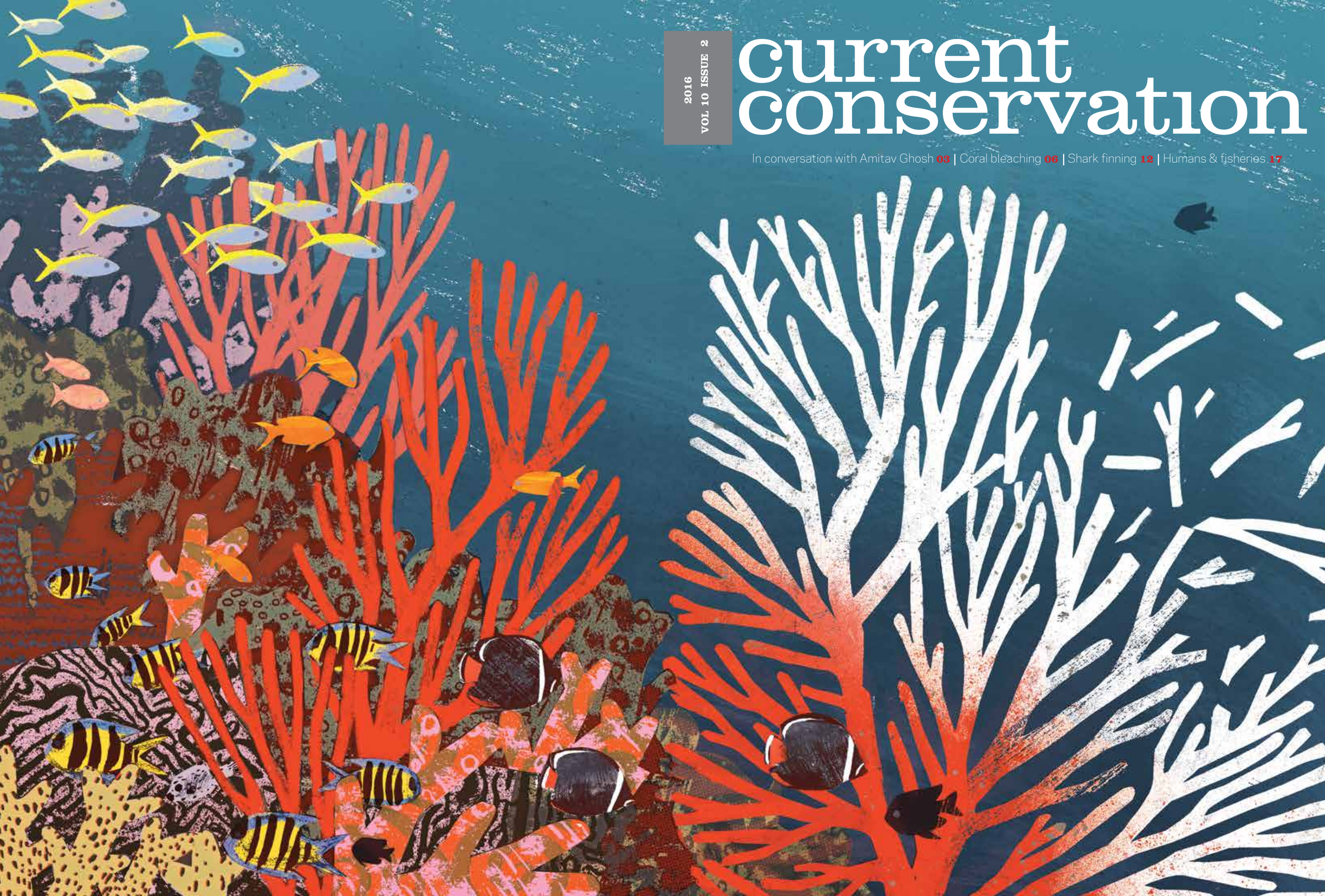
2016
VOL 10 ISSUE 2

current conservation



This magazine is produced with support from:

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.

For more details, visit our website at www.currentconservation.org

ISSN 0974-0953

contents

cc kids

editor's note Marianne Manuel and Matthew Creasey

Cover art by Prabha Mallya

In the face of increasing evidence of climate change and pushed by massive public pressure, the world's leaders finally came together in Paris in Dec 2015 and signed the first universal, legally binding global agreement on climate change. Unfortunately we're already seeing countries ignoring the spirit of the Paris deal making it even more crucial for the public to remain engaged and for them to keep the pressure on their leaders. In his latest book 'The Great Derangement: Climate Change and the Unthinkable', Amitav Ghosh attempts to unpack the failure of literature and politics to grasp the enormity of climate change. Kartik Shanker talks to Ghosh about why literature and film have failed to accommodate climate change as part of our lives. In her book review, Rohini Nilekani highlights the 'many rich threads' that Ghosh weaves into his narrative.

In this marine issue, we explore what climate change means for the marine ecosystem and the vast array of life that inhabits it. Rohan Arthur and his co-authors discuss the implications of increasing temperatures for coral reefs in the Andaman and Nicobar as well as the Lakshadweep islands. Matthew Creasey and Gabriel Yvon-Durocher explain how tiny diatoms can help us predict the impacts of warming on our oceans. These larger threats only make it more critical for us to sustainably manage our ocean resources and limit the stress on these systems. Kate Barclay highlights the importance of community engagement when developing fisheries management practices. And in our photostory, Randall Arauz presents stark visual images of shark finning and decries its collateral damage on marine life.


Rohan Chakravarty

Welcome to the 2nd ever edition of Current Conservation (Kids)! In this issue, all our stories are about the wild, wet and wonderful world of the seas and oceans – Earth's marine ecosystem. We will learn about the different ways to study marine wildlife, and what scientists can learn from local fisherman. We meet Phil, a shark biologist who spends his days on the sea, tracking the 2nd biggest fish in the world, the basking shark.

And once you've finished all that, we're sure you'll be ready for lunch – why not take a trip to the cleaner fish café? Dive with us down to the coral reef and read about the small fish that earn a living by cleaning the scales of bigger fish, and their relationships with all the other species living amongst the coral. Together, let's plunge into Earth's oceans, and meet the fascinating people and wildlife that live there.

In conversation: Amitav Ghosh and Kartik Shanker

Amitav Ghosh is a highly acclaimed Indian writer and celebrated for his contributions to Indian writing in English. In 2007, the Government of India honoured Ghosh with a Padma Shri; in 2012, the Sahitya Akademi awarded him the Tagore Prize for his work, Sea of Poppies. Some of his notable works include The Ibis Trilogy, The Calcutta Chromosome, The Hungry Tide and The Glass Palace. In his latest endeavour, 'The Great Derangement' Ghosh discusses the apparent indifference to climate change in popular culture and the general public failure to recognize the gravity of the phenomenon.

Kartik Shanker: It's not that writers, like Melville whom you've mentioned, but also Hemingway and Ken Kesey in America, and Tim Winton in Australia have not written about the 'raw and elemental power' of nature. Nature does have agency in much of that genre. And yet, even that literature has failed to acknowledge climate change as part of the everyday. Why do you think that is?

Amitav Ghosh: I think the problem lies in part with the word 'Nature' itself. This is a word or concept that comes into being during the Enlightenment and all sorts of dualisms are written into it: it has come to signify the opposite of the human. But this is an absurdity of course because humans are in every sense a part of the continuum of living things. This was acknowledged by cultures the world over until the Nature/Culture dualism was invented. But now science too tells us that bacteria and other organisms constitute a large part of the human body; we know that even our mental states are related to our intestinal flora. I think we will never be able to integrate our surroundings into our everyday consciousness if we continue to use the word 'Nature'.

KS: I was delighted that you started with a scene from 'The Empire Strikes Back', my first and easily the favourite of the Star Wars series. But even setting sci-fi films apart, do you think that movies are a more dynamic medium and accommodating of experiment than books? And if yes, it seems surprising that even movies deal with climate change only in the realm of improbability –like The Day After Tomorrow and 2012 for example.

AV: It cannot be denied that the visual media have been more responsive to climate change than literary fiction. And the reason for this may well be that improbable events are easier to convey in images. And the disturbing thing is that some of those events do not seem as improbable now as they once

did. The thermohaline patterns in the North Atlantic are already changing in ways that may have very serious consequences for the Earth system.

KS: You are right that Hutton and Lyell's idea of a steady state (versus directional change) in geological processes and constancy of natural laws has influenced much subsequent thought from Darwin to the present. Are you suggesting that climate change challenges the notion itself, or merely that we have been so transfixed by it that we are unable to comprehend climate change and its consequences as a new constant in our lives?

AG: I think climate change (or what some call the new geological epoch of the Anthropocene) challenges all our prevalent assumptions – not just those that relate to the workings of the world around us but also our ways of thinking about history and society. Indeed the ideas that it challenges most directly are those that have become dominant over the last couple of centuries.

KS: You write of your visit to Nicobar. One of our field assistants, Agu, a Karen boy was at our sea turtle monitoring camp in Galathea in Great Nicobar (his story is narrated in CC 3.1). The morning of the tsunami, he and several researchers (one of ours and some visitors from Pune) were at the beach, and when the tide receded in an abnormal fashion, he was the only one who thought there was any danger. The others were taking photographs. The long and short of it is that when the tsunami hit, they all died, and Agu survived after 9 days adrift at sea. Do you think that the disappearance from various narrative forms of the extraordinary, the improbable (except in the realm of the fantastic and then we don't take it seriously) has made us collectively more vulnerable?

AG: It often happens nowadays that people start taking pictures and selfies in situations of danger. It is as if they had become so accustomed to virtual reality that they cannot believe that real dangers exist. Looking back now, I sometimes wonder about my encounter with the tornado of 1978. Were it to happen today would my response be to film it on my phone or to run from it, as I did?

KS: Ironically, significant parts of the environmental (and conservation) movement have been driven by the same capitalist (and neo-liberal) approaches that powered the development model that has caused this crisis. Is a 'neo-Gandhian' delinking necessary (and possible) for a solution?

I think climate change (or what some call the new geological epoch of the Anthropocene) challenges all our prevalent assumptions – not just those that relate to the workings of the world around us but also our ways of thinking about history and society.

AG: It is tempting to pin the blame on neo-liberalism but I don't think the connection really holds up. There are many factors other than ideology that are responsible for creating the global dependence on the carbon economy. For example the dominance of the US dollar is closely tied to its position in the petroleum market – decarbonization would therefore be a grave threat to the current economic order and this is no doubt one of the reasons why there is so much foot-dragging about it in the US. But it's important to note that the linkage was brought about long before neo-liberalism. Similarly neo-liberalism was preceded by other ideologies that were similarly extractive and resource-intensive. The 19th century ideology of 'Free Trade' is a good example.

In general I think one must be careful about ascribing primacy to any one ideology for this (or any other) crisis – if not, one runs the risk of conceiving of history as being moved primarily by ideas. In other words one risks producing an idealist (or spiritualist) reading of history.

Kartik Shanker is the Director of Ashoka Trust for Research in Ecology and the Environment, Bangalore and the Founder Trustee, Dakshin Foundation, kshanker@gmail.com.

feature Rohan Arthur, Vardhan Patankar and Naveen Namboothri

Living with change:

local responses to global impacts in India's oceanic coral reefs

Prabha Mallya

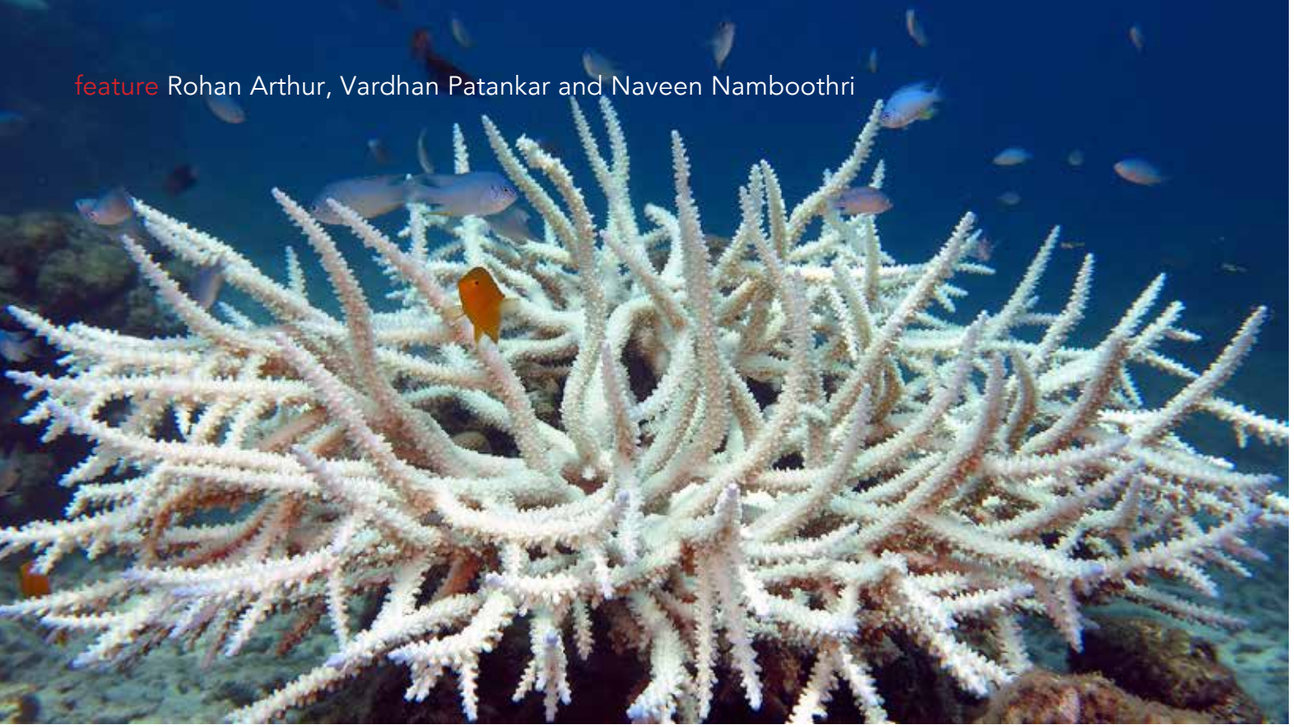
If 2015 broke all global temperature records, it is unlikely to hold on to that dubious achievement for long. We are currently in the thrall of the hottest pre-monsoon since we have had accurate data, and 2016 will, almost certainly, redefine the charts. For many ecosystems this is going to be a banner year as species and assemblages struggle to cope with the suite of abnormal conditions that come in the wake of these increased temperatures. And for tropical coral reefs, 2016 is going to mark a watershed unlike any before. Already, large swathes of the Great Barrier Reef have succumbed to the largest coral bleaching event ever recorded, and many reefs in the Pacific are dead in the wake of increased sea surface temperatures. It is disconcerting to note that it is some of the most remote and healthy patches that seem to be directly in the line of fire. In our own backwaters, ocean temperatures are soaring, and we have begun to see early signs of corals turning pale and dying. The full extent of this damage will only become clear by the end of the year. What is certain is that the way tropical coral reefs respond to these temperature conditions will set them on trajectories that may be very difficult to reverse. In other tropical reefs that have already succumbed to these catastrophic changes, piecing the ecosystem back together is proving much more difficult than it was to take it apart. The scars that this year will leave on coral reefs will stay with us for decades – if they heal at all. And while the rapid unraveling of these spectacular ecosystems would be an ecological tragedy, the consequences of this for the millions of marginalized people who depend either directly or indirectly on the reef for their day-to-day existence would be nothing short of disastrous. The cruel mismatch of global forces and local influences will be felt most acutely by the coastal communities least equipped to deal with these changes. Clearly, a lot rides on understanding the responses of coral reefs to global catastrophic events. Yet reefs are complex systems, and they respond in complex ways. It will require us to grapple with that complexity before we can understand and manage them with any degree of success.

Coral reef responses to climate change

Corals are Pre-Cambrian invertebrates whose success as the primary structuring agents of their ecosystems is hinged on the strong symbiotic association they have developed with unicellular algae called zooxanthallae. Housed in the soft tissue of the coral, these algae photosynthesize light and produce sugars and other compounds that constitute the bulk of the nutritive requirements for the host coral and help remove toxic wastes from the coral tissues. This interaction has allowed corals to successfully colonize warm, shallow and clear waters across the tropics, forming extensive reef structures of aragonite that hug coastlines, fringe islands or form ancient atolls over submerged volcanoes. The astoundingly complex architecture of the reef is home to a host of plants and animals, making reefs among the most diverse ecosystems on the planet.

The relationship between coral and its zooxanthallae is a fussy one; under conditions of stress (including elevated temperatures), the coral can no longer sustain the algae and they are expelled into the water column. This results in the corals losing their characteristic colours, bleaching completely white. If waters cool down fast enough corals can sometimes regain the zooxanthallae and recover, but if sea temperatures keep rising, corals remain bleached, becoming physically weaker and more susceptible to disease, eventually dying. While many reefs typically show some amount of bleaching as summer heats up, in El Niño years, sea surface temperatures rise way beyond seasonal averages, causing widespread coral mortality. Simply put, an El Niño develops when Pacific trade winds fail and the warm waters that are normally restricted to the west coast of South America spread across the oceans, raising ocean temperatures way above normal levels. One of the consequences of man-made climate change is that El Niño cycles are becoming increasingly unpredictable, frequent and intense. In India, at least two major El Niños have affected our reefs – in 1998 and in 2010 – resulting in mortalities of coral that ranged from 20% to nearly 90% in some regions. With this huge die-off of coral, the entire assemblage of species dependent on coral and the complex architecture it forms also declined considerably.

The 2016 El Niño is gearing up to be even more intense than these earlier events but it is far from certain how Indian reefs will stand up to this onslaught. Part of the reason for this uncertainty



Bleaching episodes, such as the 2010 bleaching of the reefs of the Andaman Islands, can quickly change splendid colourful live reefs into vast swathes of limestone debris. (Vardhan Patankar)

is that corals themselves have differential susceptibilities to increased temperatures and some coral are better equipped to deal with high temperatures than others. It turns out that the symbiotic zooxanthallae are not a single taxonomic unit and have several separate clades, some of which are able to weather stress much better. In the run up to an ocean warming event, it has been demonstrated that some corals have a remarkable ability to adjust the composition of their zooxanthallae, replacing more susceptible clades with hardier ones. This in turn appears to be dependent on local environmental conditions: corals in enclosed environments (where water temperatures usually vary considerably through the year) appear better adapted than corals in environments where temperatures don't vary as much. In mountainous areas, the slopes themselves may protectively shade reefs making them cooler and less prone to ultraviolet radiation. High concentrations of suspended sediments and decomposed litter from mangroves – which in normal circumstances can be a serious problem for reefs – can also provide some protection against ultraviolet radiation, reducing the impacts of bleaching. Local current systems and cool upwellings may also serve to make some areas naturally cooler, thus reducing the impact of sea surface temperature increases. Apart from all these physiological, geographical and oceanographic factors, local weather conditions – cloudy days, rainfall, and high wave conditions – can all act together to influence how corals on reefs respond to ocean warming events.

Given the constellation of factors that together determine reef responses, the best we can do is to make considered guesses based on what we know of our reef systems. The systems we know best are the oceanic islands, where we have been working over the last two decades. The Andaman and Nicobar Islands are characterized by some of the most diverse reef systems in India. They form extensive fringing reefs which line the coasts of most of these islands. In addition, the Andaman and Nicobar Islands have a large submerged barrier reef, of which very little is known. A combination of high current flows between the labyrinth of islands, high sediment levels and organic content, and mountainous shading provides some amount of natural protection to these reef systems. While the 1998 El Niño devastated many other reef areas in India and the world, the Andaman and Nicobar reefs escaped relatively unscathed.

However the 2010 bleaching affected several reefs across the archipelago leaving large areas dead – from which they are slowly recovering. In sharp contrast, the oceanic atolls of the Lakshadweep have none of these locally protecting mechanisms. Being low-lying islands surrounded by clear, nutrient-poor waters, these reefs declined dramatically after the 1998 event. It took at least a decade for these reefs to recover, only to be affected once more by the 2010 temperature anomaly. Recovery from this second event has been limping at best, and our most recent surveys in April 2016 is showing that even this little recovery is likely to be set back once again if anomalous temperatures do not abate. Thus, while the jury is still out on the Andaman and Nicobar reefs, the Lakshadweep reefs look primed for another mass die-off that it can barely afford.

What factors drive reef recovery after these events?

Amidst this rather grim picture, what hope do we have for these reefs recovering? From what we are discovering from the reefs of the Lakshadweep and the Andaman and Nicobar, the ability of reefs to recover depends on a coming together of several factors. All recovery is going to be essentially limited by larval supply – baby corals that get carried around in the water column to colonize the dead reef. To have an adequate pool of recruits, requires that at least a few healthy and reproductively viable adult coral patches (a refuge of sorts) survive the bleaching and that these patches produce large enough numbers of larvae that can swim and colonize dead reef patches. Even when larvae are not limiting, finding a good substrate to settle on can be an enormous challenge. Dead reefs can get very rapidly taken over by macroalgae or thick turf, both of which can inhibit and outcompete any newly settling larvae. Herbivore fish and invertebrates such as the urchins play a critical role here: their constant browsing and scraping mow down these algae, ensuring that substrates are kept clean for these larvae to settle upon. After they settle these corals still have to grow, and we are finding that the stability of the underlying substrate can make all the difference in determining how easily they take hold on the reef. Coral larvae settling on unstable substrates may grow for a few years but can then be lost to a single storm event. As the coral

The oceanic atolls of the Lakshadweep have none of these locally protecting mechanisms. Being low-lying islands surrounded by clear, nutrient-poor waters, these reefs declined dramatically after the 1998 event. It took at least a decade for these reefs to recover, only to be affected once more by the 2010 temperature anomaly. Recovery from this second event has been limping at best, and our most recent surveys in April 2016 is showing that even this little recovery is likely to be set back once again if anomalous temperatures do not abate.

Rohan Arthur

Pale reefs on the Lakshadweep atolls indicating temperature-induced stress - recent surveys indicate that the reefs are on the verge of bleaching

grows the population of other coral-destroying species like crown-of-thorns starfish can also limit reef recovery. Keeping these species in check requires a healthy population of predatory fish. This then is the recipe for a relatively quick recovery: a large dose of coral larvae, settling on structurally-stable, algal-free substrates with low corallivores or coral eroders. Getting these factors to line up would ensure that our reef systems are as prepared as they can be to deal with the inevitable surprises that climate change is going to throw their way.

This is where local management can make all the difference. Ensuring that fish populations (both herbivores and top predators) remain healthy depends a lot on local levels of exploitation and regulation; making sure that local fishers do not drive fish communities to decline is a critical part of maximizing reef resilience. Herbivore numbers in both the Andaman and Nicobar as well as the Lakshadweep islands are still relatively high: in both systems a targeted reef fishery has not yet begun, focusing on parrotfish and surgeonfish – the key herbivores in these reefs. Hook-and-line fishing in the Andamans however is affecting populations of long-lived predators like groupers and sharks, and this could have unforeseen consequences for the species they normally keep in check. From what we know, many of these long-lived predator species are highly dependent on structurally stable reefs, making them particularly vulnerable to even low levels of fishing pressure especially when reefs are changing so rapidly.

Moving forward

Climate change is now the new villain on the block, on whom we can conveniently pin all environmental crimes. A key prerequisite to any meaningful management intervention is to be able to disentangle the impacts of climate change from the rest. Easier said than done; managing coral reef ecosystems is a complex challenge with a unique, unsteady balance of science, politics, and economics. Millions of marginalized, economically backward people of the world depend on these ecosystems to eke out a living. Hence, solutions demand a nuanced approach that can balance the needs of these millions, while addressing global and local threats.

Naveen Namboothri

Fresh coral recruitment depends on the presence of a healthy population of herbivores such as the urchins (in the foreground) and the availability of stable substrates to settle on.

Rohan Arthur

A key prerequisite to any meaningful management intervention is to be able to disentangle the impacts of climate change from the rest. Easier said than done; managing coral reef ecosystems is a complex challenge with a unique, unsteady balance of science, politics, and economics. Millions of marginalized, economically backward people of the world depend on these ecosystems to eke out a living.

However, we are not the only ones going through reef crisis; reefs of several countries have been affected by multiple catastrophes in the recent past. A 2009 study predicted the local extinction of many reefs in the next 50 years. This could seriously hinder the ecosystem services they provide us with. However, a few recent studies suggest that understanding and managing local processes e.g. local hydrodynamics, ecological and physical factors, fishing pressure, could play an important role in facilitating the recovery of coral reefs. Studies have shown that some coral species have learned to adapt, switching to algal types that can tolerate warmer waters.

Although global warming may respect no management boundaries, this does not necessarily mean that management can do nothing about it. While international climate politics and negotiations are crucial in addressing issues of human-made global warming, we need to invest as much, if not more, effort and resources in understanding local processes and dynamics. More than two decades of observation and research is showing that the capacity of reefs to resist and subsequently recover from these events can be strongly influenced by local management decisions. From both island systems, we are learning that global climate change makes it MORE important, not less, to pay attention to local anthropogenic factors. It is this nuanced understanding of local factors that can give us a way beyond the easy nothing-can-be-done, attitude. Although we may not have a complete understanding of how to live with the global change, we do know that local actions make a difference to reef ecosystems as a whole and they do so across the entire spectrum of local human impacts and oceanographic conditions where reefs occur. By recognising that coral reefs and our societies are inherently coupled, we can evolve better strategies to manage them, that are ecologically sound, as well as socially and economically equitable.

Rohan Arthur is a senior scientist at the Nature Conservation Foundation, Mysore, India, rohan@ncf-india.org.

Vardhan Patankar is a research scholar at Nature Conservation Foundation, Mysore and is also associated with Centre for Wildlife Studies and National Centre for Biological Sciences, Bangalore.

Naveen Namboothri is the Director of Dakshin Foundation, Bangalore.

column Matthew Creasey and Gabriel Yvon-Durocher

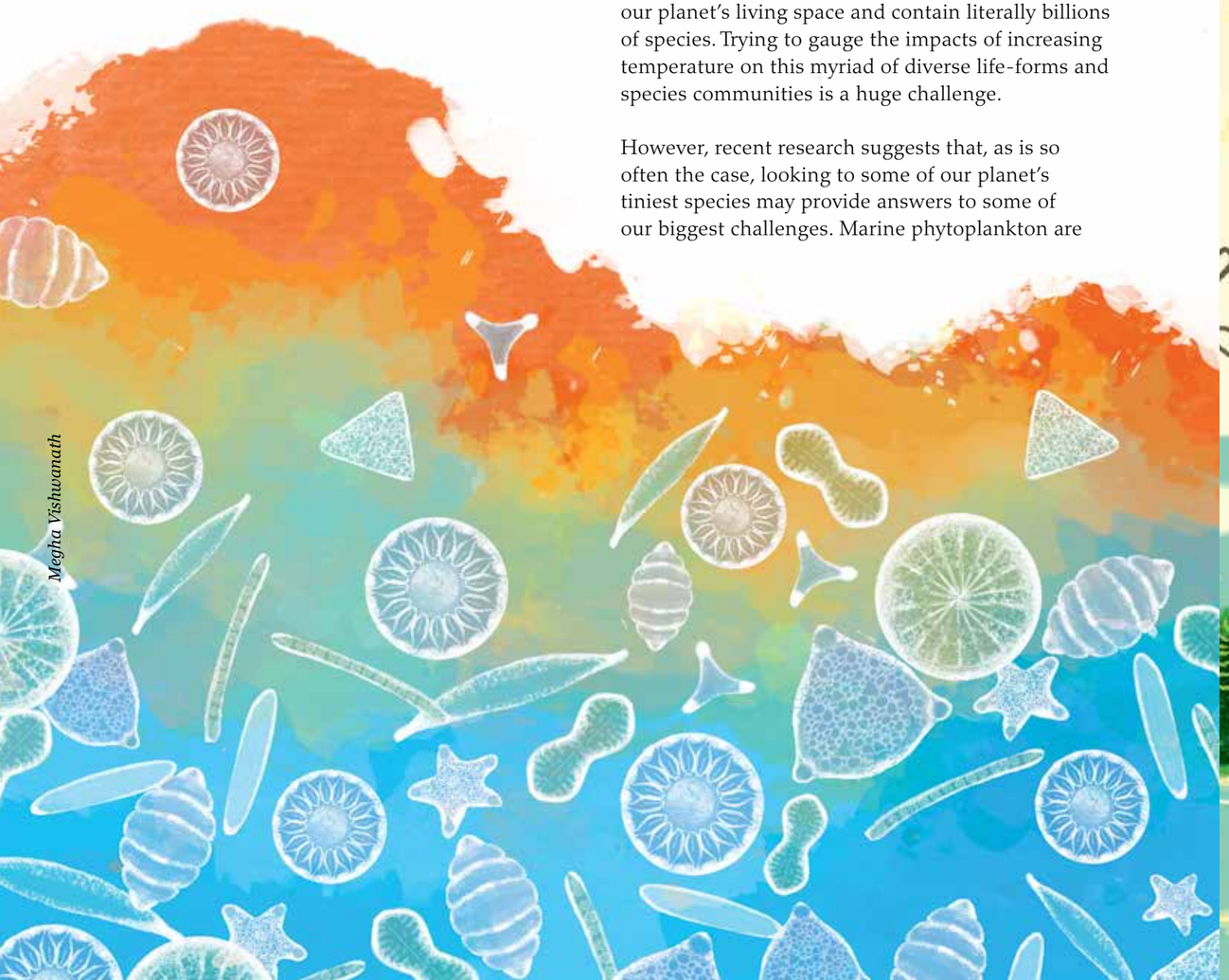
From small beginnings come great things

Forecasting the future with a miniature marine marvel – the implications of climate change for the 99%

The Earth's oceans are getting warmer. For example, over the past century, the sea surface temperature (SST) of the Western Indian Ocean has increased by 1.2° C. This is the fastest rate of any region in the tropical oceans. Warming in this region also has implications more broadly. Due to its influence on the circulation of the Asian monsoon and the occurrence of El Niño events, this area has the largest impact of any single region on global mean SST. This link with El Niño is a subject to which we will return later.

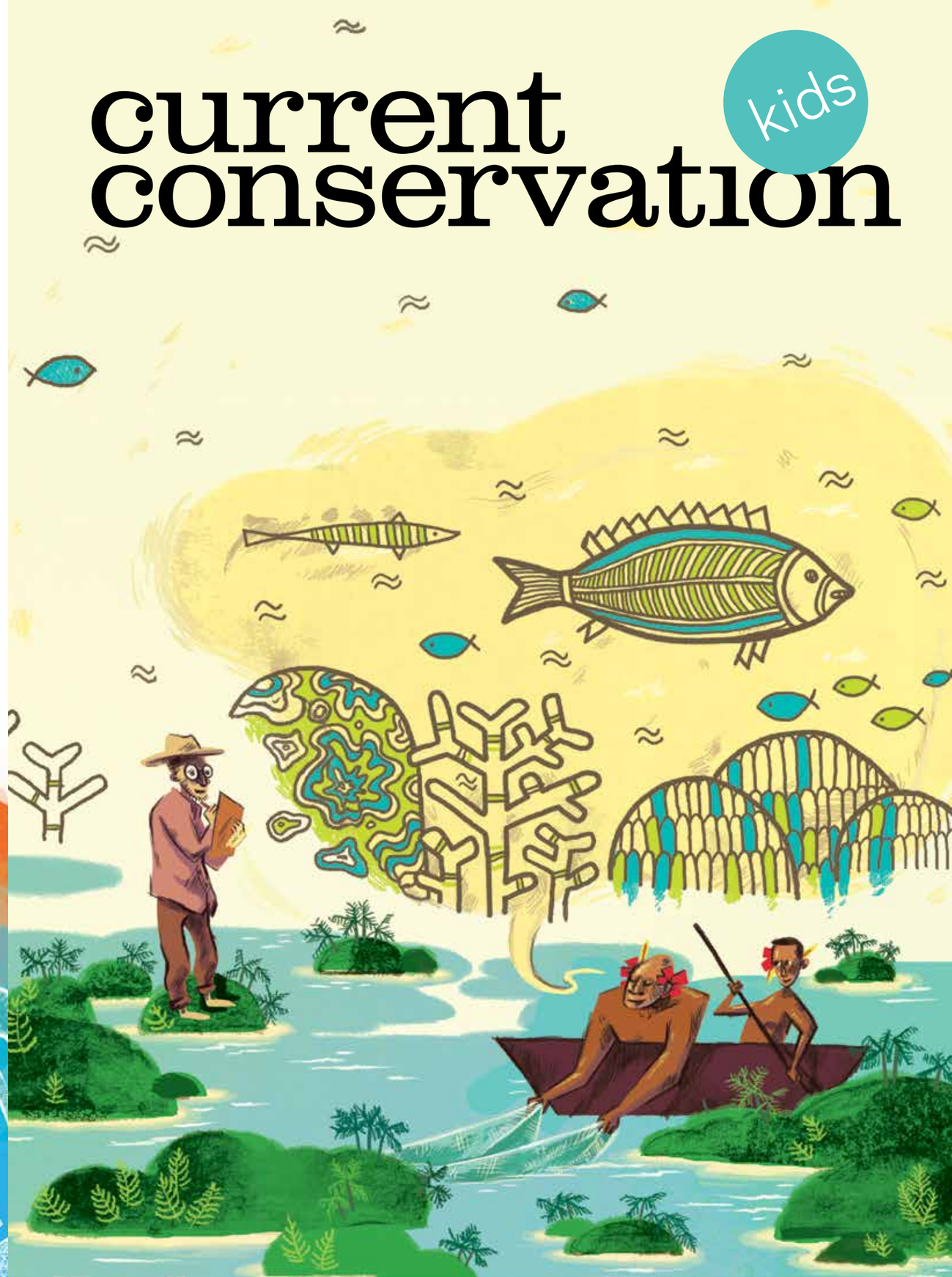
The warming of the Earth's seas is causing many to question what the effects are likely to be for biodiversity in our oceans. However, this is something which is very difficult to measure. The marine ecosystem is enormously complex. Oceans cover 71% of the Earth's surface, represent 99% of our planet's living space and contain literally billions of species. Trying to gauge the impacts of increasing temperature on this myriad of diverse life-forms and species communities is a huge challenge.

However, recent research suggests that, as is so often the case, looking to some of our planet's tiniest species may provide answers to some of our biggest challenges. Marine phytoplankton are



Megha Vishwanath

current conservation kids



 Aarthi Sridhar and Matthew Creasey

life on the wave of knowledge:

INTEGRATING FISHERS' LORE AND SCIENTIFIC STUDY

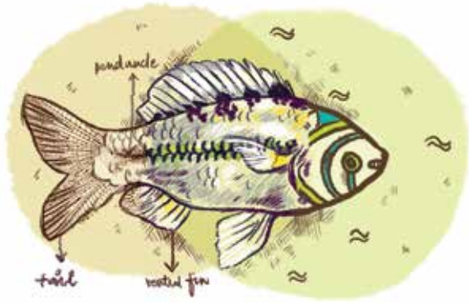
Can you be an ***expert*** in fisheries ***without a degree*** in marine biology? The famous scientist Dr Robert Johannes, a marine biologist, spent much of his working life answering this question with a ***"Hell, yes!"***

Kabini Amin

In the 1970s Johannes spent ***16 months*** living with local people in the ***islands of Palau*** in the Western Pacific Ocean, ***learning about fish*** from them. They taught him about the different types of fish, ***which reefs the fish lived on, what they ate, how they hid from predators.*** They also knew ***when*** different fish would arrive in their fishing grounds and when they would disappear, when they bred and how many of the different types there were. This information he got from the fishers had been built up over generations. ***Later, Johannes said that those fishers taught him more in just over a year than he had learnt in 15 years using research methods he practiced at university.***

What did Johannes do with this knowledge? He wrote it down, and became one of the first researchers of fishers' knowledge. Other people had lived with, and written about similar communities 50 years earlier, but their work had been lost. Johannes and others uncovered their journals and notes. He found an admiration for people in traditional fishing communities, and felt that their knowledge should be shared with the world.

There was a challenge. The scientific way of studying fish was very different to Johannes' approach of spending months with the local fishers, and recording their ocean lore. Scientists believed in their academic methods, where everything could be counted and measured. The types of knowledge possessed by the fishers did not fit easily with this.



Johannes' challenge was to bring the two approaches together. He believed we could get a complete understanding of fisheries by studying the knowledge that local fishers had built over years. This could be combined with modern science to seeing patterns within the broader picture.

Since those early years, experts in both approaches have been busy. Over time, the sea of information they have produced has become murky, and hard to read. In 2014, Dr Edward Hind, a researcher in marine sustainability, embarked on a voyage of discovery, to dredge all this information and summarise its flowing tides. In his review, he describes the ebbs and flows of both research approaches, and asks if they have started to come together. Much like the oceans themselves, Dr Hind finds that the research into fishers' knowledge has come in waves.

Wave Chart

A HISTORY OF FISHERIES RESEARCH:

Kabini Amin

Wave 1

1900 to 1970

Amateur naturalists and tradesman, travelled the seas in search of adventure and riches.

They were some of the first outsiders to recognise and deliberately record the knowledge of local fishers.

Their notes were lost until Johannes and his colleagues re-discovered them.

Wave 2

1970 to 2000

Scientists inspired by the first wave.

They focused on collecting fishers' knowledge.

Some even felt this knowledge was enough on its own to manage the fisheries.

Wave 3

2000 to present day

Largely relies on semi-structured interviews, e.g. local fishers are asked to rate fish numbers as 'good', 'average' or 'bad', or to draw information on nautical maps.

They don't think that fishers' knowledge is enough on its own to manage fisheries. Instead, they emphasise that it should be used in combination with conventional scientific methods.

Wave 4

Marine biologists, practicing 'traditional science'.

They do collect data from fishers,and only things they can count or measure like how many fish were caught, and exactly where and when the fishers caught them.

Wave 5

This is very new, just a ripple really.

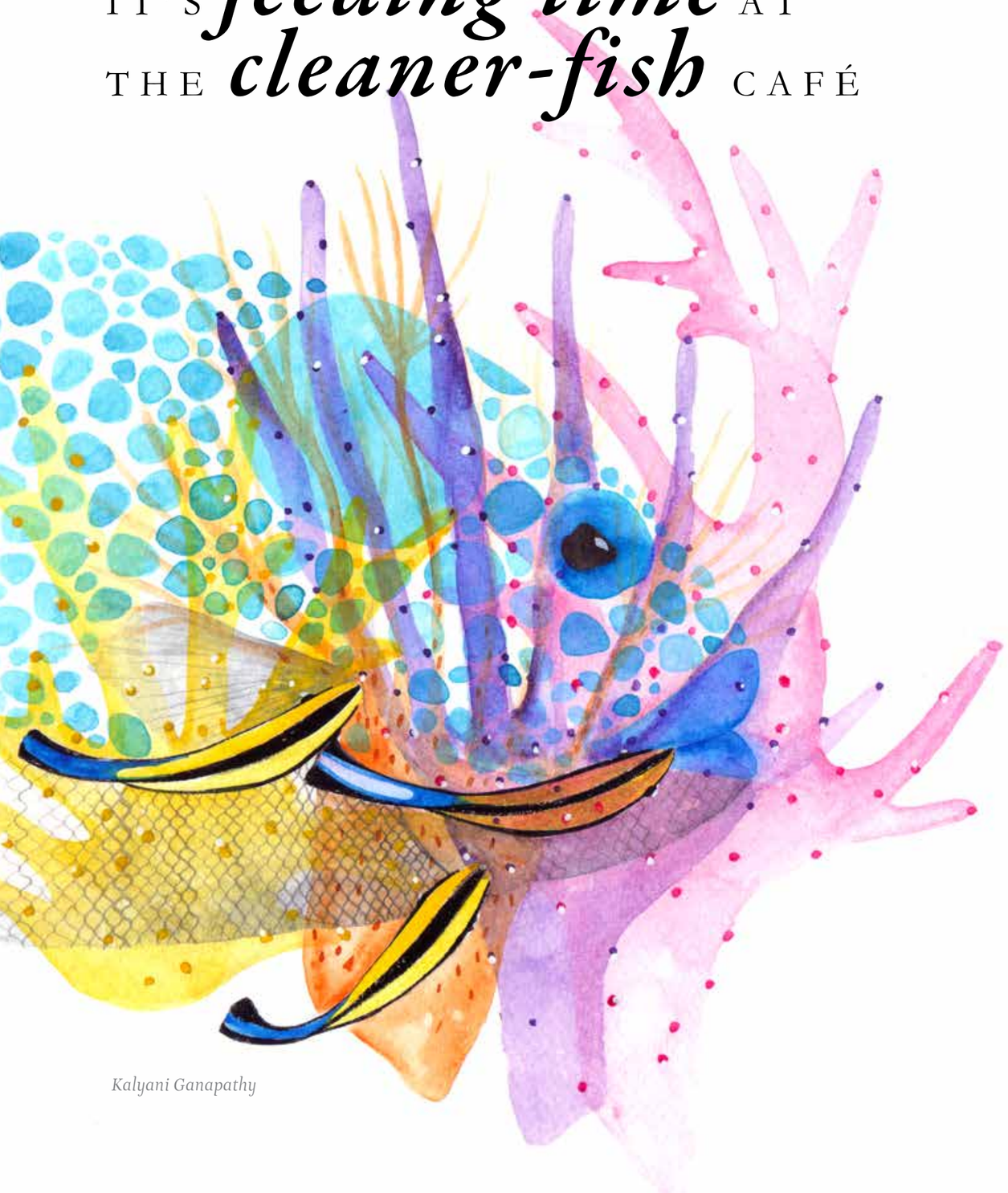
It seems to be trying to bring together waves 3 and 4, for example, interviewing local fisherman, and recording a variety of information from them, including things which the scientists can use like fish numbers.

Question

How can wave 5 link local fishers, fishers' knowledge researchers and fisheries scientists?

So where does this leave us? Is there a calmer ocean ahead for those studying fishers' knowledge and those studying fisheries science to sail forwards together peacefully? Perhaps they could even be in the same boat? Hind thinks that there is still a way to go before the two types of researchers truly work well together. Yes, scientists must drop any negative prejudices against fishers, but fishers' knowledge researchers must collect information useful to the scientists. What happens next is down to the next generation of scientists.

IT'S *feeding time* AT THE *cleaner-fish* CAFÉ



Kalyani Ganapathy

common names

Common cleaner-fish
Bridled beauty
Gadfly fish
Janitor fish

scientific name

Labroides dimidiatus

distribution

Tropical and temperate waters of the Indo-Pacific ocean. A well-known species on the great barrier reef in Australia.

habitat

Coral reefs

diet

L.dimidiatus feeds on parasites and mucus which it removes from the scales, mouths and gills of other larger species of reef fish, called 'clients'.

fact file

The relationship between ***L.dimidiatus*** and its 'clients' is called a mutualism. This means that both the cleaner-fish and client get something from their relationship. The cleaner-fish gets food, and their clients have their parasites removed. This improves their health and increases their chances of survival. The process also appears to feel good, perhaps like gentle tickling.

Cleaner-fish establish territories, called cleaning stations, from which they provide their services. Their clients know where these stations are, and visit them when they need a clean.

Although providing an important service for their clients, ***L.dimidiatus*** also takes the opportunity to cheat when possible, picking mucus instead of parasites from their client's scales. Scientists think this mucus may provide the cleaner-fish with protection from ultraviolet sun rays, as well as with a nutritious meal. Even fish need to wear sun screen when the sun is fierce. However, removing the mucus doesn't get the client fish much cleaner, so they prefer their cleaners to stick to the parasites.

client species

Spiny chromis damselfish
Acanthochromis polyacanthus
Females lay very large eggs, embryos develop slowly for damselfish, making the young very well-developed when they hatch.

Both parents look after the young for a surprisingly long period once they emerge from the eggs.

Slingjaw wrasse
Epibulus insidiator
When males of this species are trying to impress the females and find a mate, they can actually change their colour, becoming brighter. If disturbed from their displays, they can quickly switch back to their usual colour pattern.

Black-backed wrasse
Anampses neoguinaicus
This carnivorous fish usually lives in small groups of females, and are accompanied by a single male.

Black-backed wrasse is what scientists call a protogynous hermaphrodite. All individuals start off as females, but when the male in the group dies, one of the females changes her sex, becoming the dominant breeding male.

Epaulette shark
Hemiscyllium ocellatum
This shark grows to just over a meter in length, and can be found in waters as shallow as 15cm.

They can survive even when oxygen levels in the water are very low, lowering their blood pressure by 50% to maintain blood-flow to their brains.

Blunt-head parrotfish
Chlorurus microrhinos
This large and colourful fish grows up to 80cm in length, forms schools of up to 40 individuals and can live for 15 years.

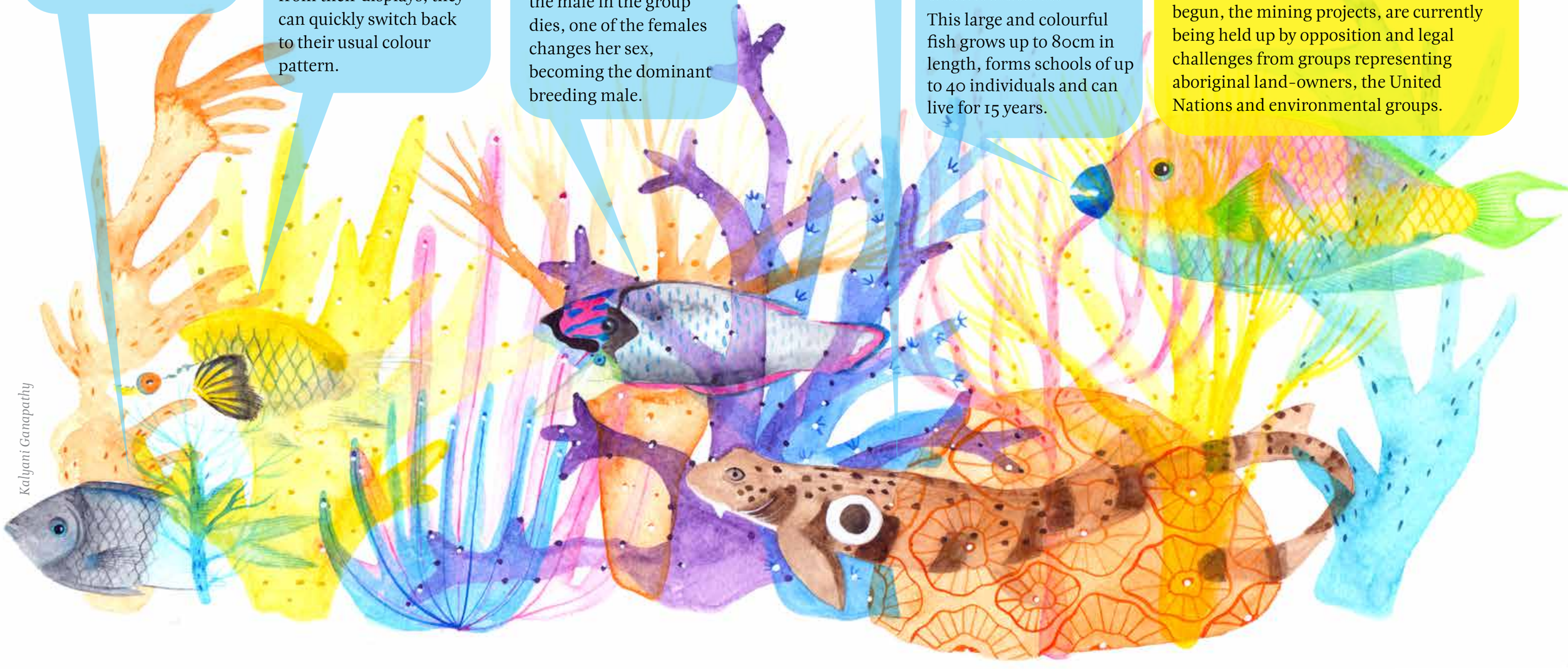
eviction notice!

In December 2015, the Queensland state government gave the go ahead for the expansion of a coal port at Abbot Point.

Although there are measures in place to protect the coral and the life it supports, these restrictions may not stop the damage.

Adani Mining, argues that the control measures are sufficient and the expansion will create 10,000 jobs and deliver $AUD 22 billion in taxes and royalties.

Although some development work has begun, the mining projects, are currently being held up by opposition and legal challenges from groups representing aboriginal land-owners, the United Nations and environmental groups.



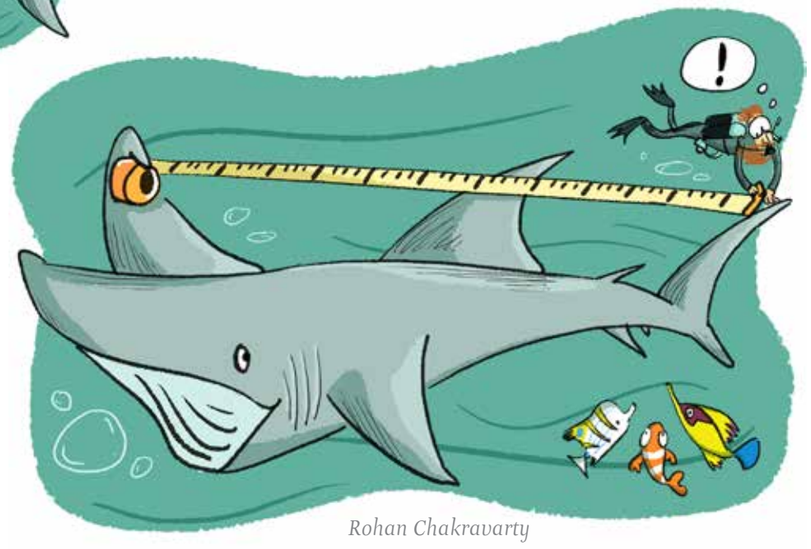
Kalyani Ganapathy

TRACKING A GENTLE GIANT

The sight of a large dark fin slicing through the water will fill some with dread. For me it's excitement and intrigue. Sharks have been swimming in our oceans for nearly 450 million years, but we know very little about key parts of their lives, such as where they eat, breed and travel to during their annual migrations. This information is critical to help provide protection for sharks, as many species are over-exploited and numbers are dwindling. This is where my research comes in...

I am a PhD student, studying basking sharks *(Cetorhinus maximus)* in UK waters, trying to uncover a little more about where these awesome creatures travel to and what they might be doing when they go there.

Basking sharks can grow up to 12m in length, making them the 2nd largest species of fish in the world. This poses the question; how can we know so little about something so big?



Rohan Chakravarty

The answer is that even though we often see these sharks feeding at the surface in coastal waters of the UK and Ireland during the summer, from the autumn onwards they move into deeper waters, disappearing from sight, and leaving us unable to follow them. However, we are now able to attach small satellite tags onto the sharks, which take detailed information about how deep the sharks are in the water, and where in the world they are swimming. The tags then fall off the sharks after a set time, and send us all this information via satellites. This allows us to follow them, without being anywhere near them! But first, we need to find the sharks to put the trackers on them. We head out on our boat each summer, searching until we see some sharks (which can take minutes, hours or days). We then approach very slowly so that we don't disturb the sharks from what they were doing. In the summer, this usually means eating. Standing at the very front of the boat, we use a long pole to attach the tag to the base of the shark's fin. The shark, unfazed, continues to swim along, feasting on the tiny zooplankton in the water. The tags then start to collect lots of exciting data for us, so we can try and make sure this enigmatic species is well looked after for the future!

Find out more at *http://www.exeter.ac.uk/esi/people/phd_students/doherty/*

http://www.exeter.ac.uk/esi/research/baskingsharktracking/

measured in micrometres (µm, one micrometre = 1 millionth of a meter). However, these minute life-forms are the foundation of the marine food-web and are responsible for 50% of ***global*** primary productivity, of which diatoms (photosynthesising algae) are responsible for about two thirds. The energy they produce is a fundamental building block on which much of our marine (and terrestrial) biodiversity depends. Therefore, establishing the ability of diatoms to respond to increasing temperatures will provide valuable information, which in turn will enable us to predict how marine biodiversity is likely to fair if the ocean's temperatures continue to rise.

The problem is that we currently know almost nothing about the capacity of diatoms for evolutionary adaption in general, let alone in response to changes in temperature. To observe evolutionary adaptation as the water gets warmer, those diatoms that can cope with higher temperatures must be given time to pass those enabling genes on to subsequent generations, while those that cannot are filtered out of the population. This means a (theoretically) temporary dip in the number of circulating diatoms, followed by a resurgence as the temperature resilient genes become widespread and the reproductive success of diatoms generally increases. Finding how many generations it takes diatoms to complete this process under different levels of warming is a critical first step in establishing how quickly diatoms may be adapting to temperature changes in our oceans. Scientists from the Ecological Responses to Climate Change research group at the University of Exeter are investigating this question. Preliminary results from experiments in the lab suggest that diatoms are capable of adapting relatively quickly (within 100 generations, which takes 6 weeks to 2 months) to a relatively moderate 4° C increase in temperature. However, when temperatures rise by 8° C, adaptation is much slower, taking 1 ½ years, which is too long in the real world as they would be outcompeted by other more adaptable organisms, which do not fulfil the same producer role within the marine food web.

The next question is what are the implications of these results for the future abundance of phytoplankton under the various projections for further temperature increases we could see in the years, decades and centuries to come? As we said earlier, the SST of the western tropical Indian Ocean has increased by 1.2° C over the past century. Based on projections by the Intergovernmental Panel on Climate Change (IPCC), if emissions continue at their current level, global temperatures could rise by 3.7° C to 4.8° C by the end of the current century. However, this is a global average, and as we have seen, the Western Indian Ocean is (a) warming particularly quickly, (b) has a particularly large impact on global mean SST and (c) is of particular importance to marine food webs due to its high biological productivity. So, given the rates at which we now know diatoms can adapt to temperature increases of a magnitude towards the upper end of the IPCC's projections, this suggests there may be cause for concern.

Researchers from various research groups have been exploring the substance of these concerns in the wild and over longer time-frames by combining two strands of data. The first looks at phytoplankton abundance over the relatively recent past. When there is a high concentration of these tiny algae, they form such dense aggregations that they actually colour the water green. Comparing satellite images of the sea surface taken over the past 16 years, scientists found a 30% decrease in phytoplankton abundance in the Indian Ocean over this period. The second data strand uses computer modelling techniques to explore phytoplankton abundance over the longer term. Their models suggest that the recent decline revealed by the satellite images is part of a longer trend, and phytoplankton have declined by 20% over the past 60 years. This is dramatic, and we are already observing effects further up the food chain. In the last 5 decades, tuna catch rates have declined 50–90% in the Indian Ocean, in part due to over-fishing, but also likely confounded by lower levels of primary productivity in the seas in which they live. This is just one example, but it is hardly a good sign.

What is more, the patterns of warming are not just bad news for life in our planet's oceans. Firstly, the productivity of the world's oceans spills out onto land. We need only think of the bounties we and other species harvest from the seas. Secondly, there are also significant implications for global weather patterns. Here we return to El Niño.

These events occur when temperatures in the central and eastern tropical Pacific Ocean increase above a particular threshold, and this heat radiates out into the atmosphere. The Indian Ocean is particularly important in this process, as circular currents cause heat to accumulate, and this region is therefore believed to be playing a major role in the increasing global mean SST, and in the occurrence of extreme weather events such as El Niño. Over recent decades, El Niño events have become more frequent. Meanwhile, 2016 saw the highest temperature ever recorded in India, 51° C in Phalodi, Rajasthan. The India Meteorological Department has cited the current El Niño as the major factor behind India's record-breaking hot summer, so increasing regularity of El Niño events suggests that such temperature peaks may also become more common. This story really is hotting up.

The patterns of warming are not just bad news for life in our planet's oceans. Firstly, the productivity of the world's oceans spills out onto land. We need only think of the bounties we and other species harvest from the seas. Secondly, there are also significant implications for global weather patterns.

The 3.7° C to 4.8° C temperature rise projected by the IPCC is based on a scenario where emissions continue at their current level. So there is hope. Governments around the world are beginning to take steps to limit future emissions, and the climate talks in Paris at the end of 2015 resulted in the first truly global agreement on targets, with this target in mind. One hundred ninety five countries signed a legally binding commitment to "(hold) the increase in the global average temperature to well below 2° C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5° C". So now, in theory, 'all' that is required is for the governments of those 195 countries to take the steps they have agreed (and in many cases going beyond them) to achieve those ambitious targets. Yes, we know, we can hear your laughter from here. But hold on a second. We would suggest that it is down to every one of us to hold our governments to account. Through campaigning, exercising our democratic rights and making our voices heard in any way we can, to make sure that their promises aren't broken. A combination of realistic targets, carrots for those who achieve the goals and sticks for those who do not. The diatoms are doing their part. It's time for us to do ours.

Further information on the work of *Professor Gabriel Yvon-Durocher's Ecological Responses to Climate Change research group can be found here: http://www.exeter.ac.uk/esi/people/academicandhonorary/yvon-durocher/*

References:

Roxy *et al*. 2015. Indian Ocean warming—the bigger picture. *Bull. Amer. Meteor. Soc.*, 96, 7, 1070-1071.

Chassot *et al*. 2010. Global marine primary production constrains fisheries catches, *Ecol. Lett.*, 13(4), 495–505.

Roxy *et al.* 2015. A reduction in marine primary productivity driven by rapid warming over the tropical Indian Ocean. *Geophys Res Lett.*, 43.

Myers & Worm. 2003. Rapid worldwide depletion of predatory fish communities, *Nature*, 423(6937), 280–283.

Polacheck. 2006. Tuna longline catch rates in the Indian Ocean: Did industrial fishing result in a 90% rapid decline in the abundance of large predatory species? *Mar. Policy*, 30(5), 470–482.

Matthew Creasey is a PhD Researcher at Centre for Ecology and Conservation, University of Exeter, UK, mjsc201@exeter.ac.uk.

Gabriel Yvon-Durocher is a Professor of Ecology at University of Exeter, UK.

From no "shark finning" to no "shark killing"...nor eating!

I am actually a sea turtle biologist. I stumbled upon the shark finning issue in 1997, when I was studying the impact of longline fishing on sea turtles. Seeing such a magnificent predator reduced to a finless chunk of meat that gets thrown overboard made me realize the magnitude of the overfishing problem, the same overfishing problem that is extirpating leatherback sea turtles from the Eastern Tropical Pacific.

Shark finning is the horrific practice of catching a shark, hacking off the valuable fins and discarding the body at sea. The inhumane and wasteful shark fin industry expanded on a global scale in the 1980s, fueled by an insatiable demand for shark fin soup, a highly paid delicacy in Asian markets, as well as expanding high seas fishing fleets that target tuna, mahi mahi, and billfish. Sharks are considered bycatch in these fisheries, but

are retained for their valuable fins. Some estimate that up to 100 million sharks per year are extracted to supply the shark fin soup industry. The largely unregulated shark fin trade represents one of the most serious threats to shark populations worldwide.

A simple policy to avoid shark finning is to mandate the landing of the shark with the fins attached. The policy was first passed in Costa Rica in 2005, and is now followed by most fishing nations. Asian nations, notably

China and Taiwan, have banned shark finning, but use a "fins to body weight ratio" system that is complicated and difficult to implement, facilitating the circumvention of the regulation. Attempts were made by Taiwanese fleets in Costa Rica to land sharks with the fins "tied back on" or "attached to spines", but the State Attorney has made it clear that the correct interpretation of "fins attached" is "fins naturally attached."

With a global shark population depletion of 90% over the last 50 years, it is without question that stopping shark finning is of the utmost importance. However, a "fins attached" policy doesn't address the overfishing problem, nor does it do anything to promote the recovery of shark populations. What sharks need now is for their mortality to be significantly reduced. This may be a

challenge, particularly in fisheries where other valuable species are also depleted and shark meat is sold and consumed in domestic markets. Nations such as Costa Rica for instance, consume 2000 tons of shark meat per year. How are we going to save the sharks if we are eating them?

What fisheries managers should keep in mind is that it is NOT a shark problem, it´s an overfishing problem with ecosystem impacts. Sea turtles, sea birds and rays are among the collateral damage. Some species, such as leatherback sea turtles, are now Critically Endangered in the Pacific due in part to high mortality associated with fisheries operations in the high seas. The

only way to help the ecosystem is to implement seasonal and spatial closures when fisheries cease to operate. Monospecific solutions for ecosystem problems just aren't going to do the job.

I have focused my work on reducing fishing effort, by producing science and attempting to curtail fisheries using various approaches, by closures in critical habitats, creation of marine protected areas, strict protection for certain species, and influencing fisheries policy in domestic courts and international forums (conventions). At the end of the day, its not better science that will save sharks, turtles, and other marine endangered species, it will be policy based on that science, and that directly leads to fewer of these animals getting killed.

Smitha Shivaswamy

Understanding the humans in fisheries

Fisheries provide a hugely important source of food and livelihoods for hundreds of millions of people around the world. As the global population grows, this source of food and livelihoods will become even more important but world fisheries production has already peaked.

Aquaculture has increased and will continue to do so, but projected aquaculture growth will not easily cover the gap between supply and demand for seafood. Making the best we can of this situation means taking better care of our coasts and oceans. Fishing and mariculture industries are limited by the environmental damage they cause as well as the other damage from human activities, particularly pollution and coastal development. Ecologists and biologists have detailed the problems caused by ocean acidification from excess carbon in the atmosphere, the massive amounts of plastic suspended throughout the water column in the world's oceans, dead zones, overfishing, problems caused by runoff and chemicals used in aquaculture and so on.

Enabling our marine environments to be as productive as possible requires persuading humans to cause less damage. Moreover, policies to protect the environment should be equitable in their treatment of the people impacted and align with economic development and other government policies. So the understanding of society is clearly central to the conservation of marine and coastal environments.

Public administration thus requires understanding the humans as well as the non-humans in ecological systems. However the knowledge we base resource management and conservation policy upon is mostly biological and to a lesser extent economic. Other disciplines have largely not been used to inform marine conservation and resource management policies. In addition, with a lack of reliable knowledge about how particular environmental policies will affect people, politicians and bureaucrats in decision-making roles have settled for policy directions based on the available knowledge plus their best guesses. With an insufficient evidence base it is also possibly easier for them to choose the path that suits their ideological bent - or that which seems most politically expedient.

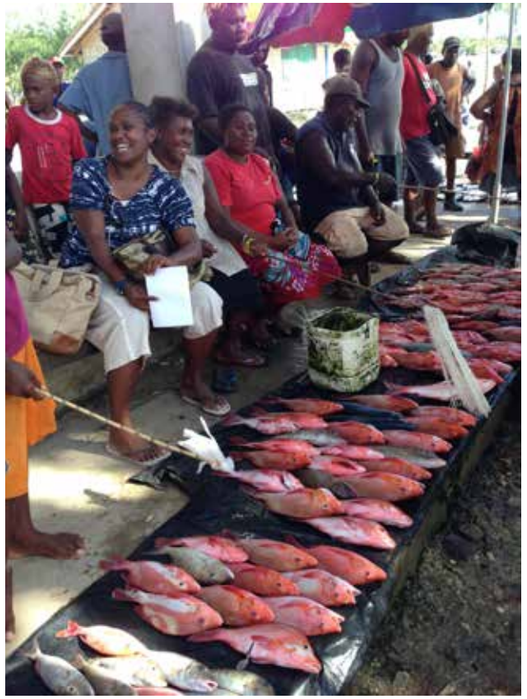
Since the 1987 Brundtland Commission Report, Our Common Future, sustainability has been an important policy principle internationally. Since the 1990s it has been widely accepted that sustainability rests equally on three pillars: environmental, economic and social. Yet governments and researchers have struggled with how to bring together the disparate knowledges about the human and non-human elements of the environment. At first a common response was to have stand-alone environmental, social and economic impact assessments. However it is hard to bring reports done independently and with different disciplinary perspectives together into a coherent policy vision. So usually the biological or the economic (or the politically expedient) route was taken, and the social was more or less ignored. Understandings of social aspects of sustainability are much less well explored than biological or economic aspects of sustainability. There have been fewer researchers working in the social sustainability area and less established methods for working out what are the social aspects of sustainability and how to evaluate them.

Problems with the lack of understanding about the social aspects of sustainability have emerged. Fisheries policies such as individual transferable quotas that seem to protect the environment better and to make fisheries more economically viable have vocal opponents because they tend to drive out small operators and consolidate fisheries into the hands of a few large companies. Small-scale fisheries make up the social fabric of many coastal communities around the world. There has been a strong push to find policies that foster small-scale fisheries because of the food security and livelihood benefits they bring coastal communities, especially for the tens of millions of poorer people in less wealthy countries. Some, including fisheries scientist Daniel Pauly, argue that small-scale fisheries are environmentally and economically better than large-scale industrial fisheries. The United Nations Food and Agriculture Organization (FAO) in 2015 released a set of International Guidelines on Securing Sustainable Small-Scale Fisheries. Small-scale fisheries can be a particular challenge to regulate since they are often informal. It is often not feasible to consider monitoring the fishery and enforcing regulations through the usual fisheries methods of keeping records of catches and having fishing vessels registered and licensed. To try to better understand the most effective ways to manage fisheries in terms of conservation as well as food production and economic and social development, researchers have been working in recent years to develop cross-disciplinary, integrated knowledge about the human and non-human elements of marine and coastal ecosystems.

One approach that has been tried is to have teams of scientists with different skills – ecologists, economists, social scientists – work with fishing communities to map out their varied concerns and interests in the local marine environment. Through this process it is possible to work out how different conservation policies would impact stakeholders differently - both economically and socially. Having people involved in the process also helps them understand the trade-offs involved in conservation policy choices, which is another big social challenge for conservation. Inevitably some people will feel disadvantaged by conservation measures, but if they see the overall benefits and thus accept the measures as legitimate and so comply with them the policy is much more likely to succeed. On the other hand, people often do not accept that conservation measures are on the whole beneficial so they ignore them or agitate politically until the measures are weakened or reversed. This problem has arisen again and again for protected marine areas internationally. Participatory and deeply collaborative approaches between the people affected, socially-aware researchers and policy-makers are really important for securing effective conservation. Projects along these lines have been conducted in East Africa involving researchers in a group called Ecosystem Services for Poverty Alleviation, and also for the Ningaloo reef off northern Western Australia by scientists from the CSIRO (Commonwealth Science and Industry Research Organization).

Another really important way to improve understanding of the social aspects of conservation is to conduct a gender analysis. Fisheries have tended to be particularly blind to gendered issues affecting operations because of preconceptions that 'fishing' occurs on fishing vessels, which are often predominantly male environments. Many reports worldwide have countered this by pointing out that gleaning in the intertidal zone, often conducted by women, is also really important ecologically in terms of the total amount of animals and plants taken from the environment, and socially in terms of food and livelihoods. Emerging researcher Dr Danika Kleiber, who is both an ecologist and a gender studies scholar, has highlighted this really convincingly regarding fisheries in the Philippines. When we look beyond actual fishing, moreover, to the whole social context that shapes and enables fishing, the roles of women and the influences of gender relations become really clear. Women are very much involved in post harvest activities of seafood marketing, processing, and consumption. Gender relations are important even for the mainly male industrial fishing vessel model, in that women hold families together and support men to go fishing in that way. In recent years, the World Fish Centre has in some of its programs taken a gender aware approach to working with communities for sustainable fisheries and aquaculture development. They have done this through revising their methods for working with communities so as to encourage men and women to enable women's perspectives to be included in decision-making about usage of resources. Without a gender aware approach attempts at community development can miss the mark, since they may result in increased workloads for women, possibly exacerbate problems of violence against women, and increased incomes may not end up benefiting women – and therefore not amount to 'development' for half the population. Gender awareness is crucial for the social aspects of sustainability.

When we look beyond actual fishing, to the whole social context that shapes and enables fishing, the roles of women and the influences of gender relations become really clear. Women are very much involved in post harvest activities of seafood marketing, processing, and consumption. Gender relations are important even for the mainly male industrial fishing vessel model, in that women hold families together and support men to go fishing in that way.



Kate Barclay

The concept of 'wellbeing' is being used increasingly in social measurement and planning, including in fisheries management and conservation. Wellbeing is a rounded idea of how individuals or communities are tracking against development goals or how they respond to a change in policy. Building on decades of 'quality of life' research that showed deficiencies in simply looking at income levels or assets, this approach recognizes that to have wellbeing involves intangible aspects as well as tangible ones. So in measuring wellbeing it is important to look at the combined elements of material wellbeing (including incomes, assets and also health status and so on), relational wellbeing (how well important relationships function to support people, within their communities but also outside to politicians and other powerful people who affect their lives), and subjective wellbeing (how people feel about their lives). Wellbeing can be used to address the social aspects of conservation policy in various ways. It can be used to track social impacts, by measuring the baseline wellbeing of a community before a policy is introduced and then again afterwards. It can also be used as a framework for setting social and economic goals as part of a conservation policy. For example, in implementing conservation measures, there could be indicators set for biological goals to achieve and also social and economic goals related to sustainability, or to alternative livelihoods if fishing is reduced. These could be measured through employment and income levels, levels of life satisfaction and evaluation of how well social relationships are supporting people in fishing communities.

The whole process of initiating and implementing conservation policy can also be studied as a social process with the aim of finding out how to do it better. The idea of 'interactive governance' has been used to gain an overview of the reasons people fish the way they do, and why they respond as they do to conservation measures. Some of the things to consider in the governance of marine resources include diversity, complexity, dynamics and scale. The more diverse and complex and the

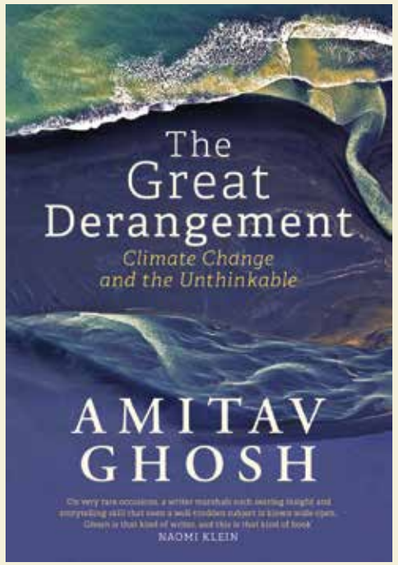
The idea of 'interactive governance' has been used to gain an overview of the reasons people fish the way they do, and why they respond as they do to conservation measures. Some of the things to consider in the governance of marine resources include diversity, complexity, dynamics and scale. The more diverse and complex and the larger the scale of a fishery the more difficult it can be to govern well.

larger the scale of a fishery the more difficult it can be to govern well. The dynamics are the different human and non-human processes that drive the fishery, such as high market demand, or climate change. A governance analysis involves looking at the policy instruments of governments to see how well they fit the fishery. It is also important to consider what mode of governance best suits the social conditions of a particular fishery. Will self-management be effective for conservation, or is government intervention needed? With government management, will hierarchical top-down methods work well, or does that result in subversion and resistance by fishers? Can collaborative co-management between government and fishers be achieved, and if so how? The socio-economic development context of each fishery affects the possibilities for different modes of governance. How well resourced is the fisheries agency? Do fishing people have feasible access to alternative livelihoods if fishing is restricted for conservation purposes? Are there sufficient financial and other business support services available for fishers to enable them to make the best value from the seafood they catch? Or are they limited to low value options through factors such as lack of livelihood skills to explore different business models, and local infrastructure for processing and transport of perishable seafood?

Marine ecologies without humans are complex and once we add humans they become even more difficult to understand and steer in sustainable directions. But we have no choice. To manage marine ecologies simply through working out what is best for the non-human elements, making some rules based on that and trying to get humans to stick to those rules has not worked. Humans have their own concerns and drivers in interacting with marine ecologies, and effectively influencing humans to be less damaging of the marine environment means understanding and engaging with those concerns and drivers. It's a 'big ask' to expect single researchers to be able to grasp all the varied human and non-human elements of marine ecologies for the purpose of conserving them better. The job requires teams of researchers with different skills working together. In recent years, groups of researchers in different places around the world have started making exciting progress in this direction. Let's hope more researchers decide to join this messy and difficult but important field of study so that it can snowball and help turn the tide towards more sustainable use of marine environments.

Kate Barclay is an Associate Professor, School of International Studies at Faculty of Arts and Social Sciences, University of Technology Sydney, kate.barclay@uts.edu.au.

Embracing the climate change narrative



The Great Derangement- Climate Change and the Unthinkable
by Amitav Ghosh

ISBN-13: 978-0670089130

Penguin Books limited

Amitav Ghosh's new non-fiction work – *the Great Derangement – Climate Change and the Unthinkable,* is a tour de force. Written lucidly and forcefully, it does not shy away from stating what many of us know to be true, in our hearts and minds, about the greatest catastrophe to face us all as individuals and as societies. For me personally, both as a writer and as a wealthy person with the associated responsibility of that wealth, it brought both clarity and nuance to many half-baked thoughts and conversations on climate change, and personal and societal responses that I have had over the years. I hope this book will spur renewed and reframed discourse around the globe.

Ghosh uses this slim offering – which is a knitting together of four lectures he gave in the fall of 2015, to make a call to action. The primary actors are to be writers of serious literary fiction. He argues that the climate crisis is a crisis of culture and thus of the imagination. When future generations look back, he writes, they will believe that our time was one "when most forms of art and literature were drawn into the modes of concealment that prevented people from recognising the realities of their plight." And that's why this era will be known as the Great Derangement.

Ghosh traces the history of the modern novel and compares its journey with those forces of empire and capitalism that drew us into the vortex of the climate crisis. Just at a time when Nature was making her voice heard in the shape of uncanny extreme events - storms and floods and earthquakes, the modern novel was receding into the quotidian and the predictable. As the vast improbable unfolded around us, most writers drew us tighter into ever smaller circles of individual mindscapes, reducing and concealing the reality of larger landscapes. Eventually, all writing about the unknown and the unknowable has been banished into the exiles of 'fantasy' or 'science fiction'.

Ghosh repeatedly makes the point that global warming is a collective predicament that requires

cooperative action, but that humanity is in the thrall of a culture where the collective has been exiled from literature but also from politics and economics. He urges, then a "way out of the individualizing imaginary in which we are trapped." So that Nature may not script an epitaph, writers must wake up." … To think about the world only as it is amounts to a formula for collective suicide. We need, rather, to envision what it might be."

There are many rich threads that Ghosh weaves into this tapestry. He asks bold new questions. Did imperialism actually retard climate change by preventing the colonies from expanding their economies? Since security establishments of powerful modern nation states recognise that the climate crisis will alter the global distribution of power, is status quo the real plan? Has the resurgence of Asia bared its own complicity and silences?

He also presents a piquant moral poser. Are some of our most treasured ideas about political virtue such as "Be the change you want to see?" completely inadequate? For all Gandhi's personal austerity, and even though he embodied the consumption patterns that would get carbon emissions down, he could not succeed in preventing India from embracing the path of consumption-led growth. For all Al Gore's single minded championing of the cause of greenhouse gas emissions control, his personal lifestyle has been relatively lavish, and media has unleashed detailed descriptions of his personal swimming pool and energy consumption. Ghosh rightly argues that neither individual can be blamed. In fact, by focusing on Gore's lifestyle rather than his message, we give the climate deniers the exact diversionary tactic they need. Both Gandhi and Gore have forever etched in the public consciousness the discourse on consumption, on growth and the consequences for the planet. But no individual can be held responsible for curating the path forward. This requires new forms of governance both at the community level and at the global level. Ghosh sadly, does not suggest how these will emerge, but then his focus is mainly on nudging fiction writers to spur such imagination.

Amitav Ghosh brings some of these questions to a climax by then comparing two important documents of the past year – the Paris Agreement and the Laudato Si' of Pope Francis. One continues with the derangement. "The very syntax is an expression of faith in the sovereignty of Man and his ability to shape the future." The other acknowledges "how profoundly humanity has lost its way and of the limits that circumscribe human agency" and reminds us that Man is spirit and will but also Nature.

Ghosh concludes on a note of optimism mixed with irony. He hopes that religious groupings joined with popular movements for equity and justice will halt the momentum of destruction. And he explores the irony that "the ever-shrinking time horizon of climate change" will isolate and thereby preserve the culture of communities in some parts of the world. It will be the communities who have retained their healthy respect for nature's might, their material skills, their relationship to the land and to their people, who will survive best. And poetic justice will be done.

Prose will have to follow. Ghosh ends on a rather romantic note. A new generation will be born, will transcend the isolation of the Derangement and create the new forms of art and literature that will reimagine the Anthropocene.

Quills on the ready, anyone?

Rohini Nilekani is the founder of Arghyam, a foundation dedicated to water and sanitization issues. She is also co-founder of Pratham Books. A dedicated philanthropist, Rohini is involved with a number of environmental and developmental organizations such as ATREE. She is also a writer of both fiction and non-fiction and has authored the novel, 'Stillborn'