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THE Marine Pollution ISSUE

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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The sea, the great unifier, is man's only hope. Now, as never before, the old phrase has a literal meaning: we are all in the same boat.
- Jacques-Yves Cousteau

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12.2 | EDITOR'S NOTE

Increasingly, marine pollution and its effects on marine life, ecosystems and on human health has been attracting attention. In particular, the issue of ocean plastics has been in the public eye in the last year or so. There are reports of enormous quantities of microplastics in the seafood we consume, as well as a host of other products. Isabella Marinho and Camilla Ter Haar provide an overview of the 'plastic age', describing both the range of harmful effects as well as possible solutions. Ter Haar and colleagues recently brought together a range of stakeholders to discuss solutions to ocean plastics at The Klosters Forum in Switzerland. Sarah Nelms and coauthors write about the perils of plastics for sea turtles, including ingestion, entanglement and habitat degradation. Further along in the issue, Martin Stelfox focuses on the impacts of ghost gear on sea turtles and the role the Olive Ridley Project is playing in addressing this in the Indian Ocean.

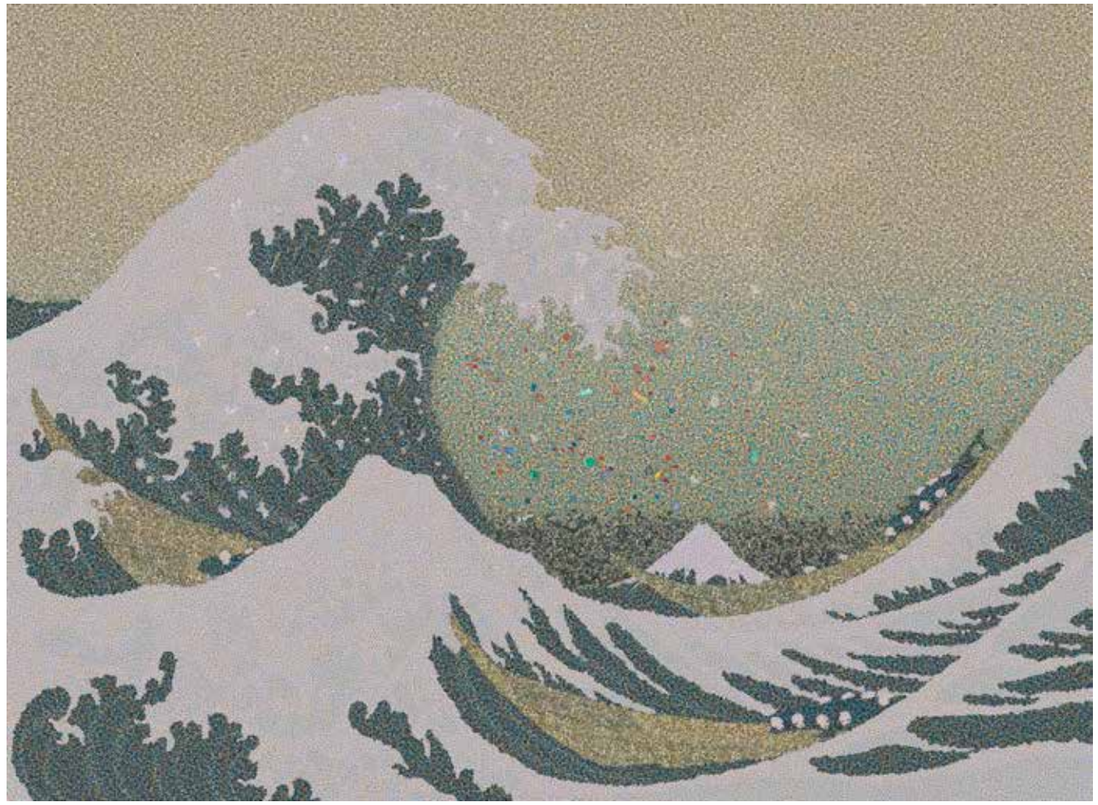
But pollution is about more than just plastics. Archana Anand talks about how Hong Kong's coral reefs give us a glimpse of the future, surviving in one of the most polluted parts of the planet. Krithika Dinesh and her coauthors write about the governance of pollution on the Gujarat coast, and how policy often ends up merely transferring the impact from one place to another. And finally, Rohan Arthur writes with languid strokes and warm nostalgia about the utter ugliness of debris, and our complicated, conflicted relationship with it.

- Kartik Shanker

In this issue of CC Kid's we have three pieces, all with an ocean theme.
First, Mahira Kakajiwala writes about her work with hermit crabs. Mahira gives us a window into their home-lives, which in the case of these crabs, they carry on their backs. Then we have the story of Nerin, a sea turtle who is fighting for her life, in danger due to ocean plastics. Join her in her fight.

And for regular readers, you may remember Dr Phil Doherty, who in issue 10.2 (2016) told us about his research on basking sharks. In the current issue's Day in the Life, we meet Phil again as he updates us on the sharks and also on his new adventures as a marine biologist.
The oceans cover 71% of the Earth's surface and contain 97% of all the water on the planet. These three stories take us into this vast, but as yet still mysterious realm.

- Matthew Creasey



GYRE, *detail.*
Depicts 2.4 million pieces of plastic, equal to the estimated number of pounds of plastic pollution that enter the world's oceans every hour. All of the plastic in this image was collected from the Pacific Ocean.

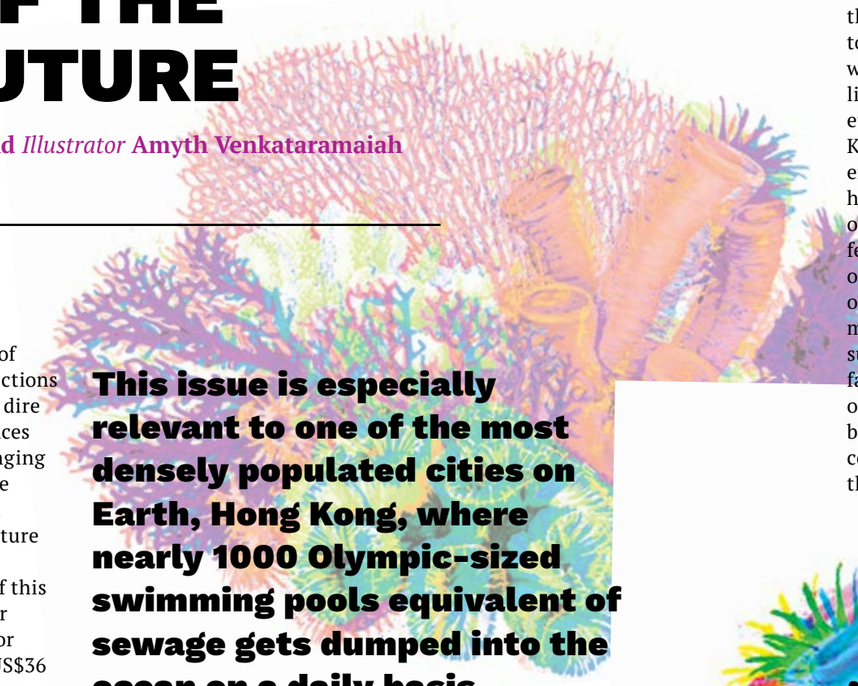
8x11 feet, in three vertical panels

CHRIS JORDAN
2009

HONG KONG'S TROUBLED WATERS HARBOUR

URBAN REEFS OF THE FUTURE

Author **Archana Anand** *Illustrator* **Amyth Venkataramaiah**



Coral reefs are in the midst of global decline, resulting from anthropogenic perturbations of climate, nutrient cycles and fisheries. Future projections of increasing sea surface temperatures alone yield dire predictions for coral reefs and the ecosystem services they provide. This issue is very relevant to the fringing and barrier reefs of the Indo-Pacific region that are home to ~600 species of scleratinian (hard) corals. Recent studies have shown that mean sea temperature is rising by ~0.5 °C every decade resulting in an alarming increase in rainfall events. The impact of this on marine biodiversity is stark and is being further accelerated by ever-increasing human impacts – for instance, reef tourism is currently estimated at ~US$36 billion every year with annual visitor numbers being equivalent to 70 million tourist trips. This has resulted in a disproportionate increase in untreated wastewater from hotels, and restaurants that is discharged into the ocean. Both nutrients and pathogens in wastewater fuel harmful algal blooms and exacerbate the prevalence and severity of disease, respectively. Sedimentation smothers and abrades benthic species, re-suspends nutrients and pathogens and blocks recruitment. Aquaculture waste poses similar threats, adding nutrients, pathogens, parasites, and sediments. Human activities can also create disease vectors. For instance, plastic debris serves as a vector for pathogens and spreads coral disease.

This issue is especially relevant to one of the most densely populated cities on Earth, Hong Kong, where nearly 1000 Olympic-sized swimming pools equivalent of sewage gets dumped into the ocean on a daily basis.

This issue is especially relevant to one of the most densely populated cities on Earth, Hong Kong, where nearly 1000 Olympic-sized swimming pools equivalent of sewage gets dumped into the ocean on a daily basis. Human impacts in Hong Kong date back to the Tang dynasty when the slaked lime industry thrived. Although this died following WWII, several coral communities were lost. The presence of abundant corals in the past to support a slaked lime industry suggests that the coastal waters were extremely hospitable to coral communities, with low sediment load and high water quality. In the 1980s and 1990s, rapid urbanisation through reclamation and dredging facilitated in explosive economic development but with trailing wastewater treatment infrastructure. This resulted in a tragic loss of water quality and associated foundational species such as coral reefs and seagrass beds. Moreover, we now see a distinct gradient in water quality (total inorganic nitrogen concentrations) with low biodiversity in the west to high biodiversity in the east.

Yet, Hong Kong is home to more hard coral species than the Caribbean! In fact, the marine environment is home to some especially old coral colonies (~200 years old). So, what makes Hong Kong coral communities special? In the little time I have spent in this city with a long-standing eutrophication problem, I have observed that Hong Kong's seawaters are one of the most human-impacted environments on this planet and the coral communities have been naturally selected for only resilient genotypes owing to multiple environmental stressors. In the last few years, the coral biogeochemistry lab at the University of Hong Kong has been studying water quality impacts on marine biodiversity. They now believe that the marine environment has improved considerably for coral survivorship following several Government initiatives. In fact, Hong Kong is a recent signatory to the Convention on Biological Diversity (CBD) and is now implementing a biodiversity strategy and action plan (BSAP). However, coral recruitment continues to be negligible implying that without assisted management and restoration, corals are unlikely to persist in this part of the world. Is Hong Kong receiving coral larvae dispersed from its neighbours? Or are Hong Kong corals reproductively isolated? The former will require intervention that could be more aligned with the viewpoints of the Chinese government. The latter will require local protection and assisted restoration.

It is an important time for China and its neighbours to elevate public awareness and support for marine conservation specifically focusing on human activities such as reclamation and pollution. In fact, the region has seen positive shifts in mindset for the shark-fin trade and sustainable seafood campaign. After years of development, even the most pristine reefs around coastal cities are likely to transition into heavily turbid, patchy, and poor-recruitment driven, yet naturally selected and genotypic-resilient corals. With ~200 years of development, Hong Kong is a crystal ball through which we can witness the impacts of coastal development on coral reefs. Hence their name, urban reefs of the future. ✹

ARCHANA ANAND is an engineer and a biologist. She is currently doing her PhD at the University of Hong Kong and researches human impacts on water quality, marine biodiversity and ecosystem functioning. Her other interests are dancing and painting.

... coral recruitment continues to be negligible implying that without assisted management and restoration, corals are unlikely to persist in this part of the world.

SEA TURTLES AND THE PERILS OF PLASTIC

Authors **Sarah Nelms, Mariana Fuentes, Valencia Beckwith**
Illustrator **Punit Hiremath**

The problem with plastic

The explosion of plastic production in the 1950's could arguably be noted as one of the most pivotal moments in our recent history, revolutionising the way we eat, drink, shop, travel and treat illness. It is a modern-day wonder material that saves lives, food and money and has brought great benefits to our society. Yet, this incredible resource is both a blessing and a curse. The durability and affordability of plastic are key reasons for its popularity, but mismanagement and irresponsible use have resulted in what can only be described as an environmental time bomb. Cheap plastic items can be thrown away after only one or two uses that may last just a few minutes or even seconds. But where plastic is disposed of can vary greatly. Globally, only 9% of plastic is recycled and the rest (91%) may end up in landfills or, in many cases, our oceans, beaches, rivers and lakes. It is estimated that 8 million metric tons of plastic enters the oceans every year. Compounding this, plastic does not biodegrade and persists within the natural environment for an indefinable amount of time. This means that the problem of pollution will only grow and accumulate if plastic input is not halted. Unfortunately, it's not just about the plastic that we can see. At the sea surface and on beaches, wave action and ultra-violet radiation from the sun causes plastic to fragment into smaller and smaller pieces, resulting in microplastics (less than 5 mm in size). These tiny and colourful pieces can be ingested by a plethora of marine organisms, from the microscopic, such as zooplankton at the base of the food chain, to the massive, such as filter-feeding baleen whales.

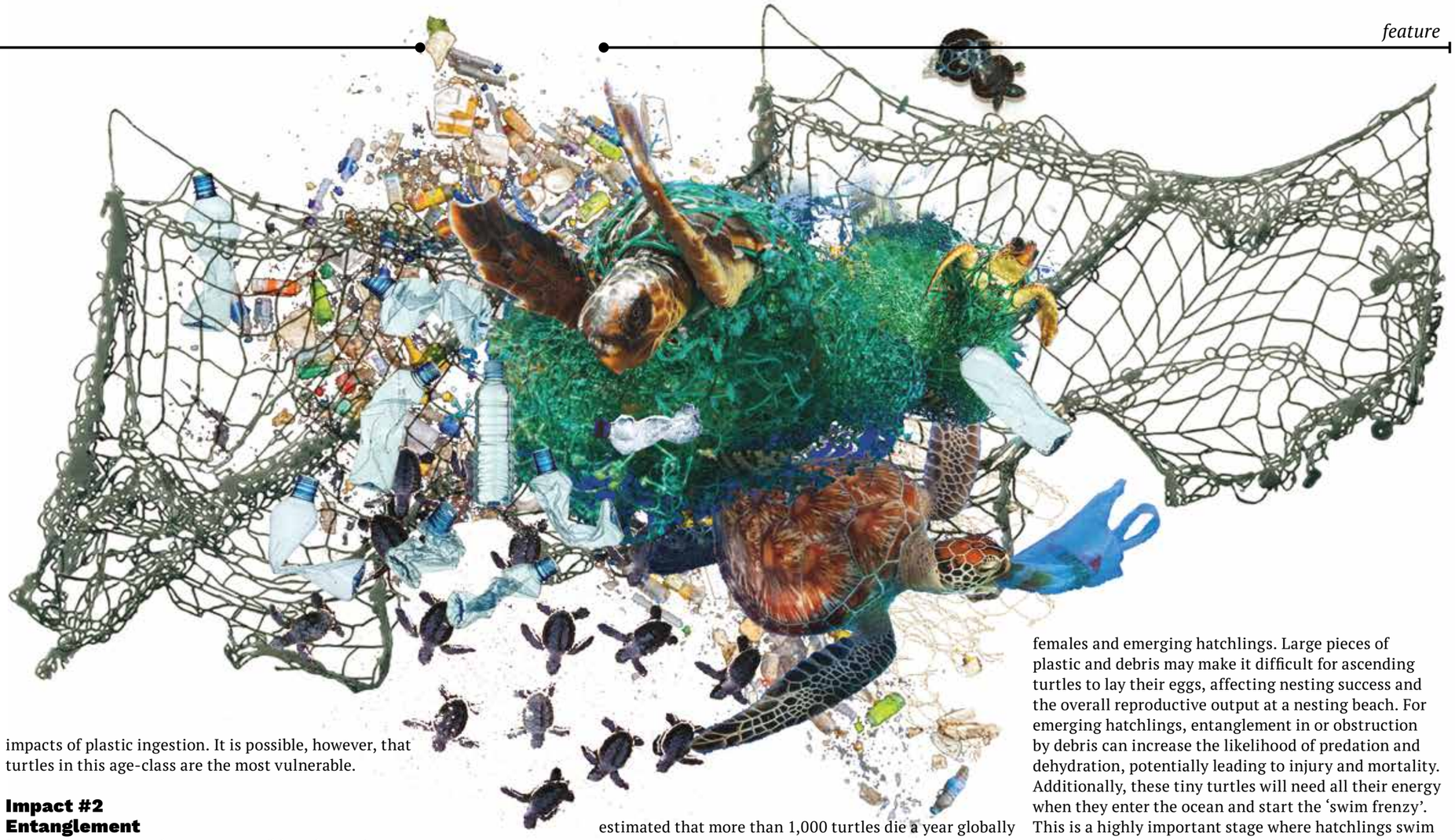
Why sea turtles?

The impact of plastic pollution on sea turtles is of particular concern. Turtles are highly mobile, travelling huge distances between foraging and breeding areas and they use both terrestrial and oceanic environments. Already under increasing pressure from a range of human stressors, including climate change, by-catch and habitat destruction, these charismatic animals are undergoing a three-pronged attack from plastic in the form of ingestion, entanglement and habitat degradation.

Impact #1 Ingestion

All seven sea turtle species and approximately 52% of all individuals are estimated to have ingested debris. Ingestion may occur for a number of reasons. Firstly, turtles are primarily visual feeders and may mistake anthropogenic items, for example plastic bags, balloons and sheet plastic, for food due the visual similarity to prey, such as jellyfish. Secondly, plastic may become mixed up with the turtle's natural dietary items. Grazers, like the herbivorous green turtle (*Chelonia mydas*), consume plastic pieces that have become entangled on the seagrass fronds they feed upon. Thirdly, carnivorous turtles, e.g. loggerheads (*Caretta caretta*), may ingest microplastics via their crustacean and mollusc prey, a process known as trophic transfer. This is when microplastics are consumed by animals near the base of the food chain which are in turn, eaten by predators.

Macroplastics (more than 5mm in size) are particularly hazardous for sea turtles when ingested. Downward-facing spikes in their oesophagus, called papillae, help them swallow slippery prey while expelling seawater. This trait, however, did not evolve with plastic in mind and the papillae actually prevent plastic from being regurgitated. Instead, it enters the digestive tract where it can cause injuries, such as internal lacerations and punctures or blockages. It can also make the turtle feel full and weaken the desire to feed, leading to malnutrition and eventually, starvation. Additionally, sea turtle buoyancy disorders, commonly referred to as 'bubble butts,' are a growing issue. This condition is often caused by gas trapped inside the turtle's digestive system. Disruption to digestive processes caused by marine debris is believed to be the reason for many of these cases. Sea turtles that cannot properly submerge will have trouble feeding and become more vulnerable to boat strikes, predation and entanglements.



The consequences of microplastic ingestion for turtles are as yet poorly understood. When consumed by marine invertebrates, such as worms and zooplankton, they have been shown to reduce food intake, cause a decline in energy reserves, lower their ability to reproduce and cause detrimental changes to the way their intestines function. For larger animals, such as turtles and marine mammals, any effects of microplastic ingestion are more likely to originate from the chemicals on or within them than the microplastics themselves. Chemical contaminants present within seawater, such as heavy metals and polychlorinated biphenyls (PCBs) which were used as flame retardants (and are now banned) among other things, are hydrophobic and so stick to plastic like cooking oil sticks to the side of a washing-up bowl. These toxicants are known to cause cancer and disrupt hormonal systems. For their size, microplastics have a large surface area to volume ratio, meaning they can concentrate these chemicals. In addition, plastic itself contains chemicals, called plasticisers, which are added during production. When plastic is ingested, this cocktail of chemicals is released and likely enters the tissue of the animal. We are still trying to work out what kind of effect this has on turtle health but it's possible that it causes sub-lethal effects, such as lowered immune system function and reduced reproduction rates.

As it stands, we do not fully understand the scale of turtle mortality caused by plastic ingestion or the resulting potential population-level effects. It's likely that the occurrence and consequences of ingestion varies with species, age-class and population due to their differing feeding ecologies and diet, as well as habitat use. For example, loggerhead turtles are at higher risk of consuming plastic due to their generalist feeding strategy, but a more robust digestive tract (in adults and sub-adults) enables foreign objects to be excreted. Hatchling and juvenile turtles are likely to be more vulnerable to encountering and becoming injured as a result of plastic ingestion due to three reasons. Firstly, six of the seven species of turtles undergo a period of time in the open ocean, called the lost years. After hatchlings enter the water for the first time, ocean currents often transport them away to highly productive areas, called oceanic convergence zones, where food, along with debris, is concentrated. This spatial overlap potentially creates an ecological trap for young turtles because it increases the likelihood of exposure to plastic. Secondly, their naivety may mean they are more likely to consume debris. As they learn to identify and select the best things to eat, young turtles will invariably encounter and potentially ingest plastic. Thirdly, young turtles, that are small in size, may be at higher risk of mortality from plastic ingestion due to their smaller, less robust, digestive tracts. Of all life stages, the lost years are the least studied and the least understood in terms of the impacts of plastic ingestion. It is possible, however, that turtles in this age-class are the most vulnerable.

Impact #2
Entanglement

In the ocean, sea turtles are susceptible to becoming entangled in floating plastics, since they tend to use oceanic fronts, currents, and driftlines where floating rubbish and debris is concentrated. Entanglement may lead to injury, amputation or choking which may ultimately cause drowning or death by starvation. Lost or discarded fishing gear, known as 'ghost gear', has become a huge issue since the 1950s when the fishing industry replaced natural fibres, such as cotton, jute and hemp, with synthetic plastic materials such as nylon, polyethylene and polypropylene, which do not biodegrade in water. Turtles are also known to become entangled in a variety of other items, including plastic twine, six pack rings, plastic packaging, plastic chairs, balloons and their string, sheet plastic and boat mooring line. Hatchlings and juvenile sea turtles are particularly susceptible to becoming entangled as they may 'set up home' near floating debris, as it provides shelter, and can remain there for years. Based on beach stranding records, it is estimated that more than 1,000 turtles die a year globally after becoming entangled. However, large knowledge gaps exist about the severity of entanglement of sea turtles, since not all turtles that die from entanglement wash onshore as they decay at sea. Therefore, rates of entanglement are likely a gross underestimate. Nevertheless, a survey of sea turtle experts indicated that plastic and other pollution pose a long term impact on the survival of some turtle populations and that they perceive entanglement as a greater threat to turtles than oil spills.

Impact #3
Habitat degradation

Large quantities of plastic are also found in coastal areas, which are crucial for sea turtle reproduction; nesting females emerge onto land to lay their eggs, and after about two months, hatchlings emerge and make their way to the ocean. Plastic at nesting grounds can cause obstruction and entanglement to both nesting females and emerging hatchlings. Large pieces of plastic and debris may make it difficult for ascending turtles to lay their eggs, affecting nesting success and the overall reproductive output at a nesting beach. For emerging hatchlings, entanglement in or obstruction by debris can increase the likelihood of predation and dehydration, potentially leading to injury and mortality. Additionally, these tiny turtles will need all their energy when they enter the ocean and start the 'swim frenzy'. This is a highly important stage where hatchlings swim continuously for a day or two until they reach offshore currents, which transport them away from land and out into the relatively safe open ocean. Any energy that gets wasted as a result of trying to get around, through or over obstacles and detangling could reduce their ability to run the gauntlet of predators waiting in the shallow water off the beach. Naturally, only approximately about 1 in 1000 hatchling turtles will survive to adulthood but interactions with human debris at this early life-stage could reduce this survival rate even further.

Plastic fragments, in particular microplastics, can also alter the specific conditions needed for beaches to provide a suitable nesting environment. As hatchling success and sex ratio is influenced by temperature, alterations to the incubating environment could negatively affect the development of hatchlings, the proportion of males to females produced, and mortality rates. Plastics, particularly those containing dark pigment, warm up

when exposed to heat, and their presence within the sand may increase nest temperature, potentially leading to a higher proportion of female hatchlings being produced. This phenomenon has already been observed as a result of rising temperatures related to climate change, but plastic debris could exacerbate the issue. Nevertheless, research is still under way to determine what type and quantities of plastic would be required to alter the incubating environment and negatively impact sea turtle reproduction. Further, chemical additives found in plastic can also be transferred to the incubating environment potentially causing detrimental effects to the health of sea turtles.

Ocean optimism

With so many negative impacts, it is easy for the problem of plastic pollution to seem so huge and widespread that the damage is irreparable. Yet, many of us working on the issue feel it is not too late. Indeed we are seeing a rise in the cases of sea turtles ingesting and getting entangled in plastic, but there has also been a rapidly growing grassroots movement to tackle the issue from the bottom up. Pressure is building on businesses and governments to mitigate the waste created by unnecessary plastic packaging on food and other goods, and there has been a huge uptake in the number of individuals saying 'No!' to single-use disposable items, such as drinks bottles, cutlery, shopping bags and drinking straws. The age-old mantra of 'Reduce, Reuse, Recycle' is one which many of us will be familiar with but perhaps forget to strive for the first, and most effective, step of reducing our plastic consumption. There are now many alternatives to plastic products and making simple changes in our everyday lives, for example by using refillable water bottles, reusable cloth bags and declining unnecessary plastic packaging, can lead to a significant reduction in waste.

Ghost gear collection initiatives, such as Net-WorksTM, integrate business with conservation by enabling local people to earn an income collecting derelict fishing nets from the ocean and recycling them into products like carpets. This 'circular economy' approach is growing in popularity and gives cause for hope that plastic may one day be seen as a valuable resource, rather than something to be discarded. Cleaning up what has already entered the environment is another approach to tackle plastic pollution. Citizen-led beach cleans not only remove vast quantities of litter from our coastlines, but they have also been proven to improve ocean literacy, particularly in children, as well as leading to positive changes in behaviours and attitudes. As with any great environmental issue, it is important that people feel empowered to create change and contribute to the solution, not just the problem. The tangible nature of plastic pollution means that it is visible in our everyday lives and the public are easily connected to it. This has inspired many to become aware of the other threats faced by our oceans in such a way that plastic pollution has inadvertently become a catalyst for marine conservation.

With the tipping point looming, it is of great importance that we remain proactive in capitalising on this new found awareness and continue gathering evidence, developing policies, pressuring governments and designing innovative solutions. Above all, we must remain optimistic that the plastic tide can be turned. ✹

Further reading

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SARAH NELMS is a PhD researcher at the University of Exeter and Plymouth Marine Laboratory interested in understanding the pathways by which anthropogenic activities may affect marine megafauna. Her work focuses on the interactions between plastic pollution and marine mammals, turtles and sea birds.

MARIANA FUENTES is marine conservation biologist at Florida State University, whose research focuses on developing science-based solutions for the conservation and management of sea turtles.

VALENCIA BECKWITH is a student at FSU studying the impacts of microplastic on marine turtles.

PUNIT J HIREMATH is a graphic designer and artist studying new media design and production at Aalto university.

HARMFUL EFFECTS AND SOLUTIONS

Author **Isabella Marinho**

Marine pollution has grown dramatically since the introduction of single-use plastic into society, as a response to rapidly growing consumer demand for cheap and accessible plastic based products. Plastics have become a symbol of the negative social, economic and, most significantly, ecological impact human development has had on the planet. Several anthropologists and historians have begun to refer to this period of human history as the 'Plastic Age'.

Negative economic impacts are seen in the industries of tourism and fishing, as a result of the degradation of local ecosystems. Adverse impacts are not solely confined to the economic: approximately 50 marine species are reported to ingest plastics. However, more are affected as these species enter the food chain and plastics accumulate in other species. Furthermore, recent scientific studies have suggested that consumption of foods with exposure to toxic waste products may lead to cancer, long-term health problems, and birth defects. The extent of such risks is an ongoing debate; whilst negative effects on marine life are acknowledged, governments and policies should not wait for further environmental degradation and greater economic loss before justifying against the risk of human and ocean health impacts.

Plastics are the most widespread, commonly found and significant marine debris. A great proportion of single-use, disposable plastic – such as food packaging and plastic bottles – ends up dumped in the ocean due to the lack of enforced waste collection and management, especially in emerging markets such as India and China. Industrial waste is also a major source of plastic pollution. 80% of marine debris comes from land-based sources, whilst shipping and fishing industries are largely responsible for the rest. Plastics frequently contain toxic chemical additives, which can be released as plastics are

Plastics have become a symbol of the negative social, economic and, most significantly, ecological impact human development has had on the planet.

broken down into microplastics. Since microplastics are consumed by small marine animals and thus make their way up the food chain, the chemicals may be harmful to marine life and could pose risks to marine ecosystems according to a recent study. Many communities rely on the ocean for their livelihood and quality of life; plastic pollution can undermine this. A study by Ghent University highlights that people who consume seafood on a regular basis ingest approximately 11,000 particles of microplastics annually. Microplastics are defined as small plastic pieces less than 5 millimetres long. Unless action is taken, this number will keep rising as the level of plastic pollution found in the ocean is expected to treble from 2015-2025.

The highest amounts of marine debris are improperly disposed food containers, packaging and plastic bags. Therefore, any solution to marine plastic pollution must address the pressing issue of usage and disposal of such plastics. Much of the plastic packaging used for food and drink is unnecessary, and can be reduced by shifting towards innovative materials and reusable containers. A total of 480 billion single-use plastic drinking bottles were purchased in 2016, most of which could be replaced by reusable glasses or water bottles, as well as implementing refilling drinking water stations in designated commercial and public spaces. Measures to reduce plastic usage have had significant success, especially when the relevant governmental institutions back them. A government scheme in the UK that introduced a 5p charge for plastic shopping bags reduced usage by 83% in the first year.

New targets to reduce consumption include taking action on plastic straws, which are also a major source of marine pollution. Fast-food chain Starbucks has launched a campaign to eliminate the availability of plastic straws in their facilities across the globe by 2020. The ways individuals shop for and consume food can be modified to reduce or eliminate disposable food packaging. One example of this is shops where consumers bring their own reusable containers to fill with groceries and personal hygiene products. Demand for zero-waste packaging products have led to a rise in grocery stores providing consumers an alternative to plastics, as seen in London's Bulk Market, Il Gusto and Field Fare.

These examples suggest that a combination of individual, corporate, and governmental action can be highly effective in reducing the use of single-use plastics in our daily habits. Finally, we need to reduce the volume of pollution leaked to the ocean. In order to facilitate such action, it is essential to bring various stakeholders and people with different forms of influence together. The issue of plastics is so broad that we need everyone to work in tandem. The Klosters Forum aims to do this and will be focusing from 2018-2019 on the issue of ocean pollution with a focus on plastics.

...people who consume seafood on a regular basis ingest an approximate amount of 11,000 pieces of micro plastics annually.

Beyond reducing usage, strict measures must be taken to ensure that, after a product's single use and disposal, it does not make its way into the ocean. Ships and industrial enterprises dump plastic in the ocean as a cheaper alternative to safer methods of waste disposal: stricter penalties and regulations for companies and ship operators could be preventative and may encourage behavioural change. Incorrect waste management leads to leaking of plastic waste that is blown off by winds from rubbish trucks and landfills. Solutions could include requiring a rethink of landfill covering, and an improvement in the design and operation of rubbish trucks in order to secure the disposal of waste products at the end of their life cycle. Making a 'life cycle' truly circular rather than linear would however be the optimal solution.

In many coastal cities in the global South, informal settlements are spreading, often located along waterfronts, which have little or no rubbish-collection infrastructure. Inadequate formal management, a fast-paced, growing population, and a, frequent, lack of alternatives to single-use plastics for essential items means that the local capacity to manage waste is stretched to its limit. Smart urban planning and investment in infrastructure and waste-management services could significantly reduce the amount of plastic pollution found in waterways.

Several schemes have been proposed to remove plastic pollution and other debris from oceans; however, these are yet to be proven as viable long-term and large-scale solutions. Whilst removal of plastic from the ocean is necessary, it does not address the root of the problem: the large quantities of plastics flowing into the ocean. It is essential to stop plastic entering the ocean: this can be done through various ways. Changing how people use and dispose of it and reducing its prolific use through policies to encourage this behavioural change which include the imposition of taxes, charges, and regulations. Further steps should be taken to ensure that plastic, once thrown away, does not make its way into the ocean. Innovative technologies for alternative materials and delivery systems ought to be developed. Fundamentally, however, using an indestructible material for fleeting uses needs to be radically reconsidered: a good start would be to reduce the use of avoidable single-use plastics and to eliminate the use of unnecessary single-use plastics and to find ways to make global economies truly circular. ✹

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ISABELLA MARINHO Isabella is an education enthusiast with a passion for environmental conservation. She is in her last semester at the Environmental Studies degree program at The New School and completed previous studies in art curating and criticism at Central Saint Martins. During the Summer she worked for The Klosters Forum and assisted in executing their 2018 Ocean Pollution conference.

HAS THE PIPE ONLY BECOME LONGER?

A LEGAL COMPLIANCE CONUNDRUM

Authors **Krithika Dinesh, Hasmukh Dhumadiya and Bharat Patel**
Illustrator **Kabini Amin**

Mithapur is a coastal town situated in Gujarat, known for the salt plant in town more than its beaches. In fact, the place derives its name from 'mitha', the Gujarati word for salt. Mithapur is also referred to as the birthplace of Tata Chemicals, which took over Okha Salt works in 1939 and is today the second largest soda ash producing company in the country.

If you happen to walk around the Mithapur and Padli villages, you cannot miss this massive factory. You will also see an open channel arising from the factory, going to the Gulf of Kutch. The channel carries industrial waste water, including chemicals like sulphur, chlorine and ammonium nitride. Over the years, people say that water from this channel has seeped into the ground and affected groundwater, nearby agricultural fields and grazing lands. They also say that due to the contamination of ground water, there are no sources of water left for them and their cattle.

Back in December 2016, when people learnt that some of these impacts could be mitigated, they filed complaints before the Gujarat Pollution Control Board (GPCB). The GPCB took a note of this and issued a show cause notice to the company after 4 months. The GPCB also directed the company to concrete over the channel along with several other directions to ensure no further seepage of waste water into the ground. But there was no visible change in Mithapur. The people complained again to the GPCB, following which a site visit was conducted by the GPCB. Similar directives were given again to the company by the GPCB. There is however still no compliance, and the effluents flow through the open channel as usual.

Transferring pollution from land to sea

The people of Mithapur are now facing a dilemma. While the compliance to the directions given by GPCB is being awaited, an announcement was made by the GPCB about a proposal to build a deep-sea pipeline for Tata Chemicals. An underground pipeline of 2.5 kilometres long and 45 metres wide, is proposed to be laid down, to take all the waste water from Tata Chemicals directly into the Gulf of Kutch. The standards required for discharge onto the sea are also said to be lower as compared to inland water.

Now here is the problem. This pipeline will pass through mangroves, the Marine National Park (MNP) and will end a few meters beyond the Ecologiclly Sensitive Zone in the area. Established in 1982, the Gulf of Kutch MNP was the first of the 13 MNPs in India. It is home to various species of fish, corals, mangroves, octopuses and supports several marine mammals like dugongs, dolphins and porpoises. At the same time, the Gulf of Kutch is also a source of livelihood for the fisherfolk in the area. The fishers feel that the the pipeline will pose a threat to their movement since navigating in those areas will be restricted. The Environment Impact Assessment study conducted for laying the pipeline in Mithapur did not even mention the issue of access of the fisherfolk to these areas. The proposal is currently being examined by the Expert Appraisal Committee of the Environment Ministry.

This is a story of how governments allow for impacts to be displaced from one place to another, and not addressing the reasons the problem have occurred in the first place.

Harishbhai, who is one of the complainants affected by the open channel says, 'The pipeline will be a short term solution which will solve the problem of land getting polluted, which has been happening for around 40 years now. For the longer run, it will be better to concrete the channel. The company will probably not agree to it, as they will have to stop operations for a few months. Only then can the discharge be stopped and concreting can happen.'

This story shows how governments allow for impacts to be displaced from one place to another without addressing the reasons the problem occurred in the first place. The solution of a deep-sea pipeline merely shifts the point of discharge; it does not in any way ensure better compliance by the companies or monitoring by the concerned

feature

authorities. Tata Chemicals is just one among many companies that have proposed to or laid down a deep sea pipeline along the coastline of Gujarat. There is no publicily avaialable information on the how many such pipelines are in the pipeline in India.

A problem across the Gujarat coast

The western Indian state of Gujarat has the largest coastline in India of around 1600 km and a diverse marine ecology. It has the first marine national park and sanctuary in the country that extends from the Kutch district to the Devbhumi district. This is known for the rich mangrove forests, coral reefs and is a hub for near threatened species of birds. Gujarat also contributes to 20 percent of the nation's fisheries production and has more than a thousand fishing villages.

The large coastline has also resulted in an influx of activities around these coastlines, making it a hub for import and export and large scale processing units. The 1960s saw a large number of industries being set up under the Gujarat Industrial Development Act, 1962. While the Gujarat economic model has been discussed by various actors – politicians, academicians, media and the public – the pollution crisis that Gujarat has been facing has not featured in these debates.

The pollution crisis has been acknowledged over the years through various orders from the judiciary as well as academic and newspaper reports. In 2009, the Central Pollution Control Board studied the pollution levels in 88 identified industrial clusters in the country. Based on the pollution levels, 43 such clusters were identified as critically polluted areas. Six of these 43 clusters are located in Gujarat, with Vapi and Ankleshwar topping the overall list. Rivers like Amalkhadi in Ankleshwar and Khari and Sabarmati in Ahmedabad were declared unfit for domestic uses in 2012. In 2018, the MOEF&CC recognised 20 rivers in Gujarat as polluted.

History of deep-sea pipelines as a solution

We have observed that this is not the first time deep-sea pipelines were proposed to tackle land-based pollution. For example, in 2009, when Vapi was recognised as one of the most critically polluted industrial clusters in the country, an action plan was made to reduce pollution. One of the points of action was the laying of a deep-sea pipeline. Currently, treated effluents from Gujarat Industries Development Corporation(GIDC) are disposed off into the Damanganga river, impacting the livelihoods of fisherfolk.[1]

Another instance is when in 1999, following a Gujarat high court order that disallowed releasing untreated industrial effluents into Amalkhadi river, a proposal was made to lay a deep sea pipeline in Sarigam.[2] The deep-sea pipeline in Sarigam however has not resulted in resolving the problem. There have been several news reports of fish mortality in these areas due to untreated effluents released into the seas. Residents have also complained that it has resulted in their health being affected. A detailed investigation of the impacts of already existing deep-sea pipelines need to be assessed. There has also been instances of leakage in pipelines in some areas where such pipelines have been installed..

An environmental justice issue: Displacing the impact

Environmental pollution problems often result in solutions where the burden is merely shifted whilst the pollution remains the same. Laying deep-sea pipelines as a response to complaints against rising pollution raises more questions than answers. What are the impacts that arise out of laying and maintaining a deep-sea pipeline? Is the pollution load being reduced or the burden being shifted?

Without having robust measures in place to ensure compliance, measures such as deep-sea pipelines will only result in displacing the pollution and shifting the impact. The shift needs to be accompanied by a structural change in how the problem of discharging untreated effluents is addressed in the first place. There needs to be more robust monitoring mechanisms and punitive measures. The basic issue of non-compliance and the impacts that arise are not dealt with. When the industries as well as the authorities have failed to demonstrate compliance to existing protocols, the question remains as to why there has been a shift in the dumping ground. The pipes will just become longer, but has anything else changed? ✹

KRITHIKA DINESH, is a legal researcher with an interest in environmental issues. She is currently working out of Keonjhar, Odisha in an Environment Justice Program of Centre for Policy Research.

BHARAT PATEL, currently work on the issues of coastal industrialisation and livelihoods of the fisherfolk in Mundra, Gujarat. I am the General Secretary of MASS - Machchimar Adhikari Sangharsh Sangathan.

HASMUKH DHUMADIYA is an Enviro-Legal Coordinator working in the Environmental Justice Program of Centre for Policy Research out of Devbhumi Dwarka district in Gujarat

KABINI AMIN is a communications designer and illustrator based out of Bangalore. Her current interests lie in exploring the intersections of scientific research, cultural interventions and active-ism within the context of sustainable living

Foot notes

1. http://indiatogether.org/vapi-decades-of-damage-environment
2. http://www.downtoearth.org.in/coverage/industrial-discharge-seaward-ho-15440

GHOST GEAR

THE SILENT KILLERS IN OUR OCEANS

Author **Martin Stelfox**
Illustrator **Amyth Venkatramaiah**

What is ghost gear?

Before the dawn of plastic, fishing nets were made from natural materials such as cotton or coconut fibre. These days, plastic nets have replaced most types of natural materials because they are lighter, stronger and cheaper to produce. Plastic is impervious to biodegradation and remains unchanged for decades. As a result, abandoned, lost or discarded fishing gear, commonly referred to as ghost gear, are clogging the marine environment at an alarming rate. It is estimated that around 6,40,000 tons of ghost gear is produced every single year, but this amount is likely a gross underestimation of the true quantity entering our waterways today.

The reasons for ghost gear production are varied and include, for example, accidental loss, operational damage or gear conflicts. However, illegal, unreported or unregulated (IUU) fishing may increase the chance of intentional gear loss due to gear abandonment and a lack of port side disposal by IUU vessels.

What is ghost fishing?

Ghost nets follow one of two journeys; either they drift on the surface following oceanic currents and winds to eventually end up littering beaches or locked in ocean gyres, or they sink to the sea floor. In both scenarios, they continue to entangle animals in a process known as ghost fishing. Ghost fishing is insidious, cryptic and occurs across national boundaries making it a difficult issue to address. The exact number of animals that become victims of ghost gear through entanglement or ingestion is unknown, but a recent expert survey highlighted that marine debris in the form of ghost gear is widely recognised as a major source of mortality for marine organisms. Ghost gear not only causes mortality through entanglement or ingestion but can smother sensitive habitats such as coral reefs. Furthermore, the transient nature of floating ghost gear makes it the perfect object for hitchhikers. For example, microplastics have been shown to harbour a wide variety of bacterial and microbial communities. Therefore, it is not a stretch of the imagination to assume invasive communities could colonise ghost gear and introduce disease to local fauna.

Does ghost gear impact fisher livelihoods?

Ghost gear carries with it a socioeconomic impact that is difficult to measure. Quantifying the financial burden of ghost fishing is challenging but research suggests that it could be severe in some cases. Ghost fishing can undermine best practices when managing stocks and are usually not included when analysing bycatch rates. Ghost fishing not only impacts fish population but can put a financial burden on fishers due to gear replacement and loss of catch due to ghost fishing.

What can we do to help?

A common tendency is to think that the problem of ghost gear and associated ghost fishing is so big that nothing we do as individuals will help reduce or even stop the issue. However, as consumers we can dictate how seafood is caught and how much we catch. To start, we must not be afraid to ask questions about where our seafood comes from and how it is caught. Restaurants, supermarkets and local fishers must be held accountable for the seafood they sell. We can also reduce our consumption of seafood in general if we are in the position to do so and this will help lower the global demand for seafood products and will help reduce many problems associated with overfishing but also ghost gear production.

A worrying trend that is often seen on social media platforms is the demonisation of small coastal fishing communities and their role in the ghost gear problem. In reality, the people most impacted by ghost gear are exactly these communities and therefore we must work towards providing alternative livelihoods and education in these areas. This is particulary important before policies or legislation are implemented to ensure local laws are followed and fishers do not end up losing out.

The Olive Ridley Project

The Olive Ridley Project (ORP) is a registered charity that works towards protecting sea turtles and combatting the issue of ghost gear in the Indian Ocean. The project was set up due to the alarming number of olive ridley sea turtles found entangled in ghost nets in the Maldivian archipelago. In response to this, ORP developed a fully equipped turtle rescue centre run by sea turtle vets, which is the only one of its kind in the Maldives. The project also works with small scale fishing communities to help improve livelihoods and reduce ghost gear production. For example, work within a small fishing community of Abdul Rehmangoth, Pakistan has resulted in the clean-up of over 3 tons of ghost gear from local fishing grounds and turtle nesting beaches. After many educational workshops and discussions, this local community uses ghost gear to make bracelets that bring in an alternative income to the fishing community. ORP also provides educational presentations and learning experiences about the dangers of ghost gear to sea turtles to local schools in the Maldives and wider Indian Ocean. ✹

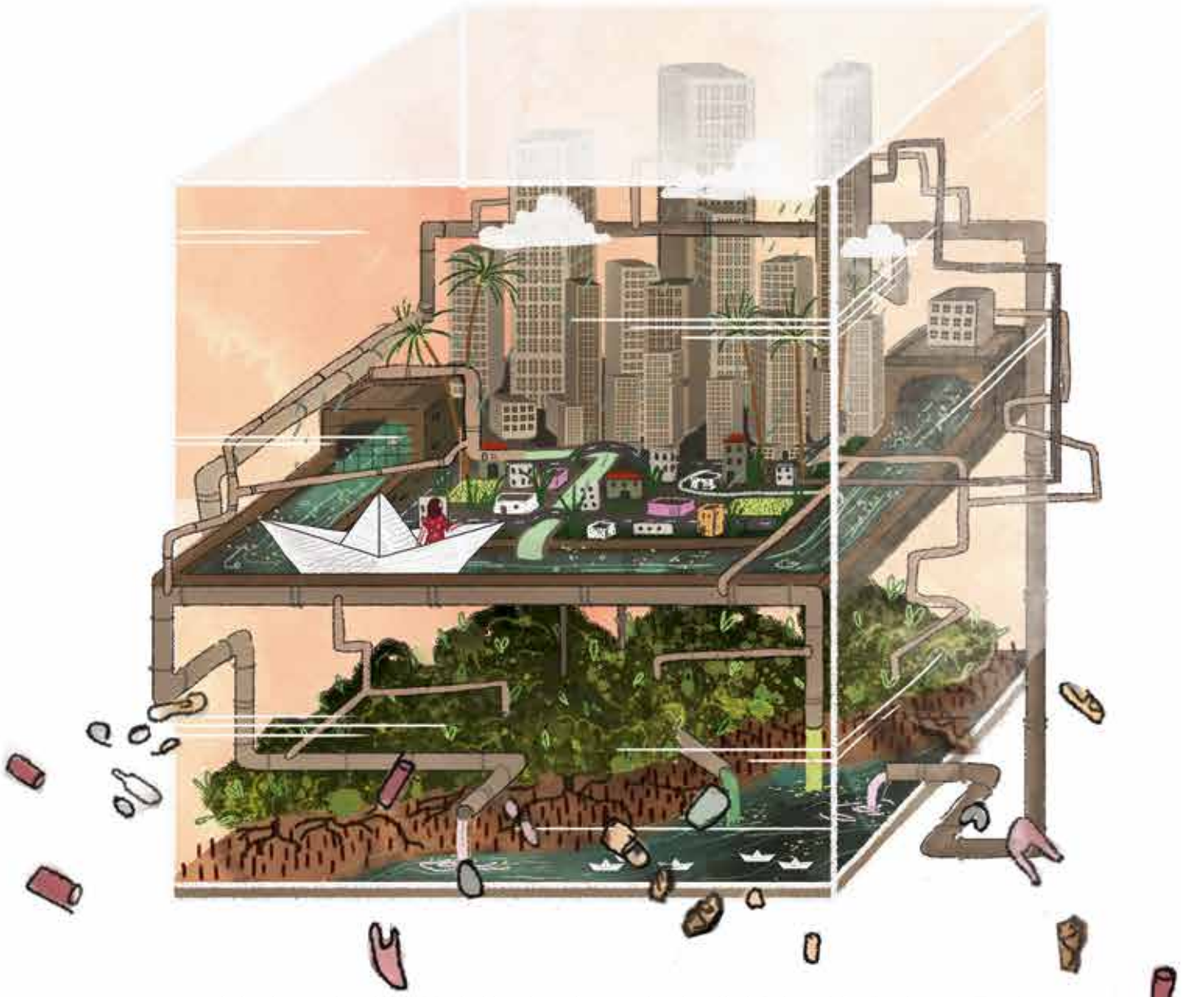
MARTIN STELFOX is a biologist and conservationist currently in the final year of PhD at the University of Derby. He is also the funder and CEO of the Olive Ridley Project.

AMYTH VENKATARAMAIAH runs a graphic design + film studio called Newsense in Bangalore, where he grew up. He lives with his family and 2 year old nephew who inspires him to keep curiosity levels high. Plants, animals, art and music make him happy.

DEBRIS

Author: **Rohan Arthur** • *Illustrator:* **Svabhu Kohli**

I'm seven. I'm spending the vacations with my grandparents in a little peri-urban village that will soon be digested within the messy innards of Bombay. The village is my landscape of summer dreaming. Outside the garden gate, down past the dirt track that leads to the asphalt road, there is an open storm drain. It collects wastewater and sewage, swilling together the private leavings of the nearby houses. It flows past our little lane but connects to a larger drain on the main street, which is connected yet again to other tributaries in a dizzying network that pours untreated waste into the ragged mangrove patches near Versova, finally trickling into the Arabian Sea. It ebbs and flows with a rhythm that links the daily ablutions of the village with the rain and the tidal cycles of the Indian Ocean. Some days, for reasons my seven-year old mind cannot fathom, it is less of a flow and becomes a thick slurry, bubbling and burping ever so slowly, an enticing, glistening black. At other times it is a clear sap soup, getting clearer each time it rains. When grease from the kitchens pour in through the drains, an oily rainbow flits on its surface and I can play with it, disturbing the vibgyor with a stick, watching it form again lower downstream. Mostly though, the stream is a dark, slightly viscous indigo. In the neighbourhood it is called the Gutter. The Gutter is the subject of folklore in the village. Of lost treasures big and small - four anna coins and engagements rings. Of late night drunken stumbling and mucky ankles. Of the sad village idiot called Gutter-Bamboo, who spends his day poking about it with a pole for anything he can find. For me, the Gutter is a place of endless fascination. Each morning, I rush out the lane to check on the progress of the stream, make a mental note of its colour, its texture,



any subtle change in odour. My dad has bought me a book called Origami for Beginners. Tearing out pages from my double-line notebook, I follow the instructions. Square folds, mountain folds, unfolds - and I have my first origami boat. A trifle wonky, but I'm proud of my craft. I rush down to the gutter to float it. It is glorious in the stream - wafting on an ebony river, down to where it meets the larger tributary. Buoyed by this success, I grow in my naval ambitions. I spend the rest of the morning building an entire armada with boats of different sizes. I make small triangular flags for the larger ones, borrowing a few sticks from grandma's broom for the masts. The tinier craft require more skill I realise, but my fingers are small and deft. I colour these little ones with felt pens in bright primaries. By evening I have an entire fleet, including a large flagship made with a piece of chart. It has a proud mast, portholes, and, in an inspired touch, a forward cannon, made with leftover bits of paper. I sleep the sleep of a master shipwright, pleased with his craftsmanship. It rains all night and the gutter is in spate. Still, by 11 am, the floods have calmed a bit and I am ready with my fleet. One by one I launch the ships...all 17 of them, from flagship to little skiffs. They start off in a proud orderly convoy, but quickly bunch together in the centre of the stream. At the confluence, I watch the messy flotilla get taken over by a more furious flow. A few of the small skiffs overturn and sink, but the hardiest rough the waters into the distance. I'm not allowed to venture far down the main street so I watch as my brave fleet floats and bobs its way to grand adventures out toward the ocean.

I'm older now. On a small island in the snapping jaws of the Gulf of Kutch. I've been here several months, and I've made it home. 'Are you coming?' asks Dadi. 'Yes, I'll be right there' I say. Dadi and Dada are my adopted family on the island, and I'm helping Dadi in her daily beachcombing. Every day, the tide goes out for several kilometers. Then swarms back to shore with the force of a river, bringing with it a scattering of debris. Every evening Dadi and I walk around the beach, picking up bottles and putting them in a large gunnysack. I try to imagine how a modern-day Crusoe would construct the world from all the stuff that floated to his castaway island. Urgent empty missives delivered in a torrent of Pepsi and Bisleri bottles. Our beachcombing is not a cleanup exercise. It is a gathering expedition, a way to gain a small supplementary income. On the mainland, Dadi gets 25 paisa for every undamaged bottle she finds, more, if it has the cap on. Within a fortnight of collecting, we have enough for several hundred rupees. Dadi has spotted something in the distance, near the lighthouse. We rush to see what it is. A small wooden crate, likely dropped from a passing ship. It's been floating for a while because it is has algae and a few bright barnacles growing on it. I drag it to the Porta Cabin and, between Dada and I, we break it open. It's a 12-pack of pear juice, not yet past its date of expiry. We are ecstatic. We tear into one and taste it, gingerly at first but then with greedy gulps. It is delicious. We have no refrigerator, but there's a spot beneath the mangrove where it's always cool. For four days we feast on the best pear juice known to man. There's treasure everywhere.

I'm older still. We are diving off Kiltan atoll in the northern Arabian Sea, trying to take stock of the reefs after the last massive El Niño event. The coral itself is struggling, but for the most part, the fish don't seem to care. There's bustle everywhere as the fish wander through their metropolis. Skulking in ambush among the boulders, busily scraping the turf, getting parasites removed at cleaning stations, angrily shooing away territorial invaders. They barely mind us, gawky camera-toting tourists. The reefs of this archipelago are climate-weary after repeated battering, but at least on this reef, things are not so bad. We are in expedition mode so we have to work efficiently. Everyone knows their job - who lays the transect, who takes the benthic pictures, who counts the fish. Transect three. Something dark and ominous against the blue. We all spot it together and our eyes widen. A gigantic fishing net has drifted in from the deep and is trapped on the reef. It has caught on the coral at around 15 m, and rises all the way to the surface. It sways gently in the swell like a single incongruous and impossibly-large kelp, reaching to the sun. It has reaped a rich bounty in its journey to the reef. Snappers, jacks, a few fusiliers, a massive tree trunk, fronds of coconut, all bound together in its gills. We abandon our transects. Despite ourselves, we are drawn to it, unable to take our eyes of its sheer majesty. We spend the rest of the dive circling the net along with schools of batfish, inquisitive unicornfish, triggers, and a host of other worshippers. With a totem of this power, all you can do is pay quiet homage, and marvel at its extravagant, wasteful beauty.

I'm travelling on the Ganga in Bihar. The river is a clayey green and there are debris everywhere. The Ghats are densely concentrated with plastic and micropackaging. Walking to the rivers edge, we must navigate the garbage and ritual offerings strewn along its banks. It has all the floral colours of spring, only brighter and more arbitrary. I'm sitting now on a little boat in the middle of the stream, quiet and happy. The gutka packets on the shore glisten gaily in the morning sun. I imagine the river goddess, vain, proud, self-aware in her own dramatic beauty. She is picking carefully through her vast jewelry case of intricate debris, lining her tresses with gaudy glitter, smiling at her reflection, clearly pleased with the result. A large bloated buffalo wanders past our boat. It has been dead for a while, and it floats content in its gentle passage. A river dolphin surfaces, snorts and disappears. A bucolic idyll. I have my notebook in my hand and something inside me wants to tear a page, make an origami boat and float it down the river. But I'm not seven anymore, so I don't do anything of the sort. In my imagination though, my little boat navigates its way around the dead buffalo, past the Farrakka Barrage, through the crocodile-filled waters of the Sundarbans, into the raging Bay of Bengal to find its home eventually among the eddies of some undiscovered garbage patch in the Indian Ocean where all paper boats, Pepsi bottles, phantom nets, gutka packets and dead buffaloes eventually land up, along with the rich histories that brought them there, swirling together. ✹

ROHAN ARTHUR is a scientist with the Nature Conservation Foundation. He works on ocean and coastal systems in the Indian Ocean and (on occasion) in the Mediterranean.

SVABHU KOHLI is an independant visual artist exploring the unique relationship our planet shares with its inhabitants. His work translates observations, conversations and experiences through visual art.

ABOVE THE HORIZON

INHALATION OF METALS DURING OIL SPILLS ARE ALSO A THREAT TO MARINE WILDLIFE

Author: **Andrea Phillott**

An explosion on the offshore drilling rig, Deepwater Horizon, in the Gulf of Mexico in 2016 resulted in an oil spill and clean-up operation of unprecedented size and effort. Most research after the disaster focused on the environmental fate and impact of the oil and chemical dispersants. Studies found few health effects in marine wildlife that were linked to chemicals such as PAHs (polycyclic aromatic hydrocarbons) after the spill, possibly because their continuous exposure to large amount of oil that seeps from natural reserves under the sea floor has made them resilient to such chemicals.

However, the effects of exposure to metals in crude oil on the health of marine animals was an overlooked aspect of this disaster, so between 2010 and 2012, Dr John Pierce Wise Jr, University of Lousville, and colleagues collected skin and blubber biopsies from sperm whales, short-finned pilot whales, and Bryde's whales that reside in the Gulf of Mexico. They found that whales were likely to have been exposed to metals during the oil spill, resulting in concentrations higher than known averages worldwide, and that most exposure probably occurred when whales inhaled metals that were released when spilled oil was burned during clean-up operations.

These metals are known to be genotoxic, and therefore can potentially change the genetic information in cells and lead to cancers. The metal concentrations in the whales' tissue samples decreased during the study between 2010 and 2012 but there may be ongoing health effects, and longer-term research is required to better understand the toxic legacy of the Deepwater Horizon disaster for marine wildlife. ✹

Reference

Wise, J.P. Jr et al. 2018. A three year study of heavy metals in skin biopsies of whales in the Gulf of Mexico after the Deepwater Horizon oil crisis. *Comparative Biochemistry and Physiology, Part C* 205:15-25.

PROF. ANDREA D. PHILLOTT is a sea turtle biologist teaching conservation biology, ecology and environmental studies at FLAME University in Pune, India.

photo contest

RADHA RANGARAJAN

'Inniku high heels curry saapadlaam!'
(Let's eat high heels curry today!)

'Inniku high heels curry saapadlaam!' (Let's eat high heels curry today!) exclaimed one man, and the others laughed aloud in agreement. These fishermen at Marina Beach had just brought their catch in, the choppy sea didn't make towing the boat up the beach easy. They began to pull the net apart - a mud crab first, then a little skate, and then came this lone sandal. A comic relief for the onlookers, but a regular annoying moment for the fishermen.

This is what happens to garbage, it simply ends up in the sea. All along the coast, I kept photographing nets that had been pulled up by fishermen, and irrespective of the place and the quantity of fish, the one constant presence in all nets and on all beaches was garbage.

RADHA RANGARAJAN is usually found lost in either a forest or a book. A photographer, Radha dabbles in filmmaking, art and writing. She's a natural history buff and is partial to elephants, fungi, owls and trees.




STASHIA D'SOUZA

Washed up

I'm a photographer who has been shooting objects washed up on the shores of Mumbai, India for the past year and a half. The series is called Washed Up. The images that I have attached here are a mix of toys, idols, medical waste and everyday objects. Through the process of shooting this series I've noticed how life in the city has an impact on the kind of waste that gets washed up. For example, after specific festivals a number of immersed statues return. The same can be said of activities happening close to the shore line. On days when oil residue washes up on the shores, it is often accompanied by a huge amount of dead marine life.

STASHIA DSOUZA is a photographer and psychology student based in Mumbai.

LITTLE RED HOME

words
Mahira Kakajiwala

pictures
Prabha Mallya

Excerpt from 'Little Red Home and Other Stories'. An upcoming series of childrens' books published by Dakshin Foundation. dakshinfoundation.india@gmail.com

strut strut

I was crawling around the mangroves, very proud of my new shell.

You see, my older one was now a little too small. I did love it. It was perfect when I found it, but I had outgrown this shell I called home. It was time to abandon it for one that was larger and would give me some space to grow.

too weird

too small

too meh

too big

too alive

Finding this new shell was much harder. I had to compete with a whole group of other hermit crabs that were about the same size as me. This meant that we were all looking for similar sized shells.

When we find a shell that fits us right, the ends of our soft bodies can curl into the spiral of the abandoned shell.

We use the end of our body to hold tight to the inside of our new home – a home that keeps us safe from deadly predators.

One day, not so long ago, while on a quest for my new home, I came across a shell that I had never seen before.

It was red, a great bright red! Such a pretty colour it was.

And it was just the right size!

such envy

so fetch

many bling

much weirdo

It did fit a little strangely, and no one else seemed to want it, but I was so enamoured by the colour that I decided to ignore the fit.

STYLE OVER COMFORT IS WHAT I SAY.

Soon after I started strutting around and showing off my new shell, I spotted a mud crab, stealthily walking towards me. Mud crabs, I knew, eat my kind.

Now ordinarily I would have crawled back into my shell so that only my hard legs would be exposed and my own soft body protected. But this strange, new, but very pretty home wouldn't let me do so!

Oh, gosh! How foolish was I! I got so entranced by the beautiful red colour that I didn't stop to think about my safety.

MAHIRA KAKAJIWALA in her past lives, has been a marine biologist and a baker. She is now an educator, looking for ways to communicate the amazingness of the oceans and its critters to anyone who will stop and pay attention.

PRABHA MALLYA is an editorial illustrator and comics creator. She is known for drawing insects in the margins, pressing flowers into endpapers, and populating spines with kittens.

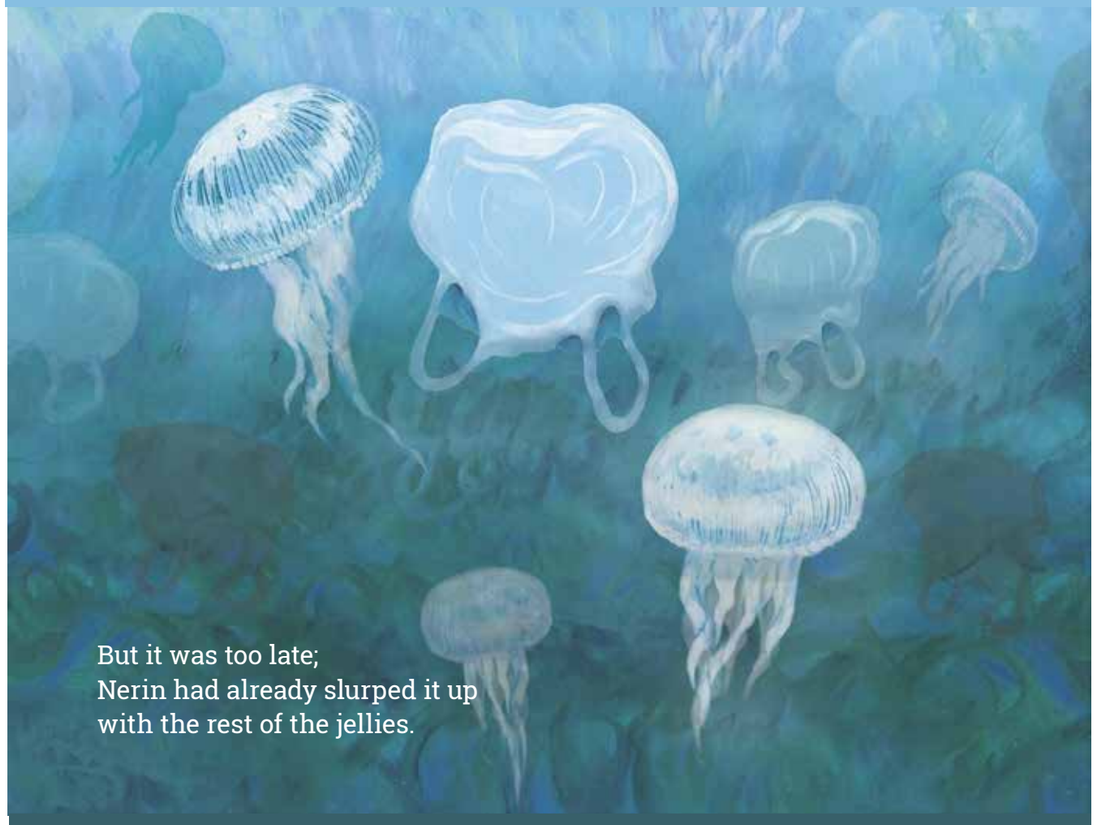
Nerin–
whose name means
'someone from the sea' -
was a turtle who lived
in the open ocean.

Her big flippers and smooth shell meant she could glide effortlessly through the water.

This was a very good thing because she sometimes had to travel thousands of miles in search of her favourite food, jellyfish.

One day she came across a whole swarm of jellyfish, bobbing about in the water.

'Yippee!' She cried.
'I'm so hungry I could eat them all!'.
Nerin rushed towards them and started hoovering them up like jelly off a plate.
In her haste, Nerin didn't notice that one of the floating white blobs wasn't a jellyfish at all but a plastic shopping bag, the kind you see at the supermarket. Someone must have dropped it in the sea by mistake.



But it was too late;
Nerin had already slurped it up with the rest of the jellies.

'Oh dear',
she groaned, 'that last one didn't taste very nice.' Perhaps I've had enough for one day'.

So off she swam to take a nap at the surface of the water where she knew the warmth of the sunshine would help her dinner go down.

storytelling

A little while later Nerin began to feel unwell. Her tummy ached and she still felt very full.
'Hmmm...maybe I ate more than I thought', she pondered. 'I must stop being so greedy.'

Over time she began to feel more and more poorly. She couldn't eat and she was finding it difficult to swim.

One day a big storm came. She was so weak from not eating that her flippers weren't strong enough to fight the swirling waves.

Eventually after drifting for a long time, she found herself somewhere very unfamiliar. She could hear the sea but couldn't feel it. Instead she felt rough sand on her flippers and a gentle breeze on her face. When she opened her eyes she realised where she was. On land!

Without the water to support it, her body felt heavy. She tried to move her tired flippers but she was just too weak.
'What am I going to do?', she thought. 'If I stay out here I'll bake in the sun!'

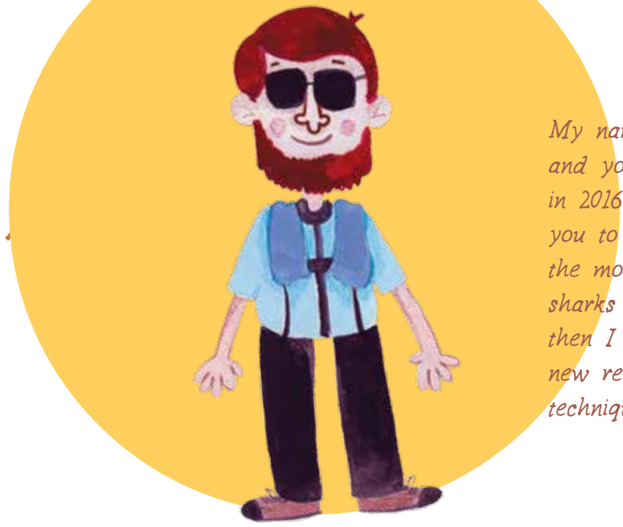
All of a sudden she heard a noise. It was a sort of snuffling that got louder, as if whatever was making it was moving closer.
Then she heard,

'BARK!
'BARK!
'BARK!

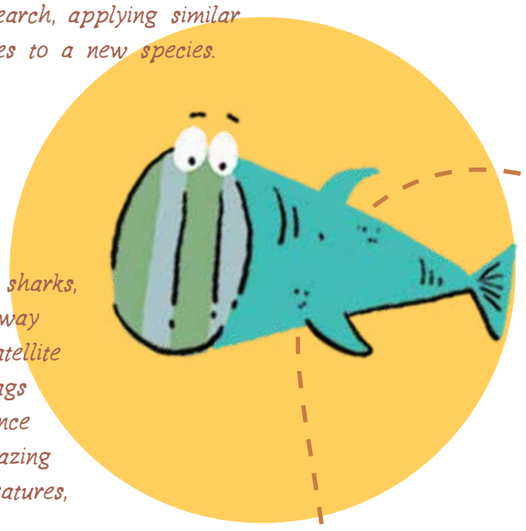
To read the rest of Nerin's tale, head to https://issuu.com/universityofexeter/docs/turtleplasticjellyfish

Catch up with Dr. Phil!

Author **Phil Doherty** • *Illustrator* **Shreya Sen**

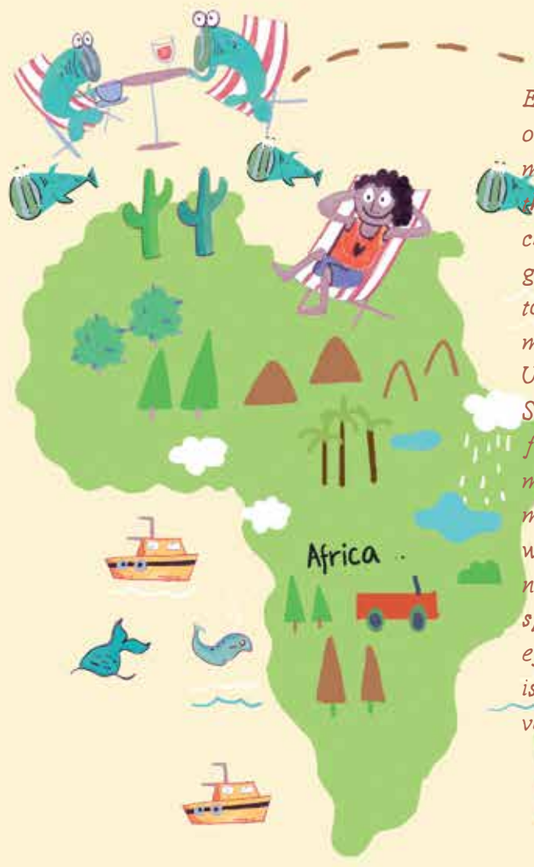


My name is Dr Phil Doherty and you may remember back in 2016 (issue 10.2) I introduced you to my fieldwork studying the movements of basking sharks in UK waters. Since then I have moved onto some new research, applying similar techniques to a new species.



In the summer of 2014, I completed my final field season working with the basking sharks, waving goodbye as they swam away carrying the latest in designer satellite tag accessories. Since then, the tags have detached themselves, and once collected, they revealed some amazing things about these mysterious creatures, and the journeys they make.

Some sharks decided not to go very far from where we tagged them, remaining within 200 nautical miles from the UK coastline. In contrast, others decided to head off on an adventure, with some sharks travelling as far as North Africa and reaching depths over of 1 km along the way! This type of information is critical in trying to decide on ways of protecting species of conservation concern and can help inform where to put protected areas.



Even though I would love to have worked on basking sharks forever, all projects must come to an end. As a researcher at the start of my career, I will need to change between projects several times, to get the broad range of experience required to become the best scientist I can. So for my next adventure, I'm working with a UK charity called the Marine Conservation Society, analysing satellite tracking data for green turtles in the Caribbean. You may see a trend here – this is similar to my work with the sharks. I am now using what I learnt in my early work to provide new information on a completely different species, again in the hope of identifying effective conservation measures. This work is similar to the basking shark project in various ways.

We are hoping to find out where these animals go, when this happens and the reasons behind why they are going there. For example, perhaps they are looking for new areas to find food. This work will again look at current legal protection and try to foster multi-national cooperation in conserving this species, which unfortunately often gets caught by mistake in fishing gear. Even though we are using similar technology and techniques, the turtles have a very different range of behaviours and ecological requirements to basking sharks. For example, turtles need to breathe air and so frequently have to surface, whereas basking sharks have no need to surface to breathe, but are often seen at the surface, where they feed on summer plankton blooms.

It is these differences that are so interesting, and so important to understand, if we are to find the most appropriate conservation strategies.

DR. PHIL DOHERTY is a marine ecologist focusing on the movement ecology and spatial patterns of marine vertebrates. His research integrates the use of spatial ecological tools, including satellite tracking, and remote sensing to inform conservation strategies

SHREYA is an Illustrator based out of Kolkata. Analyzing narratives, procrastination, comics, humour, imitating people, making chai are some of her interests.