

It would help to put this serious issue in context right at the outset. Uttar Pradesh (UP) and Bihar are the two Indian states with the largest populations of traditional fisher communities, including the Mallah, Nisad, Majhi, Keut, Bind and allied castes in the Gangetic plains. Most members of these communities are landless and dependent almost entirely on river fishing through the year[1]. River fisheries across India is considered an underperforming economic sector on account of continuously falling production and the Gangetic basin that supports nearly 10 million people is no exception[2]. Despite both historical and contemporary importance of the Ganges for fisher livelihoods, policy neglect of Gangetic fisheries has compounded in recent times. As a result, many fishers have left fishing due to poor incomes and from fear of conflicts.

Resource scarcity is thought to lie at the heart of conflicts on the Ganga. Dams, altered flows and pollution have resulted in a collapse of fish population stocks. But over and above scarcity, the complex political history of access and rights needs to be understood to identify causes of continuing conflict in the fisheries of UP and Bihar. Whatever little fish resources remain have been rendered worthless by ambiguous property rights, undefined tenure and the politics of access. This is linked to the inherent problem of water tenure in the dynamic alluvial rivers of the Gangetic plain: rivers keep changing their courses with every flood season, remapping land and water through erosion and deposition. Hence, it becomes nearly impossible to know, for fishers, over how much water and how much time their stakes truly lie. This uncertainty forms the substrate for the politically powerful to reinforce their authority. In the highly feudal and stratified societies of these states, fisheries conflicts are often colored by violence and bloodshed.

Despite broad similarities in the geography, hydrology and anthropology of fishing, political history has yielded disparate resource access regimes in the states of UP and Bihar. UP has a system of private contracts over river segments of variable lengths, which are leased to contractors through periodic auctions, who in turn employ traditional fishers as fishing labour. In contrast, all flowing water in Bihar can be fished open-access, i.e. fishery is 'free-for-all' by state decree. These private and open-access systems have now existed in parallel for the last 20-25 years (c.1990-present), having diverged from a shared colonial past. The rest of this article will discuss how these seemingly divergent systems of resource access have in fact produced the same effects on the lives of fisherfolk.

The Jalkar or Panidari system in Bihar, the riverine counterpart of feudal Zamindari (landlording), was fortified by land tenancy acts passed by the British colonial administration in the late 18th century. Though the British were aware that such 'permanent' settlement was a paradox given the dynamic floodplain, they nevertheless did so to consolidate long-term revenue earnings. Zamindari establishments could sublet water areas for fishing to smaller entrepreneurs who would hire traditional fishers to work the fishery. This came about through the exercise of English riparian law, which allowed ownership of any water body adjoining a landowner's estate. The 'right to fishery' was thus aligned with private land-based property rights, leaving landless fisher folk without any stakes. Writings by British officials serving in eastern Bihar (erstwhile Bengal) resonate the worry that fishers would overharvest and destroy the rich fishery of the Ganges if not for privately owned and regulated river stretches. Although the colonial administration grappled constantly with the problem of river channel changes on the one hand, and poverty and equity on the other, this did not result in actual dilution of powers vested in the Jalkar owners and lessees.

The Panidari control became brutal and coercive over the years. Though Zamindari abolition happened in independent India (in 1952), Panidari continued in the Bhagalpur district of Bihar till 1991. Only after a fisher-supported movement, the Ganga Mukti Andolan, which got political mobilisation at a fisher settlement called Kagzi Tola in the Kahalgaon block, was the fishery freed from the Panidari's clutches. The new ruling socialist party seized the opportunity provided by the movement to reach out to lower caste vote bases and made fishing 'free for all'. This symbolic breaking of 'private' boundary was portrayed as a victory of the 'oppressed over the oppressors' but in reality, it did little to secure livelihoods. Instead, due to open-access fishing, the absence of any settlement of fishing rights, and the resulting weak institutions, a fishery mafia gained influence. Even today, criminals use highly destructive fishing practices causing serious declines in fish recruitment, and powerful people enforce these practices through violence and threat to local fishers. The last three decades have seen several brutal massacres of fishers and fish grabbing by criminals is common.

As fishers in Bihar admit today, with shame, they did not see the writing on the wall in 1991. Given the current situation where 'non-traditional, opportunistic, destructive fishers' and criminals rule the roost without any sanctions, even the oppression of Panidari is described as though it were a blessing.

"We worked under the Panidar (waterlord) for a long time. It was bonded labour. Often we would get meager payment for our work, whereas our fish would be taken away since it belonged to the Panidar. Even the river stretch we fished between Sultanganj and Pirpainti, belonged to them. As

Nachiket Kelkar

Millions of fisher folk depend entirely on the Ganga River and her tributaries for their livelihoods

1 Many fishers also work as farm labourers, rickshaw-pullers, divers, construction workers in urban areas and as boatmen at pilgrimage centers to augment their incomes.
2 Most commercially valuable fish species (large carps, large catfish, Hilsa etc.) have shown declines in the range of 70-100% over the past 40 years. Trash fish (gobies, minor catfish and minor barbs), which nobody touched before, are now bought at over INR 100 for a kilogram.

workers we faced years of oppression. Our community united in the late 1980s and overthrew this oppressive regime. Phir Gangajee mein machhli marna Lalu ne firi kar diya (Then Lalu Yadav, the erstwhile Chief Minister of Bihar, made fishing in the Ganga river free for all). This change we ushered in was also our biggest mistake. The Panidar was our oppressor but also our protector within his domain. Now any Rangbaaz (criminal or thug) comes with a gun and loots away the fish. We fish in fear. We hope that the good days of the Panidari will return. (sic)"

- Fisherman in Bhagalpur, Bihar (2012)

The fisheries in UP shared a common history with Bihar with the Zamindari having major influence on control of fisheries. In the late 1980s, the contract system was introduced and the Thekedar (contractor) obtained lease rights to fish through government auction schemes. Today, fishers complain that contractors exploit them by paying poor wages and make them work in fixed areas as laborers. This exploitation easily moves on to fish grabbing, as the 'contractor's friends' can descend on the fishing stretch and order fishers to give them fish for free. These friends are often government officials (police, irrigation departments, fishery departments etc.), who help the contractors win auctions in the first place. Leases are typically short-term and may be sold for huge amounts. What is more, investment recovery is ensured through highly destructive and overfishing practices.

"Thekedar haraami hain (the contractor is a cheat). He will make us work for 12 hours everyday and pay only 100 Rupees each, and will also take all the fish. When the contract system came, we entered it stupidly. But now we are repenting, as we are poor and don't have any other means than fishing. And fish are disappearing from the Ganga anyway. All we can do is hope that somebody gets rid of these wretched Thekedars and free the river for fishing. (sic)"

-Fisherman in Banda, Uttar Pradesh (2012)

As the above narratives from the two states suggest, fishers are suffering, no matter what the resource access system. The UP fishers demand a river free of contracts, and the Bihar fishers desire to go back to private ownership of river fishery[3].

3 Along the Ganga River in UP, a few river stretches can still be fished in an open-access manner while some are privately controlled. Similarly, a few stretches in Bihar are still perceived to be under private control (although this is ambiguously defined), whereas almost all other flowing water bodies are open-access. I asked fishers from both regimes in both states about what they would prefer as an alternative. Up to 70% of fishers (n=117) working in private contracts in UP said that this was a problem and they would like to have fishing made 'free-for-all'. On the contrary, 63% of fishers (n=110) in Bihar clearly preferred the privately owned fishery of the past as a solution to problems facing their fishing livelihoods.

These narratives are hopeless: they swing between the sinister ends of bondage and release, enclosure and the false promise of liberty. Underlying this hopelessness is institutional failure, reflected by the failed property rights arrangements, that have aggravated the collapse of Gangetic fisheries. This has become a 'cycle of doom' with endless transitioning between private and open-access fisheries in UP and Bihar over time. It calls for an empirical investigation of the effects of these two regimes, on fishery productivity, livelihood security, incomes and perceptions. The urgent concern is: which one is better? Market economics tells us that private ownership is more efficient than open-access under any circumstances; the latter is expected to bring about a tragedy of the river commons. But is this true? How do property rights regimes affect incomes and other benefits to traditional fishers? What are the implications for fisher membership of the regimes? What could be alternative regimes of resource use? Is there ground between these two states?

These questions kept coming back at me all the time, when I travelled in 2012 across the Gangetic basin for a study on fisher livelihoods. I wanted to understand the factors underlying declining fisheries-based livelihoods and biodiversity in the Gangetic plains. I spent over 6 months interviewing over 200 fishers in several settlements along the Ganga River and also 12 of its tributaries flowing through UP and Bihar. These interviews allowed me to understand what the fishers perceived as problems and possible ways out. What I report here is similar to the results of a poll.

The major finding was that both resource regimes –private contracts and open-access – have performed rather poorly in terms of effective management of fish resources. This was counterintuitive - diametrically opposite property rights regimes were causing the same problems. But indeed, there were almost no differences in fishing practices in UP and Bihar: 60-90% of

Kadambari Deshpande

Fisher-boatman in Bihar. (this is the picture with the bridge).

fishers across UP and Bihar lamented the use of highly indiscriminate methods which caught fish of all sizes and types. These destructive methods (involving mosquito-nets, seines and poisoning of river channels) cause mass killing of fish fry, eggs and spawn. As per the fishing acts of both Bihar and UP, such destructive fishing is illegal, but no ground action is being taken to improve this condition. Due to the 'managed' fisheries of UP, fungicides for fish are used rampantly, leading to the death of aquatic plants and insects, and invasive food fish species (e.g. Chinese Carp, Tilapia) are increasing in numbers and spreading, affecting native fish diversity. Fish selling prices have increased nearly fivefold in UP and fourfold in Bihar in the last decade.

The socio-economic benefits and costs to fishers were also very similar in both the regimes. Monthly incomes of fishworkers in UP and Bihar averaged around INR 2500 (± 1500 SD) per month, with the fishers managing to save only one-fourth of this. In addition to this poverty, were constant threats to social security (fish grabbing, criminal extortion, contractor oppression and caste-based violence), which nearly 75% of fishers in Bihar and 60% in UP reported as their gravest concerns[4]. Fishers also stressed the hard physical labor they had to put in everyday to get enough fish for the day's meal. Overall, fishers wanted to move away from current regimes because of the rampant destructive fishing practices, risk, oppression and injustice.

Given these failures on several counts, are there suitable alternatives? With the failure of state-led cooperatives, answers seem difficult to come by. The governments of both states formed fisher cooperatives in the 1960s and 1970s. However, these have run into elite capture, generating serious conflicts with local fishers, and are largely dysfunctional today. Fishers from Bihar and UP stressed that cooperatives need to be revived for

4 Costs to secure fishing was calculated based on frequencies of cited instances of fish grabbing and threat to life from contractors (UP) or criminals (Bihar). These costs can be understood as opportunity costs in terms of 'money lost from loss of fishing opportunity' in Bihar, or 'cuts in wages given by contractor' in UP. Thus, a 65% loss of fishing opportunity is treated equivalent to INR 65 being lost per INR 100 to which the fisher was entitled. 50-75% of the interviewed fishers in UP and Bihar perceived 'high risk while fishing' from contractor oppression or criminal grabbing.

channeling benefits to local fishers (currently 10-15% of the cooperatives are functional in these states). Recent new schemes in Bihar have been aimed at reviving the cooperative structures to meet their original concerns. The failure of both private and open-access resource regimes suggest that alternatives in community-based management deserve their due, through processes of bottom-up political organisation. It is assumed that political organisation of mobile resource users (e.g. herders, fishers) is inherently weak because of the transient nature of their livelihood-earning practices. There is a need for emergence of local fisher political identity that gives the community control over fishing areas to sustain what is leftover of the fisheries today.

My personal opinion is that river fisheries management that marries customary tenure with community ownership will be worth experimenting with. Defining tenure, even tentatively, will inevitably lead to parceling of the river among local fisher groups, but there does not appear another way to balance the articulation of diverse interests within fisheries (Dey, S. pers. comm.). For example, Mallah fishers allege that 'non-traditional' fishers of 'other castes', unaware of the fine-nuances of traditional low-impact fishing, use destructive fishing methods. This represents the making of a new conflict that might lead to the demand for exclusive rights to traditional fishers, a legitimate demand in its own right, albeit a caste-based political assertion. Effective adaptive management of water tenure through continuous dialogue remains necessary for cooperation among fishers. Today, the two "states" of Gangetic river fisheries highlights the need for strengthening community identity and locally situated institutions. If community-based fishing rights and access are created, their long-term sustainability will require restoration of fish stocks and improvement in the ecological condition of rivers. Inland fisheries policy in India needs to address these complex issues urgently to safeguard the livelihoods of millions of fishers.

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One fish, two fish, three fish: collective counting and democratic conservation in Kerala's backwaters

Every year in the month of May, scientists, students, fisherfolk and the public get together to count fish in one of India's largest lakes. Hari Sridhar spoke to ***Priyadarsanan Dharma Rajan,*** *a senior fellow at the Ashoka Trust for Ecology and the Environment (ATREE) and* ***Ashish Mathew George,*** *Programme officer of the Vembanad Wetland Conservation Programme, to find out more about the annual Vembanad fish count.*

HS: What is the idea behind this annual fish count?

PDR: This is an activity planned mainly to bring the fisher community closer to fisheries experts, students, and the general public. ATREE went to Vembanad at a time when the local people were worried about the burgeoning backwater tourism and the lake pollution caused by it. The fisherfolk were more concerned because it was affecting the fishery and alienating their traditional fishing grounds. To make any conservation intervention a success, one has to first gain the confidence of the traditional stakeholders, in this case the fisherfolk. Our first challenge was to win their trust. They are a traditional community, who were always skeptical about outside people. They were not antagonistic, but they were not willing to take any outsider into trust. They denounced research: 'Many people come, do research and go, but how are we benefited?'. It is true what the local people were telling. There are several scientists and institutions working and several large research studies implemented, but not even basic water quality data was available to the people. So rather than getting into any active research at the start, we decided that what Vembanad required was some action to empower people to regain their rights to the lake. The fish count is only one among many activities that ATREE initiated in Vembanad. Our main intention behind the fish count was to create awareness about the state of fishery. We also wanted to convince them about the importance of this kind of scientific data collection for their own benefit. The first count was conducted in 2008. This year, on 23rd and 24th May, we conducted the seventh successive edition of the count. A number of agencies and individuals participate in this event – Kerala University for Fisheries and Oceanic Sciences, Saint Albert's college in Ernakulam, Environmental Science Department of M G University, Kerala State Biodiversity Board, the Casino Group of Hotels, Vembanad Nature Club, volunteers and most importantly, the fisherfolk themselves.

HS: Let's step back a bit from the fish count and talk about Vembanad; why was ATREE inter-

Setting up a 'fish sanctuary' in Vembanad lake

ested in Vembanad in the first place?

PDR: I would put it differently: it was really the interest or passion of individuals for the conservation of theses backwaters which ATREE encouraged and facilitated. SD Shibulal, who was then the Chief Operating Officer (later CEO) of Infosys, hails from the village of Muhamma in Alapuzzha district, on the banks of Vembanad. He made an offer to ATREE: if ATREE is ready to do something for the conservation of Vembanad backwaters he will provide the funding. I was born and brought up near the backwaters and my neighbourhood—the Ashtamudi backwaters—had a major influence in shaping me as an ecologist and conservationist. My early conservation years, when I was in UG and PG, were all linked to these backwaters. When an opportunity to do something for the conservation of the backwaters came up, I was not in a position to back out. My colleagues Seema Purushothaman and MC Kiran, who also hail from Kerala and shared my interest, also joined the team. We did a reconnaissance survey in 2006 and started the programme in 2007.

HS: Tell us a little more about Vembanad. Why was there a need for a conservation intervention in Vembanad?

PDR: I think that Vembanad is more important than even the Himalayan glaciers. It is so unique. It maybe the only place on earth where cultivation happens below mean sea level and thousands of people live a semi-submerged existence for part of the year. It supports a highly productive agricultural system - Kuttanad, the 'rice bowl of Kerala'—spread over 1,100km² in a reclaimed portion of the lake. If you consider the livelihood support provided by Vembanad, it is next only to that provided by the Arabian Sea. Most of these livelihoods, be it fishing, farming, coir industry, clams, duck farming or more recently tourism, all depend on the water and the quality of water in the lake.

Vembanad is also important for its biodiversity. It is a Ramsar site and an Important Bird Area. A lot of migratory birds come to the eastern side of lake. There are a few small islands which have very good vegetation diversity. The fishery resources are also quite high here. In fact ours is not the first fish survey. In 1979 and 1984 Dr BM Kurup conducted surveys and documented more than 150 fish species. But in our surveys we documented only 71 species. We believe that the reduction in diversity has to do with the building of the Thanneermukkom barrage in early 70s. The barrage was built to reduce salinity entering to the southern side of the lake, to aid rice cultivation. Before the barrage came up the lake used to include both freshwater and marine species; but now very few marine migrants reach the lake.

The barrage has changed the ecology of the lake. Many freshwater species require some salinity for breeding - the best example is the giant freshwater prawn (*Macrobrachium rosenbergii*); there are also some local eels. Similarly, there are some marine species, like shrimps, that require freshwater for breeding. The barrage poses problems for such animals.

The barrage has also caused another problem: saline water helps flush the lake, keep it clean and prevent excess nutrients accumulating in it. After the barrage came up, this flushing happens less frequently. This problem is compounded by agricultural runoff. Once the monsoon floods recede, water is pumped out of the fields, to do rice cultivation, rather than into the fields as is done elsewhere. This causes heavy influx of fertilizers which results in proliferation of water hyacinth and other weeds.

So the major issue we wanted to address was the declining water quality and the associated loss in diversity and fish resources. But the first challenge to overcome was the lack of baseline data.

HS: Getting back to the fish count, can you tell us what actually happens during the count?

PDR: The fish count serves two purposes: first, it is an awareness campaign about the state of fishery resources and lake conservation issues. But at the same time, we follow a strict scientific protocol; so at least over one day every year we get some data. The fish count operates in three cruises, each covering different parts of the lake in such a way that the entire lake gets covered. 30-60 people are assigned to each cruise team. Each team has a captain and includes fisheries experts, fisheries students – for whom this is probably the only chance for direct experience with fisherfolk and the lake – and, most importantly, the fisherfolk themselves. We also invite the general public from across the country to volunteer in the fish count; this year we had volunteers from Bangalore, Coimbatore, Chennai and other places in the south. Different tasks are assigned to members of the team – helping the fisherfolk cast nets, identifying species, counting the fish, maintaining a checklist, documentation etc. Along each cruise route we count fish at five pre-decided points using three different methods—cast net, gill nets and hand nets. This way all the strata of the lake get covered. There is enough work for everyone to do because by the time the teams reach Alappuzha they have to be ready with the date to present. In fact, even before we reach Alappuzha the press people start calling us—"What are the results?" Give us the count. You know how the press is! We have to do some analysis and refine it later, but the first-hand data is presented immediately at the valedictory meeting. And the next day it is in the local newspapers. From this year India Biodiversity Portal is also partnering with the fish count. An informatics person from IBP was present in each cruise and the observations were immediately uploaded to the portal. So now there is a quicker dissemination of the data. To our knowledge, ours is the only information available about fishery resources of Vembanad in last 2-3 decades.

HS: Apart from counting fish, what other information do you collect on these cruises?

A public display board with information on water quality

AMG: Water quality sampling, other environmental conditions, sightings of birds and mammals like otters.

PDR: We also collect data from the fish landing centres. There are two landing centres in the area where the fisherfolk come very early in the morning with their catch. We station the volunteers there the previous night itself to collect data straight from the fisherfolk's baskets.

HS: What have been some of the important findings of the counts done so far?

PDR: Like I already mentioned, our counts have shown that fish diversity has reduced dramatically, from 150 species during 70s-80s to 70 species now. There is a decline in the carnivorous fishes and there has been an increase in omnivores. We have been noticing a gradual reduction in freshwater puffer fish since our first count in 2008. There has been a recent proliferation of the freshwater sponge *Spongilla lacustris*, a climate indicator, which is a cause of worry for the fisherfolk. On the positive side, our surveys have also documented some interesting, rare species in the lakes. I will send you the report with all the details. You know that by profession I am an entomologist, not a fish expert. The Vembanad project is my interest or passion, although it is a passion that has taken up almost 50% of my time in the last six years.

Ophiosternon begalensis (Bengal eel) (top) *& Eleotris fusca* (Dusky sleeper) (below), species recorded for the first time in the area.

Important findings of the report

Two fin fish species Ophiosternon begalensis *(Bengal eel) &* Eleotris fusca *(Dusky sleeper) were recorded from the landscape for the first time.*

Five exotic species— Pterygoplichthys multiradiatus *(Sucker catfish),* Catla catla *(Catla),* Labeo rohita *(Rohu)* Oreochromis mossambicus *(Tilapia) and* Pangasious suchi *(Suchi catfish) were recorded.*

Two rare fishes, Angailla bicolor *(an eel species) and* Channan diplogramma *(Malabar snakehead) were recorded for the first time in the 2014 count.*

A sharp decline in the population of the dwarf puffer Carinotetraodon travancoricus *was noticed. This species comprised ~90% of the catch in 2008 but only 2% in 2009 and was very rare or absent in subsequent years.*

Krishna Kumar K and Priyadarsanan Dharma Rajan, 2012. Fish and Fisheries in Vembanad Lake: Consolidated report of Vembanad Fish count 2008- 2011, pp 50. (pub. Community Environment Resource Centre (CERC), Ashoka Trust for Research in Ecology and the Environment (ATREE), Alappuzha, Kerala, India).http://www.vembanad.org/wp-content/themes/atree/docs/vfc_2008-2011.pdf.

HS: You earlier said that one motivation for this activity was that the data and information collected does not reach the people. What are you doing differently in this regard?

AMG: Let me give you an example. In 2012 we started *Jaladarpanam*, a community water quality monitoring programme. Once every month the fisherfolk measure water quality at various locations and the data are displayed on public display boards put up in eight locations. In April 2012 —this programme began in January—the people started noticing that the salinity wasn't coming through to the lake and level of pollution was

Participants of the Vembanad fish count

increasing, because the barrage was still closed. KM Poovu, the secretary of the Federation of Lake Protection Forums, took this data to the Alappuzha District Collector and demanded that the barrage be opened immediately.

PDR: There is a committee to decide on the operation of the barrage, which even has representatives from the fisherfolk. But the farmers are a more powerful lobby, and they manage to keep the barrage closed for longer than the agreed period. Every year the barrage is supposed to be closed only till March, but often it remains closed in April as well to suit the farmers' convenience. But once the fisherfolk had the data on the water quality in their hands, they felt empowered to go and protest before the collector and demand that the barrage be operated in a timely manner. We were surprised because we never thought that the local community will use the data to fight for their cause.

HS: Tell us more about the involvement of the fisherfolk in this whole project. What is their role in decision-making?

PDR: The fisherfolk are directly involved from the beginning. In fact they are the co-organisers of the fish count, through the *Kayal Samrakshana Samithys*, the Lake Protection Fora (LPF). These fora are independent grassroot democratic institutions that have come up for the conservation of the lake. We are trying to build an alternate model for conservation through these LPF. Conservation, usually, even under the guise of participatory management, is heavily top-down, where local communities don't have a voice in decision-making. Here we are trying a bottom-up approach: we organised the fisherfolk to use their traditional wisdom and observations, in partnership with scientists, to identify problems and even solutions. And the fisherfolk themselves implement these solutions. A good example is the fish sanctuaries established in Vembanad. We engaged the fisherfolk in a dialogue about the dwindling fish resources in the lake and asked them why it was happening. They said it is due to the reduction in mangroves around the lake. We then asked what we could do now. There was an idea from the community - earlier they were using a method called *padal* fishing, which was now banned. *Padal* refers to bundles of fresh foliage of plants like mango and cashew, which are placed in the lake. These *padals* create a plankton bloom which in turn attract a lot of fish, especially brooders. The fisherfolk suggested the use of these *padals* to create artificial sanctuaries for fishery, instead of using it for harvesting. An elderly fisherman came up with a design to prevent harvesting from these *padals*: a fence of bamboo poles around each *"padal"* such that nets cannot be cast on them. We first tried it with one sanctuary and asked fisheries scientists from St. Albert's college to evaluate it. But, even before their evaluation, we knew the fish sanctuary was a success because of the large presence of cormorants and otters around it. Today we have 13 such sanctuaries in Vembanad.

AMG: But this would not have been possible without the knowledge of the fisherfolk, about the breeding biology of the fishes, the best spots to place these *padals* with regard to depth and water flow, etc.

HS: Why did this not happen earlier? Why did it require your presence for it to happen?

PDR: We just facilitated a dialogue and collective thinking, which changed the scenario. In this

A 'fish sanctuary' setup in Vembanad lake

programme, we sometimes bring in some technical know-how, some scientific know-how, but the decisions, the identification of the problem and the solutions largely come from the community. We only facilitate this process. The reason I am so keen on this alternate model for conservation, what we call 'deliberative democratic conservation', is this: most conservation efforts are initiated by outside agencies - an NGO or the forest department - and most of the times they also act as the decision makers. In such a model, when the external agency is withdrawn the whole programme collapses. With what we are trying to do in Vembanad, even if ATREE withdraws, we hope that the momentum we have created will carry the programme forward in the future, that the people will continue with that effort on their own. Right now we do not claim that the whole community is aware of conservation, but at least some people have started discussing and thinking collectively about it. Some of them, like KM Poovu or Kailasan, who are fisherfolk from the area, are becoming champions of conservation. Poovu has even published a booklet on ethical fishing.

We believe that such an approach creates better ownership among people over the commons and is a better approach for governance of landscapes, especially heavily-used ones.

HS: Do you see the programme being on track to allow ATREE to withdraw soon?

PDR: I have already initiated a dialogue with my organisation! In our project proposal itself, we had mentioned that the CERC (Community Environment Resource Centre) set up to implement these activities should eventually be handed over to the community and ATREE should withdraw. It is seven years now, and I think it is time ATREE begins the process of gradual hand over. Before that happens some more capacity building is required: the community should be able to raise its own resources, properly manage the funds, make appropriate decisions, etc. These are the challenges we are trying to tackle now.

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Deepor beel: Entangled in a net of dangers

Banning fishing in the beel has not only affected the sustenance of the Keot fishing community in Guwahati but it is also threatening the beel's very existence.

"Posua botah", he said, "the wind is blowing from the west now so we cannot take you to the beel to show you how we catch fish. This wind cleans the water and we won't get fish. 'Bhatial botah', when the wind blows from the east, the water turns muddy and the fish come up to the surface to breathe. That's the best time to fish", he explained.

They know the beel like they know their body.

They are the '*Kewat*' (Keot in Assamese), a fishing community of more than 820 families from Keotpara in Azara. They are completely dependent on the Deepor beel for their sustenance. The beel gives them food and they look after her with sincere devotion.

With a perennial spread of about 10 km², which extends up to 40 km² during floods, Deepor Beel is Assam's lone Ramsar site, one of the largest wetlands of the Brahmaputra valley and the only major storage water basin for Guwahati's drainage. Till 2009, the beel was maintained by the State Fisheries Department. Then the state government declared the beel a bird sanctuary for the numerous migratory birds that visit annually and banned fishing. And just like that, the fishermen's lives went for a toss.

Sadly, while fishing is banned to protect the wetland, oil refinery, domestic and hospital waste is still being dumped, choking the wetland, killing fish and spoiling the very beel that the government is trying to protect.

Guwahati generates about 450 tonnes of waste everyday that finds its way to the periphery of the beel. Strangely, this garbage dump is home to one of the largest concentrations of the globally-endangered greater adjutant stork (*Leptoptilos dubius*).

The Guwahati oil refinery waste is directed through the Bharalu and Kalmoni rivers to the beel. The channels also carry other industrial and hospital waste. Official sources say that the release of sewage into the water might have caused the fall in oxygen levels resulting in the death of fishes

Earlier, fishing was enough to sustain the Kewat fisherfolk. Now, the situation is changing. Many have taken to other means to support themselves, including pig-rearing. The state government now plans to form a Deepor Beel Management and Development Authority to tackle issues related to the livelihoods of the Kewat commuity and conservation of biodiversity. This is a welcome step. Everyone dependent on the beel - be it fish, bird or man - is important and shouldn't be ignored. Finding the right balance is the key.

India Water Portal (IWP), an initiative supported by Arghyam, is a national knowledge portal for water set up by the National Knowledge Commission in 2006. It deals with issues that influence water or that are related to it such as climate change, sanitation and food security. IWP engages with local individuals and organisations all over India to highlight and provide critical analyses on water-related issues.

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