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*Current Conservation* carries the latest in research news from natural and social science facets of conservation, such as conservation biology, environmental history, anthropology, sociology, ecological economics and landscape ecology.

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Cover art **Mohith O**

At London Climate Action Week in June 2026, an event on adapting to extreme heat was cancelled due to the Met Office red warning for high temperatures. The irony was not lost on anyone. But this is our new reality as the world hurtles towards the first climate tipping point, with the widespread mortality of coral reefs underway, according to a 2025 report.

In this issue, amidst the impending sense of climate doom, Chaitanya Arjunwadkar offers surprising findings of coral reef resilience in the Andaman archipelago. Off the western coast of India, Rucha Karkarey highlights emerging tensions among traditional fishers, modern reef anglers, and spearfishers in the Lakshadweep islands, in response to market changes.

Cecylia Watrobska and Morena Mills share lessons on community-led resource management in Fiji. As a cautionary tale, Grace Orirana et al. show how similar well-intentioned projects in the Solomon Islands undermine Indigenous fisheries management and fail to address the main threats to biodiversity. Meanwhile, photographer Sarang Naik dazzles us with intriguing patterns and textures from Mumbai's intertidal zone.

In India's freshwater ecosystems, Steve Lockett sets out a roadmap for conserving the Critically Endangered hump-backed mahseer, and Anupama Sadasivan provides insights into how an annual fish count in Vembanad Lake snowballed into a conservation movement. We hope you enjoy this edition.

– **Devathi Parashuram**

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# HOW TO BUILD A CONSERVATION MOVEMENT

Author **Anupama Sadasivan**

Illustrator **Labonie Roy**

Nestled in the green heartland of Kerala, Vembanad Lake is a shimmering jewel of biodiversity and culture. Spanning over 230 square kilometres, this vast expanse of backwaters connects four districts—Kottayam, Alappuzha, Thrissur, and Ernakulam—forming the largest tropical wetland ecosystem on the southwest coast of India. Beyond its undeniable beauty, Vembanad is an ecological lifeline, sustaining countless communities, fishermen, and endemic species.

However, the lake is more than just a picturesque retreat. It is a Ramsar site, recognised for its environmental importance, and a hotspot of biodiversity that has inspired generations of writers, poets, and artists. Yet, in recent decades, rapid urbanisation, pollution, and unsustainable tourism have placed this fragile ecosystem at risk. Recognising the urgency of conservation, numerous organisations, researchers, and local communities have taken up the responsibility of preserving the lake's ecological balance.

My personal journey with Vembanad Lake's conservation efforts began through my mother, who served as the Chief Programme Coordinator at the Ashoka Trust for Research in Ecology and the Environment (ATREE) since 2006. Her dedication to conservation became my window into the world of environmental conservation.

This article recounts my experience with the first fish count initiated in Vembanad Lake, which was also my first fish count, and where I witnessed efforts to promote conservation through behavioural action plans.

## A teenage adventure with a purpose

It was 2008. As a teenager, I was more curious than ever, eager to understand my mother's world and be part of something meaningful. When I first heard about the Vembanad Fish Count being organised by ATREE, the idea instantly fascinated me. How do you count fish in an open lake? What does this count mean for conservation? These were some of the questions that swirled in my head.

The answer, I soon discovered, was simple yet deeply scientific. Fish counts involve systematically capturing fish using nets, identifying the species, recording their numbers, and releasing them back into the water. The data collected would provide insights into species diversity, population trends, and the overall health of the lake's ecosystem. The rationality of the idea inspired me to come up with a logo design for the event, which was quickly accepted and retained even today (a fish taking attendance of other fish).

After months of planning, community meetings, and mobilisation efforts, the day of the first fish count arrived. The energy was infectious as hundreds of participants—school students, academicians, researchers, local fishermen, villagers, NGOs, and conservationists—set out onto the water. The lake, in all its majestic vastness, was bustling with activity as boats fanned out across different regions.





Each team was composed of fishermen, volunteers, and scientists, ensuring a combination of traditional ecological knowledge and modern scientific methods. As our boats drifted into designated zones, divers descended into the water with nets, surfacing every few minutes with a fresh catch. Researchers meticulously documented each species, noting down details of size, weight, and external characteristics.

As the day unfolded, the thrill of discovery was tinged with an underlying concern. By dusk, the total count revealed 51 different species—a stark decline from the 156 species documented in the 1950s. The numbers told a clear story: Vembanad’s aquatic diversity was in trouble. The lake often called the ‘inland fish basket’ was being reduced to an ‘inland wastebasket’ instead!

I remember the mix of emotions that surged through me that evening. On one hand, we were exhilarated to have been part of a scientific expedition. On the other, we were confronted with the reality of ecological degradation.

### Ripple effect

That first fish count was more than just an academic exercise. It was a wake-up call. It illuminated the urgency of conservation efforts and underscored the importance of engaging local communities. The success of the initiative lay not just in collecting data but in mobilising people to act.

Over the years the fish count became an annual event, evolving into a powerful conservation tool. The involvement of fishermen, students, and researchers meant that ecological awareness seeped into the very fabric of the local community.

Each year, new volunteers joined the effort, eager to participate in what had now become both a tradition and a movement.

By 2024, the 17<sup>th</sup> edition of the fish count saw over 100 volunteers and experts from various fields. The latest results indicated a species count of 85, suggesting a slow but hopeful revival of biodiversity. However, the overall fish stock remained alarmingly low, and studies revealed that certain areas—where freshwater content was higher—had greater species diversity than others.

One of the major takeaways from these findings was the impact of human activities on fish diversity. Houseboat tourism, for example, had surged in popularity, bringing an economic boost but also introducing pollutants into the lake. Waste from houseboats and poorly managed sewage systems had altered the water quality, affecting fish populations.

Sustainable tourism policies became a central topic of discussion, highlighting the delicate balance between economic livelihood and environmental conservation. Could Vembanad sustain both its rich biodiversity and its thriving tourism industry? The answer was complex, but one thing was clear: unrestricted commercial activity posed a long-term risk.

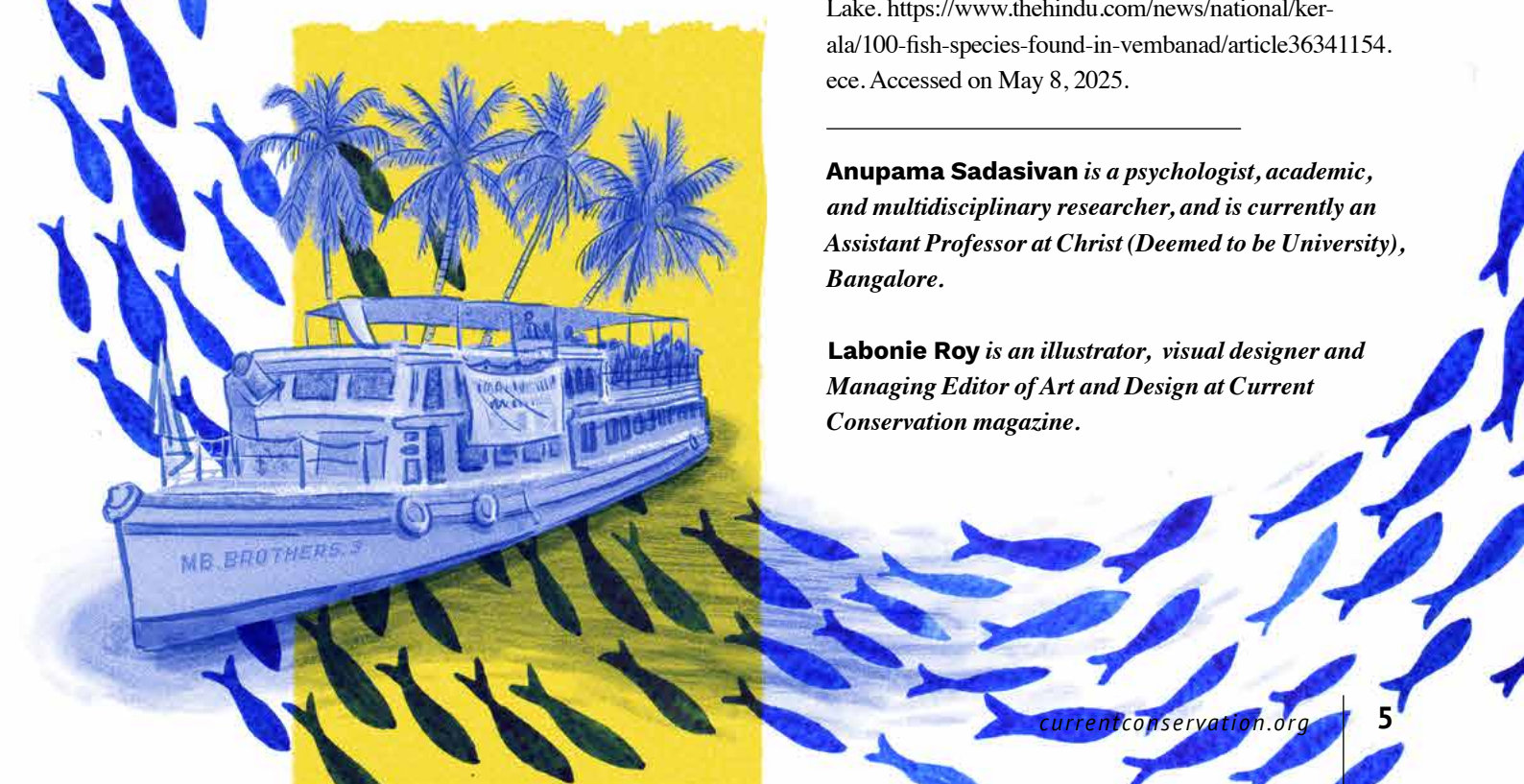
### Lessons from Vembanad

Nearly two decades later, it is heartening to know that the count continues. What started as a scientific experiment had grown into a model for community-led conservation. The initiative demonstrated that real change happens when people take ownership of their environment. Fishermen, once sceptical of conservation efforts, now actively participated in data collection, realising that the lake’s health was tied to their own survival.

For me, the fish count shaped not only my understanding of ecology and conservation but also my values and career path. Though I no longer work directly with the initiative, the experience influenced my journey as a behavioural scientist. I learned that sustained behavioural change requires community engagement, trust, and participation. Conservation is not just about protecting species—it’s about empowering people to be stewards of their environment.

Even now, when I visit Vembanad, I see the lake with a different perspective. It is no longer just a body of water—it is a living, breathing ecosystem, deeply intertwined with human lives, cultural heritage, and the fight for sustainability.

The Vembanad experience taught me three crucial lessons that continue to guide my thinking. First, conservation is a collective effort—no single organisation, scientist, or government body can single-handedly protect an ecosystem. Real change happens when communities take ownership.



Second, behavioural shifts drive long-term success—people protect what they feel connected to. The more engaged local communities are, the more successful conservation efforts become. Third, sustainability requires balance—economic growth and environmental conservation must go hand in hand. Policies that consider both are the key to long-term success.

As conservation efforts at Vembanad continue, I take solace in knowing that each fish count, each conversation, and each act of environmental stewardship contributes to a larger movement. The lake’s story is far from over, and future generations will write the next chapters.

For now, as I stand by the shimmering waters of Vembanad, I know that its legacy will endure—not just in the species that call it home but, in the hearts and minds of those who fight to protect it.

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# FIRST AMONG EQUALS

Author **Steve Lockett** | Illustrator **Karunya Baskar**

To be the largest of your kind should confer status. But does status itself bring increased awareness? Not when that animal lives its whole life below the water.

Known as the Mightiest Mahseer among a family of fishes collectively called ‘tigers of the river’, the hump-backed mahseer (*Tor remadevii*) is not only the largest species of the family, it is also the most highly threatened. This leviathan, weighing up to 55 kg, has a geographic range limited to the basin of the Cauvery river in South India—and that is part of the problem. The usual catalogue of issues affecting rivers in Asia adds to the species’ troubles, but there are some unique threats compounding the woes of this special fish.

## Cloud of confusion

It was only in 2018 that the species was indisputably named as *Tor remadevii*. For decades confusion reigned. Indeed, the fish that was initially called the hump-backed mahseer was not a mahseer at all. It was one of India’s large river carps: *Hypselobarbus mussullah*. And the fish of the Cauvery river basin has few features in common with the river carp of Maharashtra.

But a much greater number of people know about the hump-backed mahseer of Cauvery river than the giant carp of Ghod river, thanks to more than a century of anglers visiting the far south. Proud colonial era photos of huge individuals strung up on poles show the importance of this fish as a sporting trophy. Museums around the world hold dried skins and preserved specimens. At the Regional Museum of Natural

History in Mysore, there are hundreds of sets of the throat teeth of the hump-backed mahseer—relics of a time when all fish were taken to “prove” the skill of the angler.

Equally confusing is to identify different species using colour. Hump-backed mahseer are sometimes called “orange-fin-ned” but they can also be melanistic, while others have pinkish fins. A stress response in common with many other fish, the mahseer’s colours can quickly dull—depending upon water conditions and stress levels—appearing almost white. But we can be sure that of all the known photos and specimens collected from the Cauvery river system, all are hump-backed mahseer until recently.

Within my lifetime, the hump-backed mahseer has gone from “common” according to J. Juan Spillett’s 1966 Bombay Natural History Society survey, to a well-researched Critically Endangered status on the IUCN Red List. In the last four decades, an entire host of factors have conspired to pile pressure on this world-renowned species.





## Multiple threats

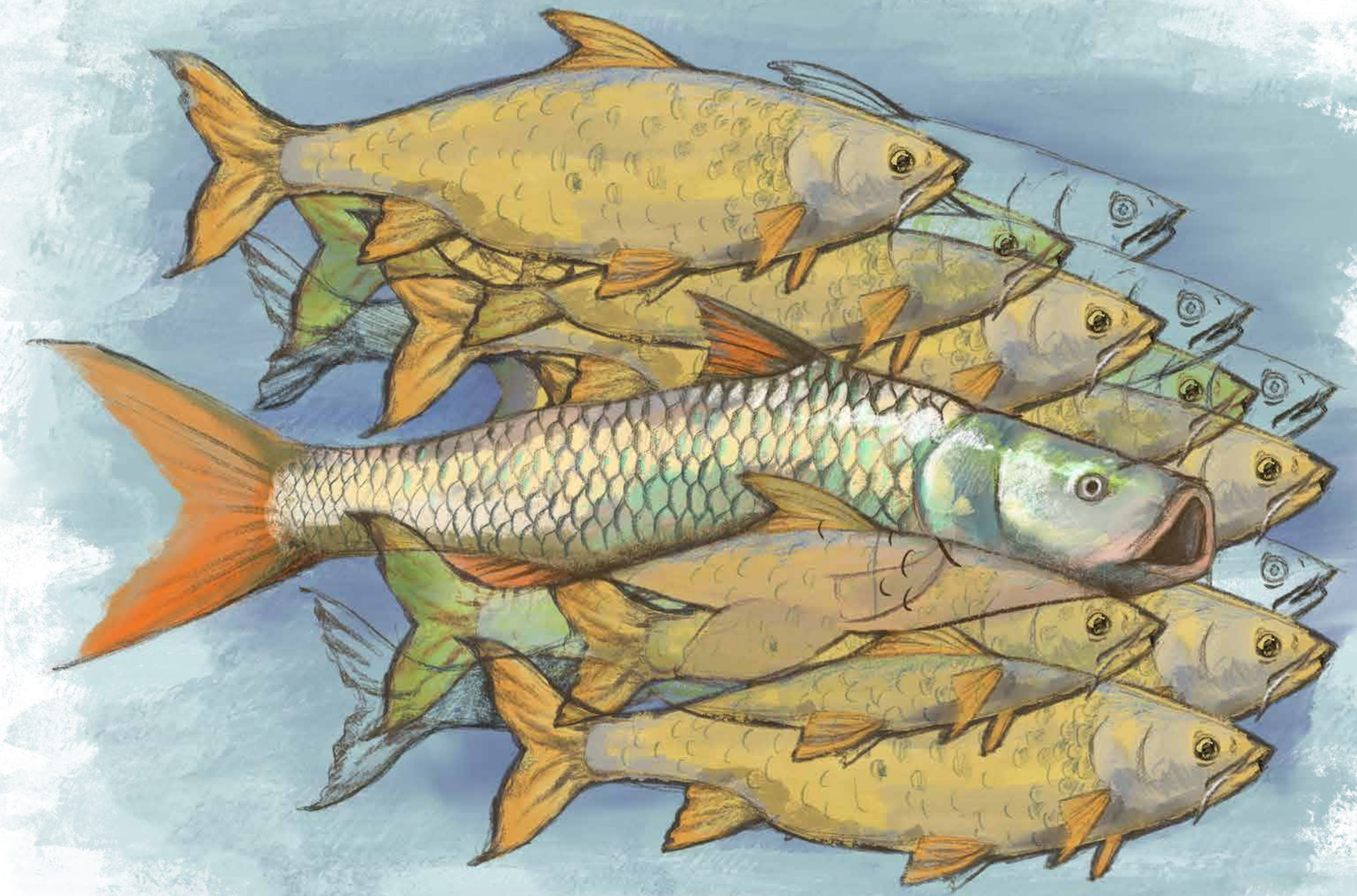
Invasive species have caused huge damage to ecosystems in India—not only plants, introduced animals have also brought increased competition for resources, as well as novel diseases. We know from history the range of problems that can be caused by invasives.

The translocation of the golden mahseer (*Tor putitora*) in the 1850s and 1870s likely played a lead role in the local extinction of an endemic fish in Bhimtal, Uttarakhand. Those translocated fish were later used in the development of a fish hatchery, and the descendants of the introduced golden mahseer are now spreading south, including into Kabini river—a prime territory of the hump-backed mahseer.

There are many who believe that to conserve a freshwater fish simply means to throw more of them into a river. And the ability to breed a threatened species in captivity is, of course, a very valuable strategy—a buffer against extinction risk. However, this approach needs to be part of a carefully considered plan because conservation is very different from farming. We also need to consider the impacts of habituation upon animals bred in captivity. How well are we equipping the animal to survive in the wild? Are the actions of those overseeing the early-life development of the animal helping or harming its longer-term survival once that animal is released into the wild?

Mahseer fish have to learn to hunt. During early life stages in the wild, juvenile mahseer will seek out insect larvae. Later, they start to ambush other fish and root out crabs. If, as has been the case, fish that are reared in a concrete tank are fed from a static block of vegetable matter, they will not be fit to survive in their natural habitat. They will also not have an innate fear of humans or other predators, which is a key survival tool.

From the mid-1970s, a programme began to stock mahseer into the Cauvery river and various tributaries. The stock population comprised Deccan mahseer (*Tor khudree*) from Maharashtra, commonly known as the black mahseer. But a large number of the introduced fish had brightly-coloured fins, and soon became known as the blue-finned mahseer. Indian scientists have now proven that all of the Deccan mahseer and their offspring found in the wild trace their origins back to a single hatchery near Pune. This presents a clear danger of genetic bottleneck: the loss of natural diversity because of inbreeding. Hybridisation between genetically-weak introduced stock and native mahseer, may let those inherited genetic “faults” become embedded in the native population.



## A matter of time

The fragmentation of rivers over the last hundred years is certainly one of the most damaging human actions. While most fingers will, rightly, point at dams, agricultural use is a major threat in the Cauvery. Multiple canals, drainage and irrigation ditches, and the huge and ancient *anicuts* (check dams) downstream have all drawn excessive amounts of water from the river.

The relentless growth of the human population throughout the river basin has pushed wildlife to the fringes. It is the same fate for endemic mahseers. They have had to escape to the hills and remote stretches of river. When the population of Bengaluru city doubled over 20 years starting from 1991, unexpected changes in climatic patterns were accompanied by a rise in demand for river water.

The years 1998, 2001, 2002, and 2003 are blips on charts—outliers on long-term trends and short-term norms—for being dryer and hotter in the Cauvery basin. What we do not know with any degree of accuracy is how these unusual years may have impacted the

ability of hump-backed mahseer to spawn successfully. Conventional wisdom suggests that mahseers move into tributaries during high water, to spawn in gravel. But this may not be the whole story. While there are mahseers of other species found in spawning condition or seen rolling on gravel during low water conditions, we must not discount other reproduction strategies. If we take the spawning in tributaries argument, then hotter and dryer years may have restricted access to suitable gravel beds.



One thing we do know is that in Cauvery Wildlife Sanctuary, where meticulous angling records were kept over many years, hump-backed mahseer numbers crashed in 2004/5 and the numbers of introduced Deccan mahseer exploded. The hump-back population became older and there were precious few young fish caught, apart from the introduced species. The fish had survived previous droughts, like the Great Famine of 1876 to 1878. The human response to that suffering was to play a part in the eventual downfall of the hump-backed mahseer when huge dams were built. How humans operate dams during periods of extreme weather affects species. Sudden, unseasonal releases of water can wash away fertilised eggs or juvenile fish. Holding back water during drought will result in fragmentation of channels used by the fish to access spawning grounds. Indeed, fish may simply run out of water for all of their ecological needs.

But the irony is that dams have also allowed a few hump-backed mahseer to survive in isolation. Those fish of the hills hide behind concrete and are safe from introductions of other mahseer species downstream. For now.

### Conservation plans

To paraphrase M. Krishnan: to save tigers, you have to know how many deer there are. For the hump-backed mahseer, the first conservation step is to study aquatic insects, freshwater crabs, and smaller fish species, and to map riparian fruiting trees.

There is no one-size-fits-all solution because there are conflicting reasons for wanting to conserve the fish, other aquatic life, or the river itself. Why do local people want to protect the hump-backed mahseer? We have worked with Adivasi groups who worship the species, while others conserve the fish and river for economic gain through ticket sales for recreational, catch-and-release angling. There are also others, including Indigenous Peoples inside protected forest areas, who rely on the fish as a food source.

We must be respectful of this range of needs, in particular if a part of the conservation plan is to halt access to this resource. A recent academic paper showed that fish across a wide range of species in the Yangtze river had recovered thanks to a strict ban on fishing. The ban and firm enforcement had been accompanied by a well-funded employment scheme to allow impacted fishers to survive without their livelihood. This kind of governmental input could be considered at the river basin scale in India. But there are inherent problems due to inter-state tensions and inter-departmental conflicts. Less remarked upon from this Chinese study is that the fishing ban was accompanied

by wider, habitat-level actions. Both in the water and along the riparian buffer, ecosystem function was improved.

### Science and traditional knowledge

Conservation is easier than restoration, so we need to ensure no further decline in numbers. But to demonstrate conservation success, we also expect to see increased fish numbers in a healthier river. Developing monitoring protocols that include the study of relationships between native mahseers, other fish, and invertebrates, will inform us of potential bottlenecks.

There has to be a habitat-level understanding, if the National Biodiversity Targets are to be met. The use of environmental, or e-DNA, is increasing and its accuracy improving. This non-intrusive sampling technique can give quick insights into whole species populations within a river. To increase understanding of interactions between riparian habitats and riverine species, we could also explore stable isotope testing in India. An agreement between Bournemouth University, UK, and the Kerala University of Fisheries and Ocean Studies is introducing knowledge-sharing approaches across multiple novel technologies. Ancient, or a-DNA, means that those museum specimens can shed new light on species integrity and population changes.

There are parts of the hump-backed mahseer's domain lying just beyond the protection of government notification. Those places offer hope. Rivers running through protected landscapes are still vulnerable to pollution from upstream, or even from inside a protected area. Where humans engage deeply with their landscapes, they are in tune with the moods of the rivers and streams. Community protection has proven to be effective in parts of the Cauvery basin,

including in Kodagu and Wayanad, and ecological monitoring is an area where locals can be employed. This will be a double win if poachers can become gamekeepers. Age-old wisdom offers clues for how and where to target efforts; we can *then* deploy modern technologies.

### Forging ahead

For a little over seven years, the Mahseer Trust has been working to build a coalition in support of a conservation plan for the hump-backed mahseer. There have been issues along the way and some false starts. But now we have interest from local communities, special interest NGOs, and government departments at both state and centre-level. The time seems right to push for a new way of protecting freshwater and this umbrella species.

A soft touch combined with a deeper understanding of the fish's ecological needs is where we are heading. Left to their own devices, fish and rivers both will sustain themselves. So: hands off, let those who are allowing them space continue to do so; let others follow their lead. The more room we give to hump-backed mahseers, the better their chances to recruit and thrive.



While we and those we work with consider *Tor remadevii* to be an umbrella species, there is merit in seeing it as a flagship species. Like the tiger of the forest, the tiger of the river is but a crucial part of a fragile habitat whole. We must focus on the habitat if we are to conserve the last few of these majestic fish and all of the other life sharing those rivers. There is still a long way to go, but it is made easier by forging strong partnerships. We can be sure that throwing even Critically Endangered fish species into a river solves nothing, but extending viable habitat gives them a chance.

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# Lessons on community-led marine management from Fiji

Authors **Cecylia Watrobska and Morena Mills** | *Illustrator David Yambem*

Healthy seas and oceans are fundamental to our survival—providing food and livelihoods, absorbing carbon, and regulating the water cycle. Working to protect them is therefore essential, as is understanding the impacts of different resource management initiatives on these vital marine ecosystems and the local people who rely on them.

Locally Managed Marine Areas (LMMA) are Indigenous-led marine management initiatives that have spread rapidly over the past two decades and are now present in almost 1,000 communities across 15 countries. Local communities create plans and set fishing rules to support their fishing needs, alongside recovery of the ecosystem. In Fiji, support and guidance for these areas is coordinated under the Fiji Locally Managed Marine Areas (FLMMA) network. Participation in the network is voluntary and decided by the community. This raises the question—why do some villages join the network while others don't? And what are the effects of participation on communities and ecosystems?

This is what our research set out to uncover. We wanted to understand what motivates villages to engage and what impacts participating in the network has on them. This understanding is important for designing future initiatives that are both positive for the community and the environment, and likely to have widespread adoption and impact. And so, we spoke with people in 146 coastal villages in Fiji who were or weren't engaged in the FLMMA network.

## Common denominator

Villages that participated in the network shared certain characteristics. For example, nearly three-quarters of engaged villages had a neighbouring village that had also engaged, highlighting that word of mouth and learning from each other may be an important factor in helping initiatives to spread. Villages who had support from organisations such as NGOs or had a resource management committee at the district level (*yaubula*) were also more likely to engage. These structures may help sustain initiatives through facilitating local stewardship and formalising management.

Interestingly, villages that engaged with the FLMMA network were also further away from tourist resorts and were more likely to be associated with Indigenous groups of greater influence. This could reflect the way in which NGOs select villages to partner with, alongside other livelihood opportunities available to villages in tourist hotspots.

## Local benefits

We found that villages who engaged with the FLMMA network had greater participation when it came to decisions about fishing rules and took greater ownership over management of resources. For example, they were more likely to have fishing rules in place and enforce penalties for breaking them. FLMMA villages also reported increased financial support, for instance, through investment in infrastructure, and an increase in perceived knowledge about marine resources, particularly among women and youth.

However, we found no effect of participation on perceived ecological health of the reefs, on fish catch, food security, or on village or household wealth. So, while resource governance is improving, these aren't necessarily being translated into desired long-term outcomes.

Interestingly, participation of women has multiple benefits yet is generally low. Villages where women participated in decision-making about fishing areas reported catching more fish, greater satisfaction with food from the sea, and greater household wealth compared to villages with lower numbers of participating women. Although women often felt excluded from management committees, the value of their input was recognised within the community.

Conservation initiatives must respond to the needs of communities, while collaboratively protecting and restoring natural resources. The FLMMA network shows us that communities are willing to engage when the right support is in place. However, there is still room for improvement—programmes can work better if they are more inclusive, and more robust data are needed to effectively assess long-term effects on people and nature.

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**Cecylia Watrobska** is a biologist interested in how human actions are affecting biodiversity. She enjoys communicating science to different audiences.

**Morena Mills** is an environmental social scientist at Imperial College London, researching how conservation scales, and how this impacts people and nature.

**David Yambem** is an illustrator and animator from Kakching, Manipur. He is also a plant lover and passionate cook, and truly enjoys the great outdoors, often setting off on hikes and runs.





# THE MIGHTY FISH

Author **Rucha Karkarey** | Illustrator **Mohith O**

Nearly a century ago, eight fishers from Bitra rowed out to Veliyapani. At a shallow channel where the sandy lagoon poured into the sea, they spotted three turtles swimming toward a large boulder, nearly the size of their boat. With harpoons in hand, they watched intently, waiting for the turtles to resurface for air, but they never did. To their astonishment, the boulder stirred; it was not a boulder but a massive, speckled grouper adjusting itself on the sandy bottom. “The grouper could feed the islanders for an entire month,” they thought. It took the strength of all eight men to haul the beast aboard. On gutting the fish, they found the very turtles they had set out to hunt—a double win!

Challakad Bitra chronicles this legendary tale in *Pullichamam: Maha matsya* (spotted grouper: a mighty fish). A resident of Bitra—the smallest fishing community in Lakshadweep, an archipelago of low coral atolls off the southwest coast of mainland India—he offers a glimpse into the lives of old fishers in his novel *Odukkadhakal* (stories of the *odum*<sup>1</sup>), recounting their heroic hunts and travels. These stories depict fishing traditions that predate the arrival of commercial tuna fishing in 1960, which pushed fishers from their familial nearshore waters into the open sea. In Lakshadweep’s folklore, groupers are revered creatures—sentinels of the sea, making men of those who dared catch them.

## What was it afraid of?

On a recent dive in Bitra, a large grouper darted across my view, scattering coral shrubbery in its wake. “What was it afraid of?” I wondered. I continued swimming along the contour of the reef while counting squaretail groupers that had migrated there to spawn. The panic was palpable. Around me, more male squaretails scattered in frantic alarm. Females made a feeble attempt to seek cover from me, their bellies too swollen with eggs for an urgent response.

A year ago, this wasn’t the case—the squaretails when engaged in their feverish courtship, barely noticed my presence. They’d let me approach within arm’s reach, while I took notes about their sex lives on my slate. This year they were noticeably skittish. And it soon became clear why. Above us an engine revved, as a boat pulled up above the site. A small band of fishers dropped like shrapnel into the water. A breath was taken, and a skin diver drew close with a speargun in hand. Before I could react, the large squaretail I was observing was impaled on his speargun.

For the past decade, I’ve been studying the ecology of spawning aggregations of squaretail groupers (*Plectropomus areolatus*) in the reefs of Lakshadweep. These aggregations are extravagant displays of fish behaviour. Each year, when it’s time to spawn, adult fish leave their territories and travel kilometres across the reef to converge at a single location, drawn by a primal urge. Under the shroud of a waning moon, these chosen sites spring to life, as predictably as clockwork.

Year after year, I return with the squaretails, tallying them as they journey to spawn, noting their sizes, sexes, and peculiar mating rituals. By tracking trends in their numbers and differences in behaviour, I can keep a pulse on population health and detect subtle signs of distress. Back in 2013, when I first scoped out this aggregation site for my PhD research, it was a sight to behold—1,200 squaretail groupers milling in an area as vast as a hockey field. But over time, things have changed.

<sup>1</sup> A traditional wooden row boat of Lakshadweep

# MAHAMATSYA



The site that once teemed with life sprawled before me, now a desolate expanse. Squaretail numbers had dwindled. Mighty bucks no longer guarded reef territories. Females no longer roamed in grand processions.

Eighty years after Challakad Bitra's story, the currents of change are sweeping through island fisheries again, beckoning fishers back to reefs from the open seas. Their gaze is set on prized reef dwellers like groupers, destined for mainland markets. The quest for bounty, largeness, and top predator—hallmarks of an unbridled fishery—has already left an indelible mark on the itinerant squaretails. As I observed their meek, flighty demeanour, I couldn't help but question their fabled status: what tales would be written about Lakshadweep's groupers today?

### “Groupers are attracted to the eyes”

One of the fishers in the *Pullichammam* story was Nallakoya's father. Nallakoya fishes like his father did before the arrival of the tuna fishery, reading signs in the weather, tracing constellations and trusting the moods of the sea to guide him. We were anchored at the lagoon entrance, when he narrated *Parava mala*, a Jeseri<sup>2</sup>-Arabic ode to the flying fish—an open water fish, traditionally used as bait. Following the ode's instructions, he divided a flying fish into seven parts and, without wasting a piece, caught six small paddletail snappers.

**“Groupers are attracted to the eyes,” he said, as he dropped the head of the flying fish into the water. We waited patiently for an hour before there was a familiar tug at his fishing line. Nallakoya had the sea in him, people said—a god-gifted instinct to fish. He scorned the modern anglers who used yellow snappers caught in the lagoon as bait. The practice of chumming the waters with live yellow snappers was a technique borrowed from the tuna fishery, its practitioners now redirecting their focus towards the reef. “It’s reckless,” he muttered, his tone tinged with disapproval. “Yellow snappers often slip away while groupers close in. Harvesting many live yellow snappers for one grouper is wasteful, when all that is truly needed is a fish head with eyes.”**

Near the lagoon crest, I observed another traditional form of reef fishing: a group of elderly fishers hauled an *olavadal*—a traditional fishing net—into their boat. As it was pulled up, a chain of coconut leaves rustled, concealing a sly gill net beneath. “The whispering of those leaves underwater lures the fish. But unlike the modern fishers, we don’t rob them of their lives, we allow them to sacrifice themselves, and only those who are ready do,” he said, explaining the difference between ‘active’ and ‘passive’ fishing styles of the modern and traditional fishers. With every heave of the *olavadal*, large parrotfish, vital herbivores in coral reef ecosystems, spilled onto the floor, along with a few gravid squaretails that had ‘sacrificed’ themselves.

Wastefulness has been a growing point of conflict between traditional fishers like Nallakoya and younger modern reef fishers in Lakshadweep. I met some of the modern fishers just days earlier, resurfacing from a solemn dive amid a small flotilla of *thonis*<sup>3</sup>. Each *thoni* was manned by a single fisher that followed their free diving partner around in the water. Curious, I chatted with a pair of them during a surface interval between dives. The team had ‘trolled’ from the lagoon entrance; i.e., the boats had slowly tugged a snorkeler behind them to observe the reef underneath, pausing to explore promising fishing spots, before moving on. As we were speaking, I watched a squaretail emerge out of the water writhing on the blade of a speargun. Within half an hour, six others joined its lifeless body by our feet in the *thoni*. Eight months ago, the young fishers had wielded their first spearguns. But now, they did this job full-time.



The young spearfishers referred to themselves as the *kadalk-kollakkaar*, pirates of the sea. They had recently run into opposition from the traditional fishers in Bitra, who had deemed their practice destructive and took official action against them. “By law, the reefs are communal grounds, are they not? We are fishers too and should be allowed to fish anywhere,” the spearfishers had said when we met. Their words got to the nub of another point of conflict: reefs as commons. The reefs belonged to no one, yet belonged to each and every one, all at once. They were a shared heritage where generations past and present were now colliding.

Ever since this conflagration, the spearfishers felt slandered and chose to operate discreetly in uninhabited atolls like Veliyapani, or under the cover of night. “No one acknowledges the wastefulness of traditional fishing practices. Those nets catch everything in sight. Even the fish that no one eats,” they lamented. “Worse still, the nets can damage coral,” they continued. “We only take what we need, leaving the reef undisturbed,” they assured me. The crew were heading next to Veliyapani with a commercial fish-collection boat from the mainland. I wondered if they’d chance upon an aggregation site there. We exchanged numbers.

### Shared knowledge

In my research, I find myself compelled to chronicle the unfolding narrative of the reef fishery in Lakshadweep, as the appetite for these fish from mainland India surges. I find myself especially intrigued by the local wisdom surrounding reef fish within these fishing communities.

**The fishers with whom I’ve engaged appear to be coalescing into three discernible fishing groups: the traditionalists, a thinning bunch, who inherit their methods from ancestral wisdom; the modern reef anglers, attuned to the rhythms of the open sea, adapting methods from the tuna fishery; and the spearfishers, a recent addition, acquiring their knowledge through the endless seas of social media. Each group of fishers has their own distinctive blueprint of the reef, with each establishing their own footprint on the waters too.**

<sup>2</sup> Jeseri is a dialect of Malayalam spoken in Lakshadweep

<sup>3</sup> A two-person, wooden fishing boat in Lakshadweep, fitted with an outboard motor







Nallakoya and the traditionalists held sacred the select locations that aligned with enduring geomorphic features of the atoll, such as *chaal*, the lagoon entrance; *kona*, a reef promontory; *pitti*, a sandpit; *bettikedi*, the deeper waters of the lagoon. Each site bore a unique name, known to kin, perpetuated through tales like *Pullichammam*, chronicling their ancestral exploits. While the traditionalists remained loyal to certain locations, modern anglers and spearfishers were less discerning. Their sites were marked as nameless Northings and Eastings on handheld GPS devices, exchanged openly and traversed by all.

Limited by where they fished, the traditionalists felt the pinch, perceiving the biggest changes in their fish catches. “We know exactly when they’ve been here,” Nallakoya remarked, alluding to the nocturnal anglers whose flashlight-lit pursuits disrupt the sleep cycles of fish. “The fish, they cease their biting.”

**In my conversations with the fishers of Lakshadweep, I sense a melancholic parting of paths. Fathers, sons, uncles, and nephews cling to their own fishing ethos, rarely engaging in mutual dialogue. Were they to do so, they’d see how they sculpt each other’s access to the shared reservoirs of resources. Each carries within them jewels of wisdom, offering pathways to sustainable stewardship of the sea.**

I pondered the interplay between this old and new local wisdom and my own scientific understanding of the squaretail groupers, contemplating where these three realms might intersect. I had shared my insights on fish spawning aggregations with Nallakoya and the spearfishers, clarifying a distinction between groupers and tunas, which was a common misunderstanding. While tunas were social creatures, always living in large shoals, groupers were solitary, only gathering sporadically to spawn. This made spawning groupers particularly vulnerable to fishing.

“We didn’t know these fish were laying eggs,” the young fishers had said in response. Nallakoya seemed surprised to hear that some of the square-tails I had examined were over 10 years old. I saw gaps emerging in our collective understanding of seasonality and breeding biology of these fish in the islands. Gaps I earnestly believed were crucial to fill together, to effectively conserve these magnificent fish. A few days later, my phone buzzed. A stream of photos of brown marbled groupers popped up on my screen. The spearfishers had stumbled upon another grouper aggregation

site in Veliyapani. I showed it to Nallakoya. He said it was close to the spot where Challakad Bitra had located his story.

### “Just like a fish laundry”

In *Pullichammam*, the grouper is dissected into 640 morsels, each salted and sun-dried, feeding fisher families for a month. Even its sturdy bones find new purpose, fashioned into knives to serve the fishers again. In 2022, after the weary veil of the COVID-19 pandemic had lifted, we strolled along Bitra’s shoreline in the gentle afternoon glow. We saw two familiar faces scaling a bounty of fish. Behind them, fishing lines were strung between wooden poles, where a solitary figure meticulously hung filleted fish to dry. “Like a fish laundry,” my colleague joked, as we watched them billow in the breeze.

Trade with the mainland had ceased for months. In response to the economic hardship facing the community, the Bitra panchayat<sup>4</sup> initiated a bold effort to revive an ancient tradition: drying reef fish. Once a monsoon staple, the practice preserved both flavour and nutrients. Bitra, spared from rats and crows, had long led this enterprise, supplying dried fish to neighbouring islands. Such practices predated the rise of the pelagic tuna fishery in the 1960s, which later came to dominate the production and post-harvest fisheries landscape. As I walked along the lines, my gaze fell on rows of squaretails, their once-nimble forms now softly putrefying in the tropical heat.

My colleagues busied themselves, packing boxes of dried fish to take home. In the tumultuous wake of the pandemic, as the world grappled with uncertainty, Bitra stayed afloat. The homecoming of spawning fish served as a beacon of hope.

At my desk, a map of Lakshadweep glows softly on my screen. It is adorned with a constellation of coloured dots that mark spawning grounds I’ve now monitored through underwater surveys, and promising locations suggested by fishers that are awaiting further exploration. With each turn of the season, new aggregation sites are being discovered as the fishery extends its grasp. These spawning sites, brimming with their promise of new life, can become crucial lifelines for island fisheries. Their temporal and location-specificity make management efforts concentrated, with benefits to the fishers and the ecosystem permeating far and wide, beyond the confines of the spawning arena.

In distant corners of the globe, spawning grounds have found guardianship under the aegis of the state or the stewardship of local communities. Across the Pacific and Caribbean seas, degraded spawning sites have even experienced a revival with minimal intervention—be it a sporadic fishing moratorium, modest catch limitations, or a communal rotation in harvest responsibilities—offering us glimmers of hope.

**However, Nallakoya, the spearfishers, and I are bound together by a shared sense of foreboding. In the absence of urgent and concerted management endeavours, the groupers of Lakshadweep teeter on the brink of a perilous fate. A decade’s worth of tallies of squaretails on my spreadsheet reveals a disquieting downward trend. Spearfishers now find themselves stretching their breaths to capture fewer and more elusive fish within their shooting range, while Nallakoya lingers longer on his boat, amid a sea that seems emptier by the day. Meanwhile, the clamour for groupers from distant shores swells ever louder.**

Will the fishers rally together to save the Maha Matsya of their lore? I find myself reflecting on Nallakoya’s words on that tranquil day in the lagoon. There is a difference, he said, between theft and sacrifice. Each leaves a distinct signature on the sea. I think I dimly see the difference, but I’m not quite sure. I often find myself transported back to that moment when I stood utterly spellbound, beholding my first encounter with the square-tail grouper spawning aggregation in the waters of Bitra. Amidst the hustle and bustle at the aggregation site, one male squaretail stood out—a titan amongst his kind, a squaretail grouper of formidable stature who captured

my gaze and held it in awe. He staked his territory on the fringes of the site, near a weathered coral boulder nestled in the sand, much like the Maha Matsya. He allowed me to approach within arm’s reach, our gazes locked in a silent exchange, before carrying on with his spawning rituals.

For several years, I saw him in the same spot, and together we forged an unspoken connection in his frenetic world. With each passing year, he looked more weathered, progressively accumulating more battle scars on his body. Then, one year, he appeared with a hook in his lip. He wore it like a trophy. A battle was won, but he was tethered now to our world. The following year, I was in the water when a spearfisher swam down to the reef and speared him through the head, rising to the surface with his writhing body. Was he taken or did he use his agency to surrender to the fisher?

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**Rucha Karkarey is an interdisciplinary tropical marine scientist studying the ecology and conservation of coral reefs in the Indian Ocean.**

**Mohith O is an architect-turned-illustrator from Kerala known for his distinctive work in film title animations, book covers, editorial illustrations, and comics.**



<sup>4</sup> A local governing council elected by the people of a village



# SEA THROUGH YOUR LENS

## — REEF PHOTOGRAPHY CONTEST —

Author **Samar Ahmad**

In November, Andaman Nicobar Environment Team (ANET) and Dakshin Foundation organised the Reef Festival 2025 in the Andaman Islands. This event brought together over 300 island residents, divers, fisherfolk, children, researchers, and government officials across three days of celebration in Havelock, Wandoor, and Sri Vijaya Puram. It celebrated the extraordinary reefs and marine heritage of the Andaman and Nicobar Islands, while centring the communities that live alongside and sustain these ecosystems.

Alongside exhibitions, cultural performances, and conversations on marine conservation, the festival hosted Sea Through Your Lens, a photography competition inviting participants to capture their personal encounters with the islands’ reefs and coasts. The competition was judged by celebrated wildlife photographer, Dhritiman Mukherjee.

The winning images speak a language of their own. Together, they offer intimate, arresting perspectives on the marine ecosystems that surround and sustain the Andaman Islands, and remind us why they are worth celebrating.

1<sup>ST</sup> PRIZE WINNER



Diving off Radhanagar Beach, Havelock Island, with near-zero visibility, my buddy and I set out hoping to find a sea turtle. Instead, we stumbled upon something equally mesmerising—a Cowtail Stingray resting on the sandy seafloor. The moment it sensed our presence, a single gentle flap of its wings sent cascading plumes of sand billowing into the water column, transforming the murky blue into swirling, dreamlike clouds. What began as a chance encounter became a reminder that the ocean always has its own story to tell.

**Anand Sekar** is an underwater photographer and dive instructor based in the Andaman Islands, who chases light through coral, salt, and silence—camera in hand.

2<sup>ND</sup> PRIZE WINNER



I was assisting Master Dickson (Shifu) on a fun dive. This was our second dive that morning at Juvie’s, Havelock Island. As we descended, about 10 minutes in, Shifu signals to me that he’s seen a green turtle. These were my initial days of underwater photography (during my dive master training) and I was thrilled to capture the turtle.

I observed the green turtle for two whole minutes, saw him go up to the surface to catch a breath and come down to spend another good 6–7 minutes. He was munching on corals, and I’d like to believe he came back to have breakfast while we gave him company.

**Pallavi Shankar** is an architect, designer, and Dive Master based in the Andaman Islands, who explores the intersections of art, design, and the human experience.



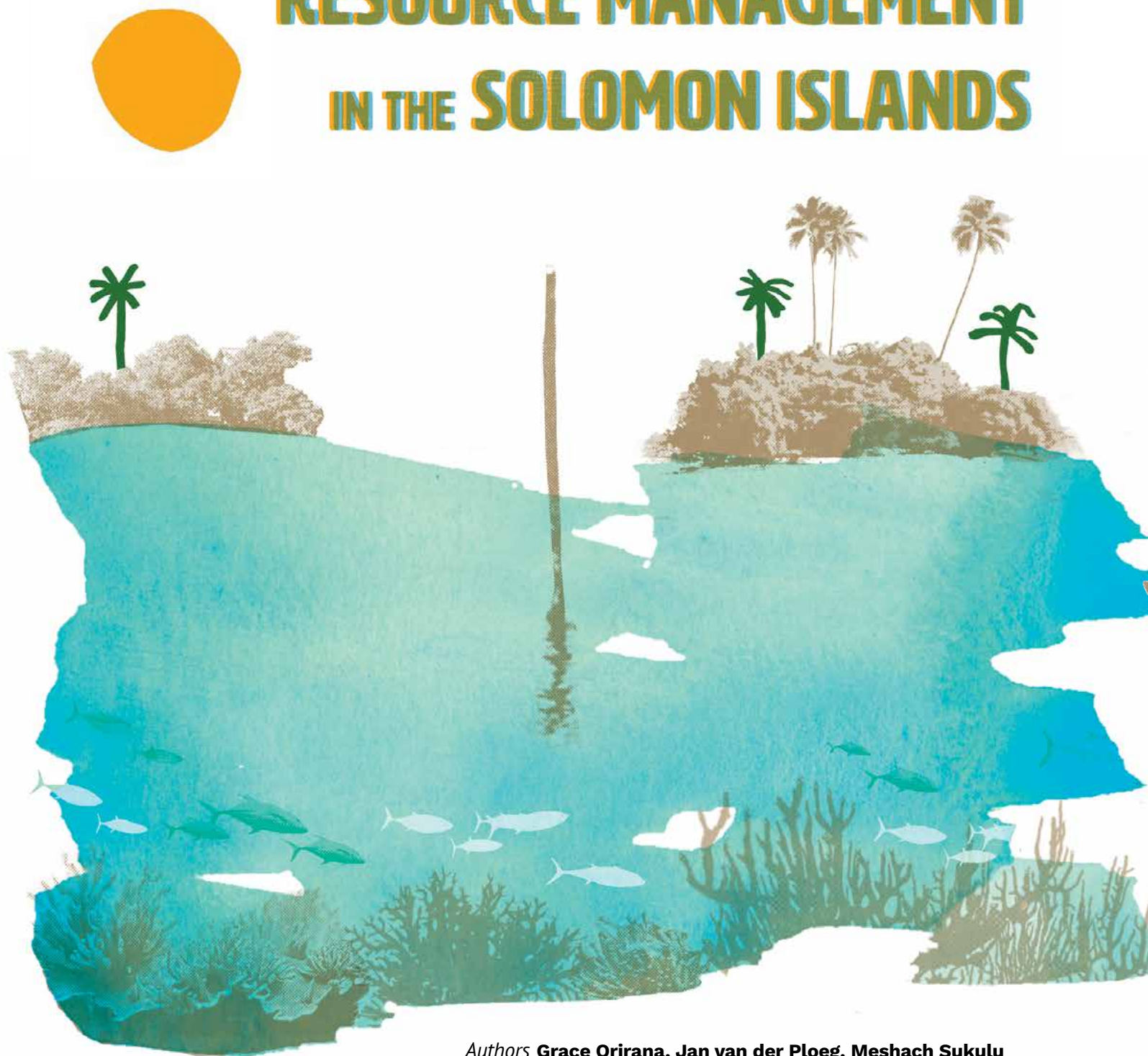
As a naturalist, I believe our role is to mediate the relationship between humans and the wild. This lionfish was not looking for a conflict; it was simply waiting for the tide to turn. Whether native or invasive, every fish carries the history of the ocean in its scales. When we walk the intertidal zones of Havelock, we are guests in their environment. By moving slowly and looking closely, we realise that this “dangerous” neighbour is a silent witness to our journey, deserving of its place in the sea.

**Prathamesh Khedwan** is a marine enthusiast, wildlife photographer, and Senior Naturalist in the Andaman & Nicobar Islands, who explores the hidden worlds of the intertidal through macro photography.

3<sup>RD</sup> PRIZE WINNER



# RETHINKING COMMUNITY-BASED RESOURCE MANAGEMENT IN THE SOLOMON ISLANDS



Authors **Grace Orirana, Jan van der Ploeg, Meshach Sukulu  
and Hugh Govan** | *Illustrator Hitesh Sonar*

Since time immemorial, Pacific Islanders have managed their coastal fisheries by proclaiming a *tabu*—a ban on fishing in a specific area. A stick on the reef or in the mangroves would signal that fishing was prohibited. Nobody would dare to break such a *tabu*, afraid of the ancestors and spirits that guarded the area. When the time was right, the *tabu* was lifted and people could harvest fish, shells, and crabs again.

In an influential article published in 2002, marine ecologist Bob Johannes described how coastal communities throughout the southwest Pacific, faced with growing resource scarcity, were reinstating such *tabus*. Fishers were once again actively protecting the marine resources on which they depend for food and income. In Vanuatu, villages temporarily closed their fishery to allow for the recovery of trochus shells. In Fiji, communities banned the use of gillnets, and in the Cook Islands, the chiefs prohibited the hunting of undersized turtles. For Bob Johannes this “renaissance of community-based marine resource management” was a gamechanger: an Indigenous environmental movement that was reversing the rapid loss of biodiversity and cultural heritage in the region.

Since then scientists, conservationists, and policymakers see community-based resource management as a solution to address the intertwined problems of rural poverty and biodiversity loss in the Pacific—an effective and low-cost alternative to fisheries development projects and marine protected areas. The Solomon Islands government, for example, identified community-based resource management as the national strategy to protect marine ecosystems and sustain food security, and passed legislation to formalise so-called ‘community fisheries management plans’. This is based on the pragmatic recognition that the reefs and mangroves in the archipelago are communally owned and that the government has limited capacity to provide public services in remote areas.

International conservation organisations such as WWF, The Nature Conservancy (TNC), Conservation International (CI), IUCN, and Wildlife Conservation Society (WCS) support fishing communities to draft such plans, thereby creating so-called ‘locally-managed marine areas’ (LMMAs). This has led to notable success stories, such as the declaration of the Arnavon Community Marine Park on Isabel and the protection of Tetepare Island in Western Province.

It is, however, becoming increasingly clear that these grassroots conservation efforts remain relatively small in size. It is estimated that over

the past 25 years perhaps 200 villages in the Solomon Islands have worked with international conservation NGOs to protect approximately 1,000 km<sup>2</sup> of coral reefs, seagrass meadows, and mangroves. That seems an impressive figure, but is in fact a fraction of the more than 3,000 coastal villages and the 30,000 km<sup>2</sup> inshore fishing area in the archipelago, and is still far removed from the global target to protect 30 percent of the ocean by 2030. Perhaps even more problematic is that the few villages that are managing their marine resources struggle to sustain these efforts over time. Many community fisheries management plans are abandoned when the external financial support ends.

In a recent article in the journal *Conservation Science & Practice*, we describe how international conservation NGOs are trying to initiate and scale community-based resource management in the Solomon Islands. But our research shows that these well-intended marine conservation projects actually undermine Indigenous fisheries management, and fail to address the main threats to marine biodiversity.

## Cosmetic participation

Over the past 20 years, international conservation NGOs have implemented numerous community-based resource management projects in the Solomon Islands, funded by international donors such as USAID, the European Union, and the Asian Development Bank. In theory, these organisations facilitate a participatory process that empowers communities to manage their coastal fisheries. But in practice, these marine conservation projects are mainly driven by the NGOs, with little meaningful engagement of fishers. This illusory form of participation becomes painfully clear in efforts to ‘educate’ people on the importance of



marine biodiversity. In most cases this consists of a top-down flow of information full of technocratic and legalistic jargon, far removed from the daily lives, experiences, and knowledge of fishers.

A typical project begins with the organisation of a series of workshops in the village, in which people analyse their problems and collectively draft a community fisheries management plan. In most cases these plans focus on the creation of a no-take zone where fishing is prohibited—in effect a small marine protected area. NGOs then invest in so-called ‘alternative livelihoods’. These income-generating activities are meant to alleviate poverty and replace environmentally damaging activities with more sustainable ones. For example, TNC promoted seaweed farming and ecotourism homesteads to reduce hunting pressure on turtles. And WWF donated sewing machines to women in villages that created a marine protected area to compensate for restrictions on fishing.



However, there are few examples of alternative livelihood projects that have led to lasting conservation and development outcomes. Our research shows that these well-meaning interventions often lead to unrealistic expectations, opportunistic rent-seeking and frictions in communities, which inhibit collective action.

Community-based resource management projects also often employ community rangers to patrol the newly created LMMA. But in most villages this is not viable without external financial support. Similarly, much time and money is invested by NGOs to set up community-based monitoring programmes. But the ecological data collected by such programmes is in most cases not very useful for fisheries management, or merely confirms what the fishers already know. Unsurprisingly, monitoring is discontinued when outside funding stops.

Travel, staff, and administration costs also make these projects very expensive. We estimate that the creation of an LMMA costs at least USD 300,000—not quite the “locally funded shoestrapping operation” that Bob Johannes had in mind 25 years ago. International conservation NGOs justify the high costs by claiming that their projects will stimulate other communities to follow the example: the so-called ‘village-by-village approach’. But such pilot projects inhibit collective action, as neighbouring villages often conclude that they cannot manage their fisheries without outside financial and technical support.

We are not the first to highlight these shortcomings. Several academic papers have raised concerns about the long-term sustainability and replicability at scale of these community-based resource management projects, but international conservation organisations continue to invest in setting up new LMMAs.

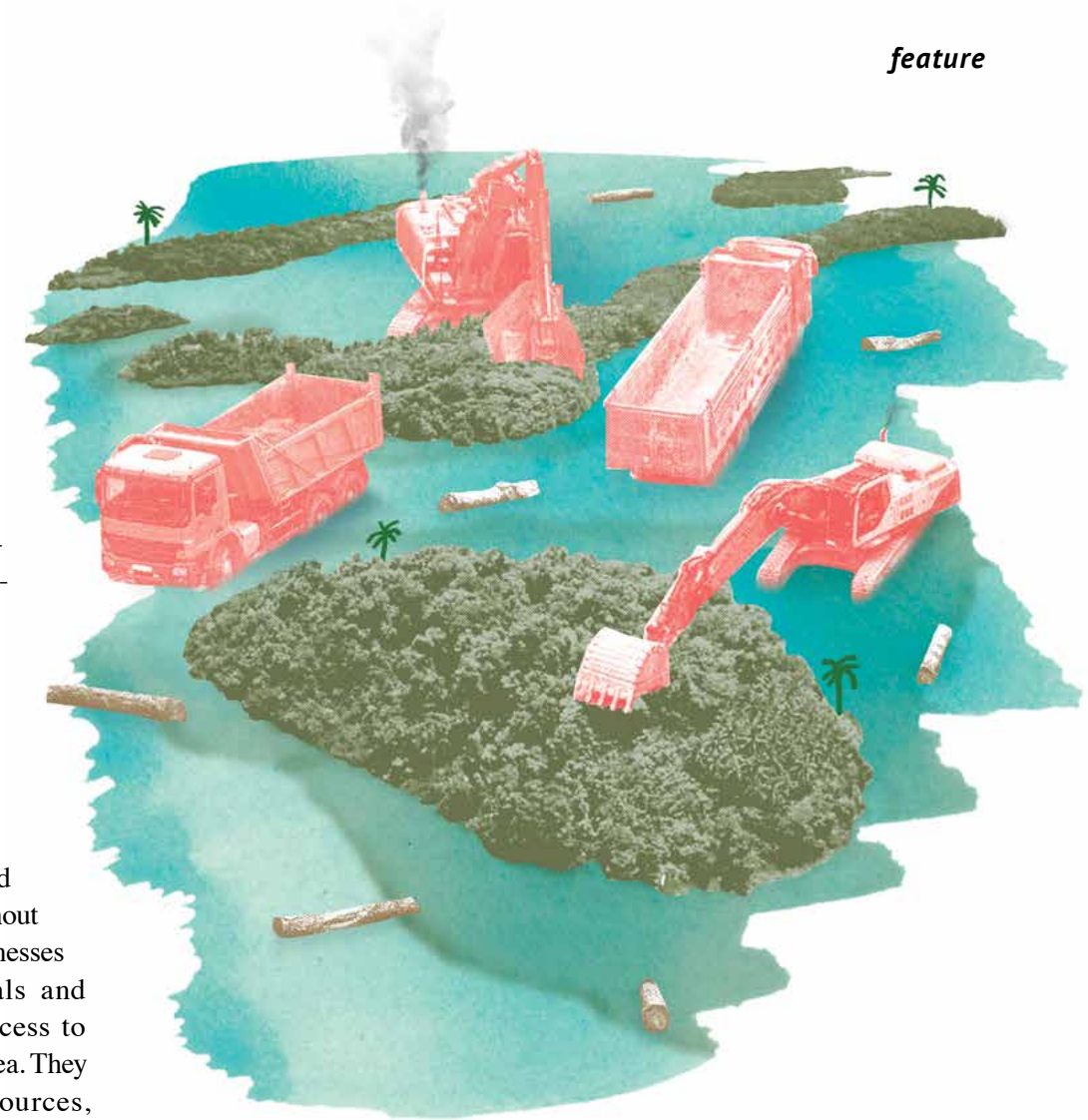
## External threats

The biggest problem with the community-based resource management projects is that they tend to ignore the main threats to marine biodiversity and rural livelihoods in the Solomon Islands: the detrimental social and environmental impacts caused by extractive industries.

Sedimentation, pollution, and destruction caused by foreign-owned logging and mining companies threaten coastal ecosystems and subsistence fisheries throughout the archipelago. Dodgy businesses bribe government officials and village leaders to gain access to customary-owned land and sea. They then pillage natural resources, violate lease agreements and legislation with impunity, and cause massive environmental destruction. This leads to mistrust, social problems, and violence in communities. Cultural values that form the foundation of community-based resource management, such as cooperation, environmental stewardship and respect for the chiefs, are crowded out.

However, international conservation organisations remain largely silent about this state-sanctioned resource plunder. The harvest of sea cucumbers is a good example. The export of this valuable commodity is controlled by a few well-connected businessmen, who make a handsome profit. LMMAs cannot address this threat, as high prices for dried sea cucumbers—called *bêche-de-mer*—simply override traditions, values, and social relations. As a result sea cucumbers are overfished throughout the archipelago and the Solomon Islands government is losing millions of dollars in tax revenues. But instead of using their influence, expertise, and resources to regulate the sea cucumber trade, WWF, TNC, IUCN, WCS and CI ignore the issue completely, and continue to work in a few, isolated villages.

The reserve to speak out against such injustices is not innocent: it undermines the efforts of local civil society organisations to strengthen



customary land rights, improve public services, and fight corruption in the government. Local civil society organisations like the Solomon Islands Development Trust and Voice Blong Mere Solomon have proved to be indispensable in designing locally-led development projects, mediating conflict, and holding the government accountable. But the sad reality is that over the past 25 years, funding for local civil society groups has dwindled as international conservation NGOs capture the lion’s share of conservation funding.

## Rethinking community engagement

In our article, we call on international conservation NGOs to rethink how to support and scale up community-based resource management in the Solomon Islands.



In our view, these organisations need to stop focusing on creating new LMMAs, and focus instead on strengthening the capacity of the government to deliver basic public services in remote rural areas.

At first this advice not to work with communities in order to strengthen collective action at the grassroots level might seem counterintuitive. But without a functioning civil service, community-based resource management is simply impossible. Communities cannot—as Bob Johannes already recognised 25 years ago—address external threats to coastal fisheries such as commercial fishing, oil spills, or sedimentation. He therefore urged NGOs to strengthen extension services, regulate export markets, and tackle corruption. In other words: to do those things that communities cannot do themselves.

Thus, instead of investing significant resources in alternative livelihood projects and community-based monitoring programmes in a few villages, international conservation organisations should address the threats posed by extractive industries to marine biodiversity and food security. This could, for example, be done by providing operational budgets to provincial governments to enforce environmental legislation, developing legal support systems for coastal communities, or supporting the anti-corruption campaigns of local civil society groups. These are not easy tasks, and the results will be less photogenic than the donation of sewing machines or the deployment of a Fish Aggregating Device. But in the long-term, building the regulatory capacity of the government will benefit many more people and create the necessary conditions for communities to protect their marine resources.

Bob Johannes envisioned a future where fishers in the southwest Pacific were once again actively managing their coastal fisheries. For him this was a pragmatic matter: these Indigenous tabus turned out to be far more effective than foreign aid-funded projects. Sadly, his advice has been ignored. Despite all the participatory rhetoric, marine conservation in the Solomons Islands continues to be driven by the agenda and targets of international conservation organisations and their donors.

It is clear that this top-down strategy is failing. LMMAs now cover less than 3 percent of the country's coastal waters. To really revitalise Indigenous fisheries management, we need to do things radically different.

The contours of a new approach are beginning to take shape as a new generation of projects that specifically aim to scale community-based resource management are currently being implemented in the Solomon Islands. But one thing is clear: it all starts with a fisher placing a stick on the reef.

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**Grace Oirana leads the WorldFish research programme on community-based fisheries management in Solomon Islands.**

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**Hitesh Sonar is an illustrator and graphic artist from Mumbai. He has worked on various projects from book illustrations, magazines, to editorial illustrations and animation backgrounds.**

# ARTISTS *of the* INTERTIDAL ZONE

Author and photographer **Sarang Naik**

A narrow strip of land that is exposed during low tide and constantly battered by waves during high tide, the intertidal zone hosts an unexpected wealth of life. I started exploring Mumbai's intertidal zone in 2017 with the Marine Life of Mumbai team. Even after nine years of walking the same shores, I continue to make new mind-blowing discoveries. It is like an infinite onion: every year I peel off what I think is the last layer, only to reveal a new one hiding beneath.

All these years of exploration and visual documentation have led to a particular fascination with small, intricate details that I capture with my macro lens. I'm delighted to share a few here.

This large, brightly-coloured egg case belongs to an equally sizeable *Actinocyclus* sea slug that visited our shores. Such bright colours are often a warning to predators that the eggs are inedible. While the egg case was easy to find, the slug itself (see second inset) was a master of camouflage.



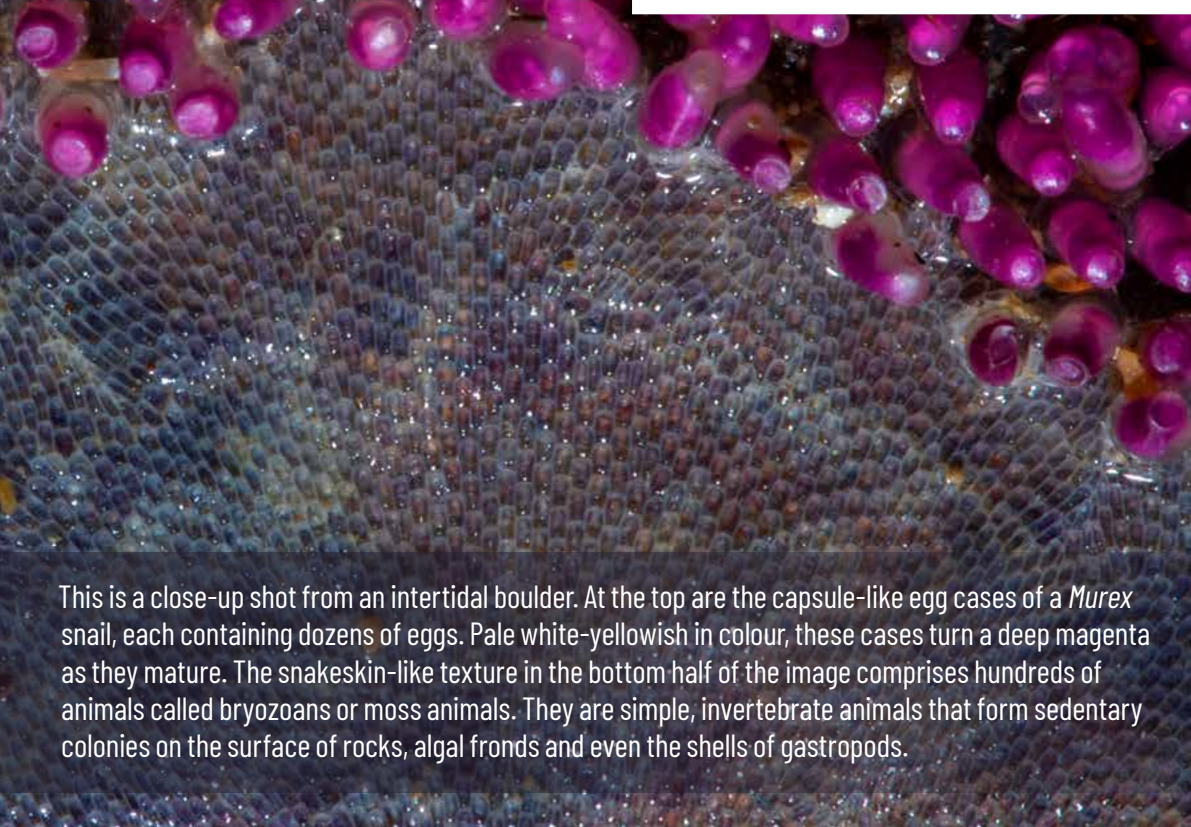




Periwinkle snails are perhaps the most ubiquitous inhabitants of rocky shores. They are adapted for surviving long periods out of water during low tide. To avoid losing moisture, they huddle together in shaded areas between and under the rocks.



Another animal that uses Mumbai's shores as a nursery is the pencil squid. In October, you can spot its gelatinous egg masses—with hundreds of eggs containing tiny embryos attached to yolk sacs swimming inside them—on sandy shores during the low tide. These embryos develop inside the eggs for a week before hatching and swimming away.

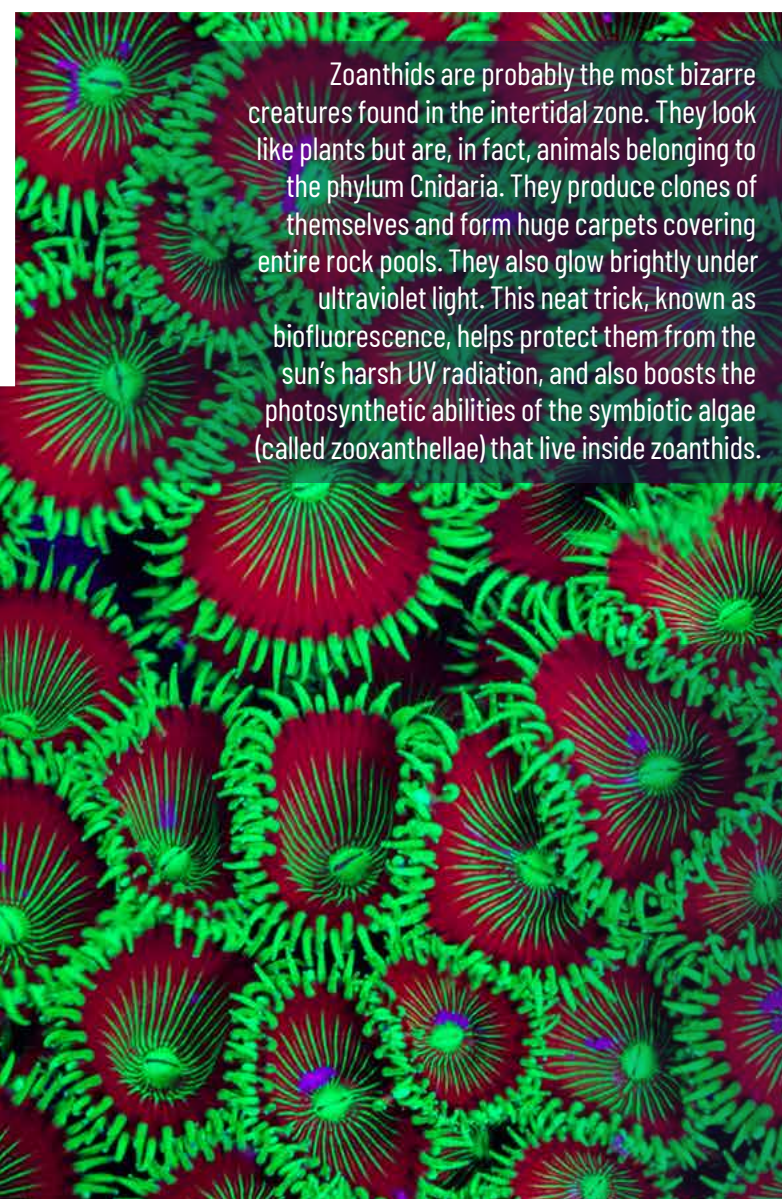


This is a close-up shot from an intertidal boulder. At the top are the capsule-like egg cases of a *Murex* snail, each containing dozens of eggs. Pale white-yellowish in colour, these cases turn a deep magenta as they mature. The snakeskin-like texture in the bottom half of the image comprises hundreds of animals called bryozoans or moss animals. They are simple, invertebrate animals that form sedentary colonies on the surface of rocks, algal fronds and even the shells of gastropods.

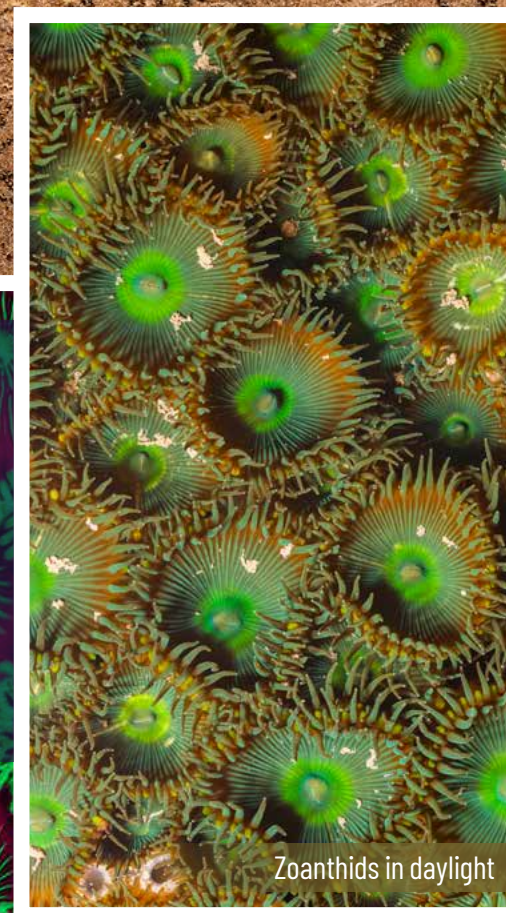


photo essay

These patterns on sandy beaches are the handiwork of sand bubbler crabs, which live in burrows on the shore. During low tide, they feed by passing sand through their mouthparts to filter detritus, and the rest is rolled into tiny balls which are discarded in this neat radial or spiral pattern.



Zoanthids are probably the most bizarre creatures found in the intertidal zone. They look like plants but are, in fact, animals belonging to the phylum Cnidaria. They produce clones of themselves and form huge carpets covering entire rock pools. They also glow brightly under ultraviolet light. This neat trick, known as biofluorescence, helps protect them from the sun's harsh UV radiation, and also boosts the photosynthetic abilities of the symbiotic algae (called zooxanthellae) that live inside zoanthids.



Zoanthids in daylight

Mumbai's intertidal zone is a kaleidoscope of textures, layers and hidden details that reveal themselves only to the patient and discerning eye. As the city's tidepooling community grows, I hope that together, we manage to protect and nurture this precious habitat for generations to come.

**Sarang Naik** is a wildlife photographer and cinematographer from Mumbai, specialising in creative nature and urban wildlife photography.



# Global tipping points and the future of coral reefs: Insights from the Andaman Islands

Author **Chaitanya Arjunwadkar**

In the Andaman Islands, at the southern tip of the Mahatma Gandhi Marine National Park, lie the Twin Islands, or Kachua Tekri as they are locally referred to. Beneath the clear, blue waters, a coral reef fringes the islands. Sunlight illuminates the reef, revealing its extent—there is coral for as far as you can see. Branching *Acropora* corals dominate the reef, with cameos by tabular, corymbose, and encrusting corals, forming an intricate structure. Here, the reef is almost completely covered by corals.

The *Acropora* branches are dotted by damselfish—some yellow, others blue or white with black stripes. Across the reef there are schools of parrotfish, surgeonfish, and rabbitfish, busy taking bites off the reef. In close pursuit are vividly coloured wrasses, opportunistically feeding on any invertebra-

tes that are dislodged. Just above the reef, a large school of fusiliers dazzles with synchronised movement as it zooms past. Along the reef crest, bluefin trevallies stealthily prowl like a pack of wolves, while a school of yellow snappers with white stripes scans the reef slope. Further out, the silhouette of a reef manta glides by.

For a diver hovering above this reef, the scene feels entirely unreal.

## Entering a new normal

But one might wonder—how long will this reef persist as I described? After all, coral reefs are at the forefront of ecosystems impacted by climate change. Rising ocean temperatures are rapidly transforming these hyperdiverse ecosystems into less complex configurations, often taken over by algae or fast-growing corals. Such has been the effect of global warming that mass coral bleaching is now recognised as the most pervasive threat to corals and coral reefs across the world.

Extreme spikes in ocean temperatures cause corals to expel the photosynthetic algae symbiont from their tissue. As a result, corals turn white and could die if high temperatures persist. Typically, coral bleaching occurs after short-term seawater temperature anomalies of 1–2°C above the usual summer maximum. However, scientists believe that we might be entering a new normal, where global average temperatures rise up to 1.5°C above pre-industrial levels. This increase in temperature is a critical threshold for coral reef ecosystems.

The *Global Tipping Points Report 2025*, published by the University of Exeter, states that coral reefs are fast approaching one of the first climate tipping points. Beyond this critical threshold, coral reefs will undergo severe and possibly irreversible change. Scientists largely agree that even if global warming is restricted to an increase of 1.5°C, reefs are projected to lose about 70–90 percent of corals. Overall, the consensus appears to be that coral reefs as we know them might be lost.

While the first tipping point looms large, coral reefs around the world have already faced four global mass bleaching events, including the most recent in April 2024, along with several regional events. Documenting the impacts of past bleaching events and subsequent recovery patterns have provided important insights into how coral reefs may look and function in the near future.

But most of our knowledge comes from well-studied systems like the Great Barrier Reef and coral reefs of the Red Sea and the Caribbean. There is a distinct lack of comparable understanding from remote, data-deficient reef systems like those in the Andaman Islands. As we approach the tipping point, we must ask—will the impact across corals and coral reefs around the world be homogeneous, or will it be more complex, with regional identity playing a big part?

## The Andaman Islands

The Andaman archipelago is situated 1,200 km from mainland India, between the Bay of Bengal to the west and the Andaman Sea to the east. This group of about 300 islands is part of the Indo-Burma biodiversity hotspot and lies close to the highly biodiverse Coral Triangle. Coral

reefs in the Andaman Islands are home to hundreds of coral species and thousands of reef-associated organisms.

Beyond ecological richness, these ecosystems are of great cultural and economic value for communities across the islands. They support small-scale reef fisheries and reef-based tourism, which play a big role in the local economy. The continuity of these ecosystem services in the Andaman Islands depends on a stable three-dimensional reef framework. However, coral reefs in this region have been affected by a series of major disturbances, including the Indian Ocean tsunami of 2004 and coral bleaching events of 1998, 2002, 2005, 2010, 2016, and 2024.

Studies following events from 1998 to 2016 documented consistently high sea surface temperatures and a loss of live hard coral ranging from 20 to 90 percent across sites. Impacts varied among locations within the archipelago, with some areas experiencing higher live coral loss during particular bleaching events, while the same locations remained relatively undisturbed during other events. Coral taxa most susceptible to bleaching also varied across the events. This indicates that just within the archipelago, spatial and taxonomic responses to bleaching events have been heterogeneous.

Indeed, the Andaman Islands present an intriguing case, both in terms of the impacts of bleaching and how reefs respond to them. Despite the repeated bleaching events, archipelago-wide live coral cover appears to be relatively stable (however, this understanding is based on reef assessments that have been spatially and temporally scattered across the islands and should therefore be interpreted with caution). There are two distinct factors that could limit coral susceptibility to bleaching in the Andaman Islands.



First, the presence of Large Amplitude Internal Waves (LAIWs), which are formed when layers of water are moved by tides and currents over uneven seafloor topography. As LAIW pass over coral reefs in the islands, they bring cool water from the depths upward, reducing high temperatures responsible for bleaching. While LAIW are present throughout the year, they are strongest between February and April—limiting the exposure of coral reefs to hot waters during peak summer months.

The second important factor that could reduce bleaching impact is the presence of turbid inshore waters across parts of the islands. Suspended particulates reduce the direct impact of solar radiation on corals by blocking light penetration, thereby diluting the combination of high seawater temperatures and direct sunlight on shallow, nearshore coral reefs.

### Lessons in reef recovery

When it comes to recovery, live coral cover alone cannot capture all aspects of bleaching impacts and reef recovery, and is often only used as a symptom of changing reefs. As part of the multi-institutional Long Term Ecological Observatories programme, our team has been monitoring select coral reefs in the Andaman Islands for the last four years. We examine coral reef community structure across sites and years, and whether variation in composition also means variation in reef functioning, the impacts of disturbance, and reef recovery.

**We monitor eight sites across Tarmugli and Boat Islands in the Mahatma Gandhi Marine National Park—four sites on the windward side and four on the leeward side of the islands. These islands predominantly experience winds and high-energy waves from the southwest, making the western sides more exposed to wave action, while the eastern sides remain relatively sheltered.**

Our surveys revealed that coral reef community structure on the exposed side of the islands is indeed markedly different from that on the sheltered side. Exposed sites are structurally complex and dominated by fast-grow-

ing *Acropora* corals, especially branching and tabular forms. These reefs also have a high cover of the pink, encrusting coralline algae that facilitates the settlement of coral larvae. Turf algae are present in sparse patches across the reefs.

In contrast, the sheltered sites are turbid, flatter, and less complex. These sites have lower live coral cover, with boulder-like, reef-building *Porites* corals being the dominant forms. Sheltered reefs have a high number of dead and broken corals, overgrown with sediment-laden turf algae. Together, these differences suggest that exposure to wave action largely influences how coral reefs are shaped across our sites.

Following the announcement of the fourth global mass bleaching event in April 2024, we carried out surveys at these eight sites in early May 2024 and followed it up with surveys in January 2025. Like coral reef composition, the impact of coral bleaching and reef response markedly differed between exposed and sheltered sites. While the bleaching impact was minimal, fast-growing *Acropora* morphologies on exposed sites were the most affected. Post-bleaching, a decrease in live coral cover was followed by an increase in turf algae across exposed and sheltered sites. Interestingly, about a year after the event, exposed sites already had a significantly

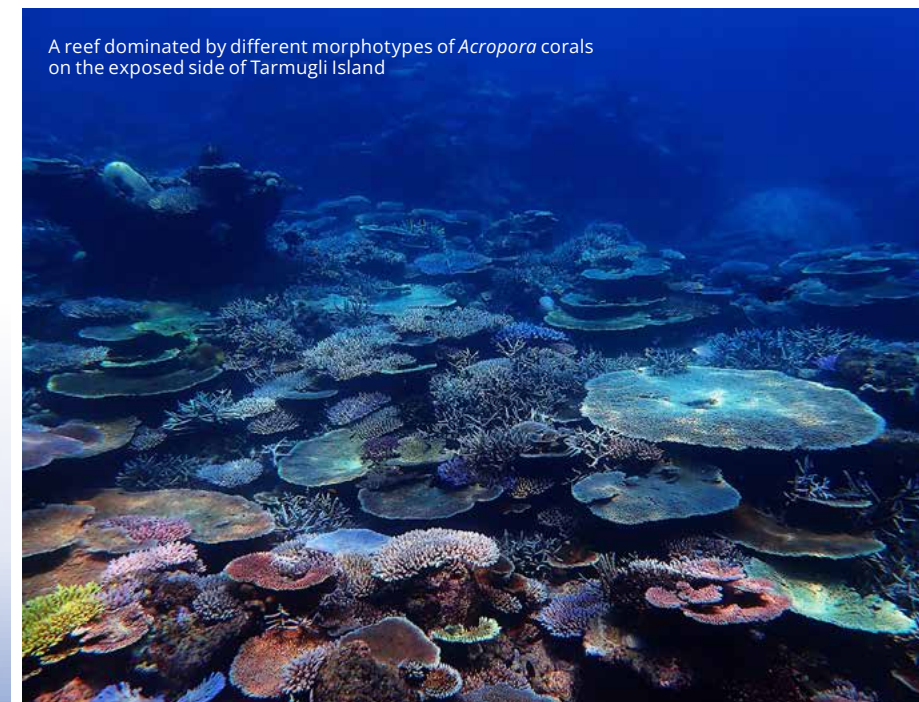
higher number of recruit (2–5 cm) and juvenile (5–10 cm) corals than the sheltered sites. Recovery of coral populations on exposed reefs had already started.

**These findings offer interesting insights: exposed sites are likely to experience higher short-term vulnerability to bleaching events due to the presence of the highly vulnerable *Acropora* corals. Yet these sites are also capable of rapid recovery post-disturbance, given the fast growth and reproduction of these corals and the availability of space. However, a different pattern emerges on the sheltered sites. The boulder-like *Porites* corals are more stress-tolerant and are able to resist bleaching events. Nonetheless, coral recovery through coral recruitment may be slower due to competition with turf algae and higher sediment accumulation, both decreasing available space.**

Overall, these findings suggest that the impact of climate change and responses to bleaching events are highly variable across time, distance, and taxonomic diversity in the Andaman Islands. It appears that the response of coral reefs to climate tipping points in the islands may ultimately depend on local environmental settings and existing reef structures.



The author monitoring coral reefs (photo by Nandita Gattani)



A nearshore turbid reef dominated by massive *Porites* corals



A large school of humpback red snappers (*Lutjanus gibbus*) on the exposed side of Boat Island



But this is still only a part of the resilience story. As part of our research, we are looking at how reef fish aid reef recovery by removing competitive algae and the balance between carbonate production and bioerosion that maintains reef frameworks. We hope that improving our understanding of coral reef structure and function across space and time will provide deeper insights into reef resilience.

### Coral reefs in a human-impacted world

The latest *Global Tipping Points* report raises legitimate alarm bells for coral reefs. However, impacts across coral reefs may not be homogeneous and coral reef change and reorganisation may be far more complex. Consider this, the Andaman Islands have faced six bleaching events since 1998. I was born in 1997, which means that these ecosystems have faced climate change impacts for as long as I have lived. Yet, in my decade of observing coral reefs, I have rarely encountered coral cover as high as that seen on some reefs in the Andaman Islands. As the tipping point looms large, I think there is still hope for the archipelago.

The report also acknowledges that despite the imminent tipping point, coral reef refugia may exist. The Andaman Islands have been deemed to be such a refugia for coral reefs in the face of climate change. However, I wonder how long that will hold true. While coral reefs are capable of self-organisation following bleaching events, their resilience could well be affected by chronic local pressures. For example, the islands have seen increasingly frequent and more intense cyclones, overfishing, unregulated tourism, heavy sediment loads, and large-scale coastal development. These pressures, in combination, have created a serious challenge for reef resilience by shrinking recovery windows. Coral reefs may not have enough time to self-organise after a mass bleaching event, given these existing stressors.

Globally, coral reefs face an uncertain future in the Anthropocene. We are heading towards widespread coral mortality and may encounter previously unseen reef configurations. It is not known how these novel configurations will continue to support not only biodiversity, but also hundreds of local communities worldwide. It is also unclear whether all coral reefs will follow similar trajectories under climate change. In fact, coral reefs already exist in a variety of configurations that span high coral cover, high turf algae cover, reefs dominated by encrusting forms, turbid reefs, and reefs with high macroalgae cover. Moreover, regional environmental and socio-ecological settings could strongly shape the trajectory that coral reef systems take in the near future. If we are to better understand changing reefs and what the future holds, it is imperative that we consider these local contexts.

Ultimately, it is perhaps time to accept that in the face of climate change, coral reefs are going to inevitably transform and many reefs will exist in low coral cover configurations. While reefs are capable of natural self-organisation following disturbances, they may not match our visual standards, which are biased by nostalgia. Yet, these transformed reefs may still be able to provide key ecosystem services and we need a more nuanced way of looking at what the future holds for coral reefs.

Robert Streit, Tiffany Morrison, and David Bellwood put it best in their 2025 paper: “We may not have the coral reefs we want, but we should perhaps learn to appreciate the coral reefs we will have (and perhaps deserve).”

### Further Reading

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