

saveourseas

THE SAVE OUR SEAS FOUNDATION MAGAZINE



SHARKS | TRACKING | SEYCHELLES

N° 11



NOTE ON THE COVER

A whale shark's dorsal fin carries a SPOT tag that will beam information to satellites in space. Whether it's tracking sharks that circumnavigate the globe or deciphering the details of reef mantas resident in a coral atoll, understanding how animals move around the oceans is a core conservation imperative. Using this information to help us work out how best to share the seas with sharks, rays and other marine life has always been central to the Save Our Seas Foundation's vision. The tenet 'when we know better, we can do better' is an appropriate guiding force.

*Photos: cover, Jenny Waack,
backcover, Christopher Vaughan-Jones*

EDITOR'S LETTER

Welcome to the 11th issue of *Save Our Seas*, the magazine of the Save Our Seas Foundation.

Recent times have been particularly challenging. Busy lives dictated by movement and connection have ground to an uncertain stasis as a pandemic forces the global community to stay home to stay safe.

This unscheduled pause has granted many of us the opportunity to reflect on the importance of home, our movements and our relationships, with each other and with the natural world. We have adapted and refocused on home and only move for basic needs, just like the animals in our oceans that balance risk and reward to survive. Suddenly we are looking at our own lives in a way similar to how we study animal behaviour, ecology and conservation.

In the feature 'Stay home, stay safe' we examine how the high residency of sharks, rays, turtles and fishes to a remote coral atoll in Seychelles will help newly announced marine protected areas to keep these creatures safe. By contrast, in 'Space race' we highlight how the global scale of their migrations puts sharks at great risk of interaction with fisheries, but also how advances in tracking technology are being used to inform conservation efforts – just as our movement during the pandemic poses risks and there is a race to develop vaccines. Meanwhile 'Ripple effect' explores hidden consequences of reduced human migration on marine conservation, including how the loss of tourism can impact conservation efforts around the world. In 'Saving giants' we also highlight how having a strong sense of home – in this case sawfishes' fidelity to the rivers of Bangladesh – has made these same sawfishes vulnerable to overfishing and in dire need of help.

Other stories include an account of monitoring a lost beluga whale and project leader Catherine Macdonald's discussion of ongoing challenges for women in marine science and how we must all contribute to making our field an inclusive, safe and positive home for all.

We are also privileged to hear the insights of Pippa Ehrlich, director of Netflix's *My Octopus Teacher*, on conservation messaging that connects with people where it matters most: the heart.

Another global theme has been education at home, and in this issue we have included an activity and learning section, Ocean Fun, in the hope it might help engage young minds about sharks and marine conservation at a time when it might be most difficult to think beyond our four walls.

Together we can use this collective period of reflection to renew our enthusiasm to make a real difference. We hope you enjoy this issue of the magazine!



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James Lea
Editor in chief

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Looking through the eyes of photographers with different perspectives, we venture to the Galápagos, both a living museum that has helped us to understand evolution and a changing oceanscape with a dynamic future (page 14).

Photo: Pelayo Salinas de León



The plight of a beluga named Hvaldimir caught the world's attention in 2020. We speak to the woman monitoring his well-being and future (page 10).
Photo: Byron Dilkes

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New marine protected areas bring hope to the sea creatures that call the waters around Seychelles' D'Arros Island and St Joseph Atoll home (page 42).

Photo: Byron Dilkes



In the midst of a global shutdown, an octopus and one man's extraordinary connection to its kelp forest home rekindled in all of us a longing for the magic of nature (page 102). Photo: Craig Foster

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Clare Keating
WRITER AND CONSERVATIONIST

A writer and conservationist, Clare was also formerly a programme director at the SOSF-D'Arros Research Centre. She believes that finding solutions to the climate and biodiversity crises depends on building connections that bridge the science and business worlds. Her history as a PADI scuba instructor with a Master's degree in environmental economics, an MBA and decades-long field experience in southern Africa and Seychelles enables her to connect capitalism and conservation in her writing and gives her unique insights into concepts that are often considered to be incompatible. She works from her home in San Francisco to design water decision support tools for NGO tech firm The Earth Genome.

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Lauren De Vos
MARINE BIOLOGIST

Lauren is a marine biologist whose love affair with the sea encourages her to keep telling its stories. Her work as a researcher ensures that she continues to ask questions about our impact on our changing oceans, while her passion for writing has enabled her to share the insights she has gleaned over the years from other scientists and conservationists about how we might re-imagine sustainable seas. Lauren is based in KwaZulu-Natal, South Africa, where she works on the Oceans Alive Project as a scientist for the WILDTRUST, a local NGO.

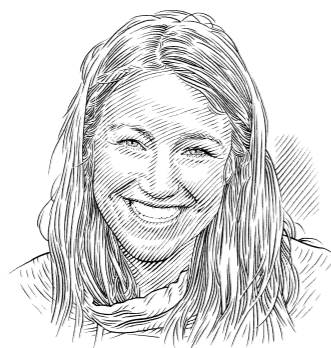
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Wisaal Osman
CONSERVATIONIST AND PRACTICE MANAGER

Wisaal's passion for the environment has evolved from a keen interest in and love for the oceans around South Africa into a need to better understand and protect our delicate natural systems. She obtained an MSc in 2011, majoring in applied marine science, and went on to enjoy a successful career protecting nature for everyone while working for WWF-SA, the CSIR (Council for Scientific and Industrial Research) and the Save Our Seas Foundation Shark Education Centre. As a result of the Covid-19 pandemic, Wisaal is currently assisting in a family business, honing her administration and organisation skills as the firm's practice manager.

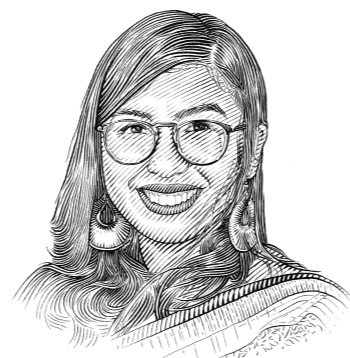
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Clova Mabin
DIRECTOR, SOSF SHARK EDUCATION CENTRE

Clova is the director of the Save Our Seas Foundation Shark Education Centre. She became increasingly aware of how remote science and its application are from the general public while completing an MSc in conservation biology and a PhD that focused on the status and management options for invasive marine species in South Africa. She is passionate about translating her scientific insights and sharing her love of the ocean. Clova believes that environmental education – teaching future generations about ecology and sustainability – is the best way to shape our future.

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Abida Rahman Chowdhury
ENVIRONMENTAL JOURNALIST

Although Abida grew up in Dhaka, the capital of Bangladesh, visits to her village home in Sylhet led her to fall in love with nature. After completing her O-level and A-level exams at school in Dhaka, she studied environmental science at university and has since worked on multiple conservation projects, including the Bangladesh Spoon-billed Sandpiper Conservation Project and the Sundarbans Finfoot Research Project. Abida now works as a journalist for *The Daily Star*, focusing on conservation stories. She has covered a range of topics, from the conservation of Bengal tigers to the impacts of building coal-based power plants in the coastal area of Moheshkhali.

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Ruth Leeney
RESEARCHER AND SCIENCE COMMUNICATOR

Ruth is a researcher and science communicator interested in developing creative and inclusive approaches to ocean protection. She is constantly inspired by all underwater life. Ruth has led research and conservation projects on sawfishes in eight countries and advised students or collaborated with NGOs on sawfish research in an additional four. The Covid-19 pandemic left her jobless and stranded on an unfamiliar shoreline, where she resorted to icy sea swims, collecting mermaids' purses and writing an educational book about endangered marine mammals.

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Flossy Barraud
EDUCATION AND OUTREACH MANAGER,
MANTA TRUST

Flossy is the education and outreach manager for the Maldivian Manta Ray Project, the founding project of the Manta Trust. She has dedicated the past three years to developing Moodhu Madharusaa, the Manta Trust's marine education programme, while at the same time conducting research on reef manta rays. Flossy initiated the Maldives' Manta Festival, an annual community event that brings together hundreds of people to celebrate the ocean. She is deeply committed to inspiring people to care about the ocean through experiential marine education, and especially to empowering women to engage with their natural environment through learning to swim and snorkel.

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Catherine Macdonald
MARINE CONSERVATION BIOLOGIST

An interdisciplinary marine conservation biologist, Catherine studies shark and ray biology, ecology, fisheries and conservation. Her research interests also include wildlife tourism and human-wildlife conflict. She is one of the co-founders and the director of Field School, an interdisciplinary marine science training and education programme based in Florida, and a lecturer and track coordinator for the Marine Conservation Track of the Master of Professional Science programme at the University of Miami's Rosenstiel School of Marine and Atmospheric Science.

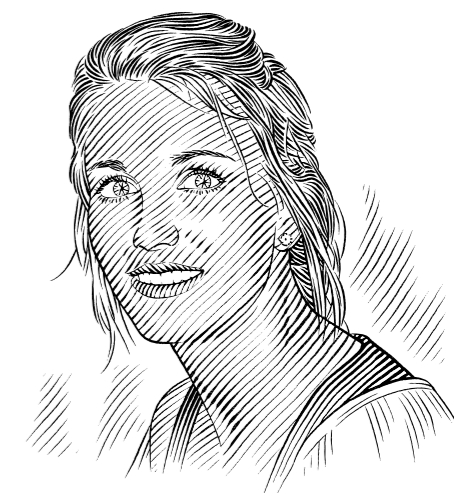
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Mahmood Shivji
DIRECTOR, SOSF SHARK RESEARCH CENTER

A professor of marine science at Nova Southeastern University's Oceanographic Center in Florida and a director of the Save Our Seas Foundation Shark Research Center, Mahmood attributes his love for nature and fascination with biology to a childhood spent in Kenya's wildest places. He completed a PhD at the University of Washington and has spent decades leading research projects in marine and conservation science. He also directs the Guy Harvey Research Institute, specialising in integrating laboratory genetics-based and field-work approaches to study and solve problems pertaining to the management and conservation of sharks and rays, billfishes and coral reef ecosystems.

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Jade Schultz
CONTENT MANAGER,
SAVE OUR SEAS FOUNDATION

Jade is the content manager for the Save Our Seas Foundation. A nature lover from childhood, she has concentrated her passion and experience into delivering conservation messaging that packs a powerful punch. With qualifications and a work experience background in marketing and media, she came to understand that not everyone shares her love for, and experiences in, nature and therefore not everyone knows how to make a difference. Balancing this understanding, Jade has honed her years of experience to define how the foundation spreads a message and raises awareness of ocean conservation challenges in today's digital world.

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MOBILE DNA TESTING UNLOCKS TRADE SECRETS

WORDS: DEAN HONEY | ILLUSTRATION: RÉGRIC

Early 2020 saw the largest seizure of shark fins in history. Two containers originating from Ecuador arrived at the Kwai Chung Custom House's cargo examination compound in Hong Kong on 28 April and 4 May and were found to be loaded with the fins of an estimated 38,500 threatened and protected silky and thresher sharks.

At the centre of the 26-tonne (28-ton) haul, which had an estimated value of US\$1.1-million, was the DNA toolkit developed by Dr Diego Cardeñosa, a Save Our Seas Foundation-funded researcher and Dr Demian Chapman, an associate professor at Florida International University.

Hong Kong is the world's largest importer of shark fins and is responsible for half of the global trade. With 41 tonnes (45 tons) seized in 2020 alone, the impact on species numbers is tangible. Thanks to Dr Cardeñosa's DNA toolkit, however, customs officials can quickly and effectively identify if the catch is derived from a CITES-listed (trade-restricted) species or not. At \$1 per test and requiring only a single day of training to operate, this toolkit clearly has potential for shark conservation.

'We're trying to change the idea that DNA is done only in a lab by scientists like us,' says

Chapman. 'We can make custom officers DNA technicians so they can do this work on the counter of a shipping port or in an airport.'

The aggregation of most catch and trade data and the misidentification of fins at species level severely hamper species-specific management and product traceability throughout the supply chain. With international trade regulations being a vital component in the conservation of sharks, the toolkit plays a significant role.

'It's amazing to see that our toolkit is being used officially in one of the largest shark fin trading hubs in the world,' says Cardeñosa.

Internationally, steps are being taken in the right direction. Since May, Ecuador has hired 75 new inspection officers and banned trade in oceanic whitetip and four hammerhead shark species, bringing the total number of protected shark species in the region to nine. However, critics say governments aren't doing enough to curb the practice and current data are inadequate to determine global population declines. With the use of DNA testing now readily available and cost-effective, we could start seeing the true cost of overfishing and its effects on our oceans.



CAMERAS FOR SHARK CONSERVATION

WORDS: LAUREN DE VOS
PHOTO: ANDY MANN

Cost-effective. Low-impact. Replicable. These are three advantages of surveying sharks using cameras, says Camila Cáceres, a Florida International University PhD candidate and Save Our Seas Foundation project leader. They are also hallmarks of the Global FinPrint Project, the largest global effort to document sharks and rays on coastal reefs using remote underwater cameras. The project was launched in 2015 to deploy baited remote underwater video systems (dubbed BRUVs) to monitor marine animals visiting coral reefs around the world. The first global analysis of the project's data, published in *Nature* in 2020, highlights the grave impact of overfishing on shark populations on coral reefs worldwide.

The analysis, 'Global status and conservation potential of reef sharks', collated data from more than 15,000 BRUVs' videos that surveyed 371 coral reefs across 58 countries. On almost 20% of the reefs featured in the study, sharks were 'functionally extinct', indicating that their populations are so depleted that they no longer play an important role in that ecosystem. 'The management of natural resources should be a collaborative and international effort. Many shark species have large habitat ranges and protection will not be effective if we only research and protect sharks in the United States,' explains Cáceres. FinPrint relies on

information from more than 120 researchers who focus on four key coral reef areas: the western Atlantic, the Indian Ocean, the western Pacific and the central Pacific.

Despite the study's bleak results, the project's researchers still see hope for sharks. 'Certain shark populations are rebounding while others are critically endangered, so it's important for us to know which places around the world are bright spots and which areas are overfished.' Cáceres cites the results from her home country, Colombia. 'Rosario and San Bernardo, near the busy city of Cartagena, were ranked among the worst sites globally for relative abundance of sharks. However, the remote San Andres archipelago ranked second in the Caribbean.' Her insights speak to some of the study's broader findings: that despite declines in shark numbers being linked to poor governance, human population density and proximity to the nearest markets, there is potential in many places to rebuild shark populations. 'As a Colombian, I found it surprising to see how our results differed depending on the site. This highlights the need for more shark research around Colombia and emphasises that complementary methods, like interviews with fishers, should be used so that researchers better understand the local fishing pressures.'



The deep sea, and its diversity of otherworldly anglerfishes, are helping us unlock new medical insights.

ANGLERFISHES, IMMUNITY & ORGAN TRANSPLANTS

WORDS: SARAH KEARTES
PHOTOS: DANTÉ FENOLIO/DEEPEND

Anglerfishes are so called because, like their human counterparts, they use a lure to attract their quarry – a glow that pierces the murky depths to draw prey into striking range. Yet little is known about the species diversity of anglerfishes, even though they are some of the most spectacular denizens of the deep ocean. To help clarify how many anglerfish species there are, and to help researchers to identify them, Prof. Mahmood Shivji of the DEEPEND Consortium and Save Our Seas Foundation Shark Research Center is using large-scale DNA sequencing to develop diagnostic barcodes of the anglerfishes in the Gulf of Mexico.

But now these deep-sea fishes are shining a light in an unexpected direction: into the future of transplant medicine. For many of the 168 species on the anglerfish roster, mating involves tissue fusion. The dwarf male – sometimes no longer than a grain of rice – attaches to the female, a bruiser by comparison. In extreme cases, everything from the skin to the circulatory system is shared between mated animals. Permanently dependent on the female for nutrients, the male lives out his days as a hitchhiking sperm donor.

Exactly how these fishes manage such anatomical melding without being rejected by a mate's immune system has puzzled scientists for decades. But a team led by researchers at the Max Planck Institute of Immunobiology and Epigenetics (MPIIE) in Freiburg, Germany, may have found the answer.

Vertebrate bodies distinguish 'self' from 'non-self' with direction from a group of genes called MHC genes. The expression of these genes is like a cellular fingerprint, either sneaking past or alerting another organism's intruder scanner: the adaptive immune system.

Some animals are able to 'sniff out' a well-matched mate by honing in on a potential partner's MHC status. 'There were some examples of these anglerfishes that had very large nostrils. So I thought, yes, this must be it,' says Dr Thomas Boehm, an MPIIE immunologist and co-author of the study.

The team sequenced the genomes of 13 anglerfish species, expecting to find MHC-matched mates that, like genetically identical twins, would be able to swap tissue without triggering an immune response. 'But that wasn't the case,' says Boehm. 'So then we wondered, what's going on here?' A deeper dive revealed that some anglerfish species have opted out of adaptive immunity altogether, lacking the genes that are critical to making both new antibodies and 'killer' T-cells.

'That was a shock,' admits Boehm. 'Human patients [in similar condition] would be so immuno-compromised, they would die without a bone marrow transplant.' Yet somehow the fishes are able to protect themselves from infection and foreign threats.

To stop human transplant recipients from rejecting donated organs, doctors have to suppress their adaptive immune response so as to stop the body from recognising and attacking 'non-self' cells. Dampening this response while maintaining enough immune defence for these patients to survive is a delicate dance.

Unlocking the secrets of anglerfish immunity could make it easier to find the right steps. 'We don't know how to do it yet,' says Boehm, 'but these fishes may show us the way.'



Lindsay Rubincam has worked closely with cetaceans for 30 years. She's formed a team to monitor Hvaldimir's location and condition.

Portrait: Kristina Balotay



FROM THE FIELD

LOST BELUGA: AN INTERVIEW WITH LINDSAY RUBINCAM

In spring 2019 a male beluga whale wearing a harness inscribed with Cyrillic script appeared in Norway's fjords and was soon dubbed the 'spy whale'. Lindsay Rubincam has been monitoring him to help inform the future of this 'national treasure'.

WORDS: JADE SCHULTZ
PHOTOS: BYRON DILKES

How did you find yourself in Norway conducting research on a beluga whale that has apparently been trained?

In April 2019 I was in contact with Eve Jourdain, the founder of Norwegian Orca Survey who was studying orcas in Norway. I had always wanted to see whales in Norway and she was helping me plan a trip. Before long we were talking about the so-called 'spy whale' that had turned up in the northern fjords and was featured on news bulletins and had gone viral on social media. It was clearly an urgent situation and we discussed what we could do to help. I have worked with trained belugas for several years and know veterinarians familiar with the species. We began to develop a plan to assist on-site and to put representatives from the Norwegian fisheries department in contact with skilled professionals who might be able to provide support for this 'lost' whale.





What in your background enables you to contribute to looking after a malnourished beluga?

By no means do I claim to be an expert on beluga whales, but I have looked after them in managed-care and I've spent nearly 30 years building relationships with trained cetaceans. Once we realised that this was a trained whale in a compromised physical and potentially emotional state, we knew something needed to be done. Eve decided to go to Hammerfest to evaluate the situation first hand and I arrived a week later.

How would you describe attitudes in Norway towards the beluga?

When Hvaldimir, as the whale's been called, first arrived in Hammerfest everyone wanted to spend time with him. To some people he's a celebrity, even a national treasure. Others thought that whether he lived or died, nature should be allowed to take its course. But when they saw his 'personality' as he sought connection with humans, many changed their minds and became protective of him and tried to keep him safe. When he left Hammerfest, some townspeople said it was as if he had taken with him the 'spirit' he had brought to their harbour. As he travelled south, more and more people became excited about seeing the friendly whale they'd heard about. But not everyone has been a fan of Hvaldimir. Since leaving Hammerfest, the beluga has developed a particular preference for fish farms, which he is apparently quite familiar with. Having been in a training environment, he is clearly used to humans and he seems to take pleasure in being around the workers at the fish farms and to 'enjoy' following their boats. The problem with farms, however, is

Belugas like Hvaldimir are highly social marine mammals that live in groups called pods. They use clicks and whistles to communicate with each other.

To some people he's a celebrity, even a national treasure.

that workers need to enter the water to do their job and he can interfere with that. Moreover, his presence may be stressful to the salmon, which can affect their health and welfare, as well as the business. Because of this he can be seen as a nuisance, even a threat.

What are your team's objectives in monitoring Hvaldimir and how do you go about it?

The primary team comprises Joar Heston, the local fisherman who originally removed Hvaldimir's harness, Fabrice Schnoller, a cetacean acoustics expert, Krisztina Balotay, a whale watch guide, Olivier Borde, founder of Darewin, and myself. Our original intention was to monitor him over a period of a year, tracking his location and regularly assessing his behaviour and physical condition. We hoped that The Norwegian Fisheries Department could use the information we gathered to review the potential to relocate him to an area where he could socialise with other belugas. But between Covid-19 and his continual movements, our plans were made more complicated and we had to adapt them. Following him has been tricky, but his popularity has meant that social media could provide us with a roadmap. By connecting with local people directly through social media posts, we have been able to track his whereabouts and what he's been doing.

How important has it been to build relationships with the local communities?

Developing relationships with locals has been at the heart of our mission. Since first seeing Hvaldimir in Hammerfest, I have been able to connect with a community of Norwegians who share a concern for his wellbeing. By establishing a network of people who keep an eye on him, we have been able to create a greater awareness of what is in his best interests. For example, when he settles into a certain location, we try to communicate with people there who know most about his daily activities, like fish farmers, ferry drivers and harbour masters. They then report back to us. In summer 2020 he settled near the town of Kjøpsvik and ferry drivers would watch out for him and ask locals

in more remote areas if they had seen him that day. This awareness created a connected community that would look out for him and try to protect him from other people's reckless behaviour.

What have you learnt about his behaviour?

He seems to seek out people. Wherever he goes—a small dock, a fish farm with a maintenance boat, a small group of people who pay attention to him—he appears to have a 'recipe' for the location. Fish farms seem to be a constant for him, possibly because it's easy for him to catch a meal, but perhaps also because they are familiar from his past life. The harness he was found in suggests he had been trained and his initial reliance on humans for food and his habit of following boats lend support to this theory. He also demonstrates an affinity for scuba divers and apparently tries to 'help' divers working around salmon nets. He is now foraging for himself, but this continued interaction with people may be fulfilling a social need. Belugas are highly social, so I think people serve as a substitute for 'family'. Unless this need can be satisfied by other belugas, one can imagine that he will continue to seek human companionship.

What would be the benefits of long-term monitoring?

Although we can't fully manage risks like boat collisions, entanglement in fishing gear or predation by orcas, long-term monitoring allows us to provide support if needed. In June 2020, Hvaldimir was apparently hit by a boat and received a dramatic injury to his back. Our on-site team was able to communicate immediately with the fisheries department and specialist veterinarians. Fortunately, the wound healed well and there was no need to intervene. To most people he is a 'wild whale' and these are normal risks for wildlife. My feeling is that if transferring Hvaldimir to a natural habitat where he can find and socialise with other belugas can't happen, then the least we can do is monitor him and seek to educate his temporary guardians as he settles into new locations.



AN EVOLVING OCEANSCAPE
GALÁPAGOS

Deep below the Nazca Plate in the eastern Pacific Ocean, the writhing earth's crust has belched molten lava for more than 20 million years. These geological dramas gave birth to the Galápagos Archipelago, a collection of islands that have clawed their way to the sea's surface over millennia. Today they rise as craggy shield volcanoes and lava piles scattered across 59,500 square kilometres (23,000 square miles) of ocean. First named 'Las Encantadas' (The Enchanted) in 1535, the Galápagos Islands and their treasure trove of life keep us enthralled. Photographers, natural historians and conservation scientists are still finding new ways to see these islands and the ocean around them, more than 180 years after Charles Darwin first penned *The Voyage of the Beagle* and formed the basis of his theory of evolution that would become *On the Origin of Species*.

The Galápagos Islands host an important diversity of sharks, with as many as 30 different species recorded in the archipelago. These sharks are vital for the islands' economy. The Charles Darwin Foundation estimates that shark sightings provide 37% of the active workforce's employment and that living sharks in these waters may be worth about \$360,000 every year to the local economy.

Photo: Pelayo Salinas de León

P O R T F O L I O



Magnificent and great frigatebirds, two species native to the Galápagos, can be seen wheeling over San Cristóbal, Floreana, North Seymour and Genovesa islands and venturing offshore to feed. Equipped with flamboyant red pouches to entice female frigatebirds, these archipelago pirates harass other birds to regurgitate their bounty. The Galápagos host 174 bird species, 26 of which are found nowhere else in the world.
 Photos: left, Jess Kraft/shutterstock, right, James Lea



The Galápagos Marine Reserve, designated in 1998, protects prehistoric marine iguanas and electric-coloured Sally Lightfoot crabs at the interface between land and sea in a 'limited use' zone. Dubbed a multi-use protected area, the reserve bans certain practices outright (like industrial fishing), but allows others (like artisanal harvesting) to continue in demarcated zones alongside sustainable uses such as tourism.

Photos: Christopher Vaughan-Jones



Photographers can record the same ocean life but bring to light different perspectives. While Darwin brought the value of the Galápagos islands to international renown based on their finches and tortoises, we're finally acknowledging that the marine life around these islands is of universal importance.

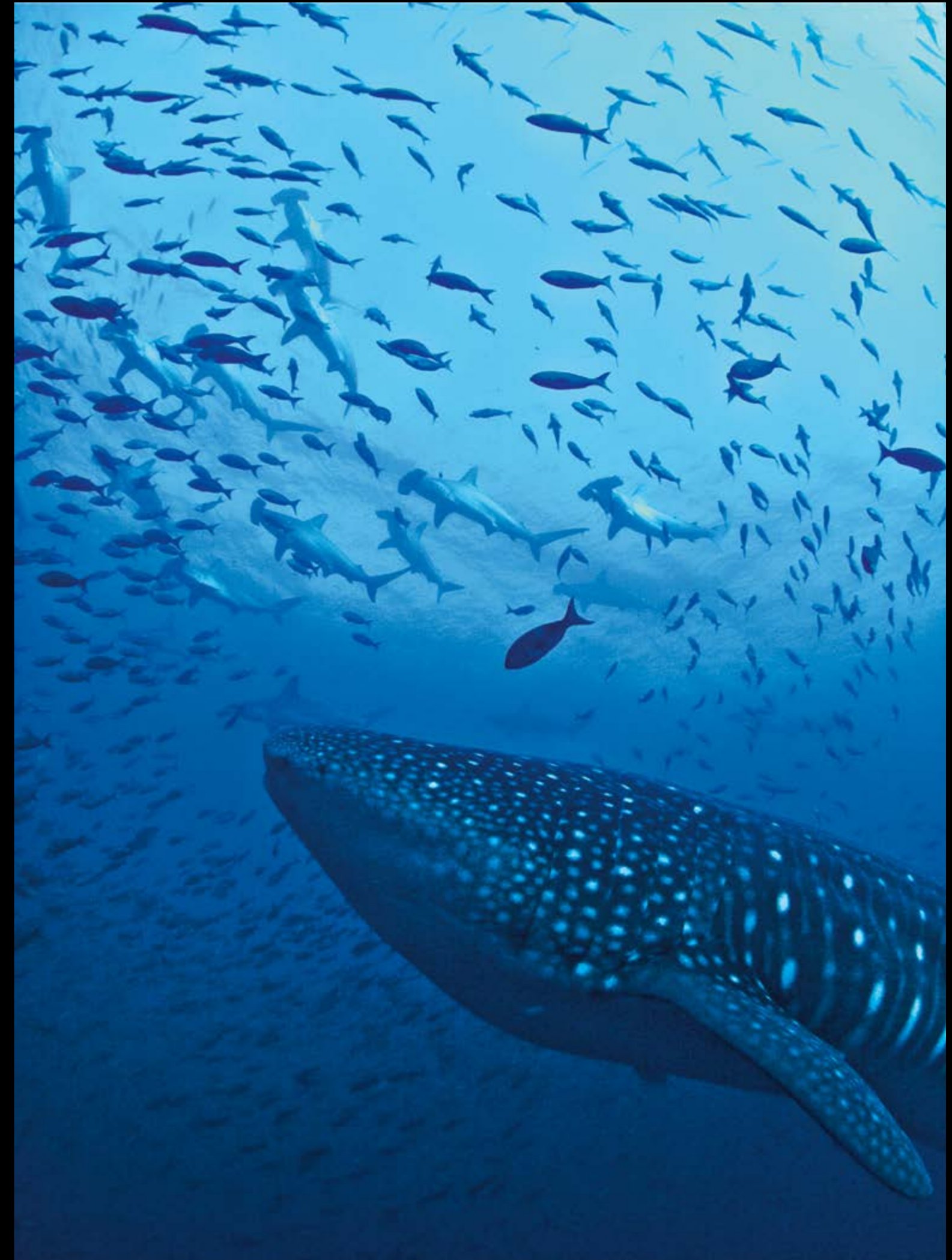
Photos: James Lea





A place of contrast and confluence: three major ocean currents bring a mixture of warm, cold and nutrient-rich waters to Galápagos, a UNESCO World Heritage Site. The result is its extraordinary diversity of life, concentration of species found nowhere else on earth and bewildering numbers of sharks, birds and fish that find rich feeding grounds here.

Photos: left, Christopher Vaughan-Jones, right, Pelayo Salinas de León



FEATURED STORIES

SAVING GIANTS

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Where once the status of sawfishes and guitarfishes was uncertain, the hard work and determination of a scientist is helping secure their future in Bangladesh.

STAY HOME, STAY SAFE

42 - 57

For homebodies like the reef mantas and humphead wrasses of D'Arros Island and St Joseph Atoll in Seychelles, an MPA may make home a safer space.

SPACE RACE

58 - 73

Our human footprint now spans the seas, but how might technology help us reconsider where we fit among the animals that call the ocean home?

RIPPLE EFFECT

74 - 85

Optimism about wildlife rebounding and illegal trade declining as the Covid-19 pandemic hit has been tempered by the reality of what it has cost conservation.

Saving Giants

in the Bay of Bengal

WORDS BY

*Abida Rahman
Chowdhury*

PHOTOS BY

*Oliver
Deppert*

For Alifa Bintha Haque, scouring fish landing sites in south-eastern Bangladesh for once-abundant sawfishes and guitarfishes has taken time, enormous effort and endless patience – and it's just the beginning of her mission to protect these species.



Previous page: Nostrils and a mouth that houses thousands of dome-shaped teeth to crush this fish's prey of small fish and crabs: a sawfish and its rostrum seen from underneath gives clues as to how it lives.

Left and right: Cox's Bazar is both a popular vacation destination for holidaying Bengali families and a busy fishing hub processing catches that are a lifeline for nearly 400 million citizens in the region.

Cox's Bazar is a blue and brown speck seen through the windows of our overnight bus. Quaint and sleepy in the morning sun, its tranquil appearance belies the secrets changing hands in its back alleys. It is hard to imagine that in the waters beyond where the tourists throng, creatures from yesteryear still swim: endangered sawfishes and guitarfishes, and mysterious sharks. The town, situated in the north-eastern corner of the Bay of Bengal, is a major tourism hub in Bangladesh and boasts the longest unbroken beach in the world. Beyond that shore lies a bountiful ocean, one that Bangladesh governs for 354 nautical miles out to sea. Nearly six million tons of fish are hauled from these waters each year – an astronomical number that corresponds to almost 4% of the total global catch. For the nearly 400 million people in the region, the waters are a lifeline. For scientist Alifa Bintha Haque, they are a source of endless questions – and the starting point for her mission to save the last of Bangladesh's sawfishes.

When we visit, Cox's Bazar is packed with Bengali families in joyful vacation mode. But there is no such frivolity for us. We are here to search the dingy establishments that run the length of the rivers snaking to the sea, trying to uncover a secretive trade in sharks and rays. We are especially interested in sawfishes and guitarfishes, which are highly vulnerable shark-like rays. Cox's Bazar gives us a window into the exploitation of these slow-growing species, the undocumented trade in them and their consequent declines. And it is here, in the tawdry trading posts

clinging to the riverbanks, that Alifa and her colleagues are looking for the answers to many questions. 'Which sharks are traded?' they ask. 'And in what numbers? Where are they caught, and what is their value?'

IN SEARCH OF OCEAN GIANTS

With scant scientific data available at the time and dozens of questions buzzing in her mind, Alifa sets about earning the trust of the local fishers. She spends hours sipping tea with them, listening intently to their stories while they repair their fishing nets. And her patience pays off: one fisherman surprises her with an invitation to join his boat. Locals believe a woman aboard a fishing boat brings bad luck, but Alifa's hours of investment have secured for her a position of trust. As a token of good faith, one of the traders presents her with a sawfish rostrum nearly as tall as she is. It's worth US\$300. Small triumphs such as these give Alifa motivation to continue tracking the catch patterns, trade routes and natural history of sawfishes.

I have come to hear these stories at first hand. I want to meet these same fishers and watch some of Alifa's experiences unfold before my eyes. And so I find myself gazing out of a bus window as Cox's Bazar rouses itself in the tranquil morning light. With me are Alifa's research assistant Mahi and Fayed, a photographer. Mahi is to be my eyes and ears for the next two days, filling me in on all the back stories and leading to me to sources – the shark traders, fishermen and dried fish processors.



THE BAY OF BENGAL BANGLADESH'S LIFELINE

Bangladesh and its capital Dhaka lie to the north of the Bay of Bengal, the world's largest bay.

Situated in the north-eastern Indian Ocean, the Bay of Bengal is almost encircled by India, Bangladesh and Myanmar and contains India's Andaman and Nicobar island groups.

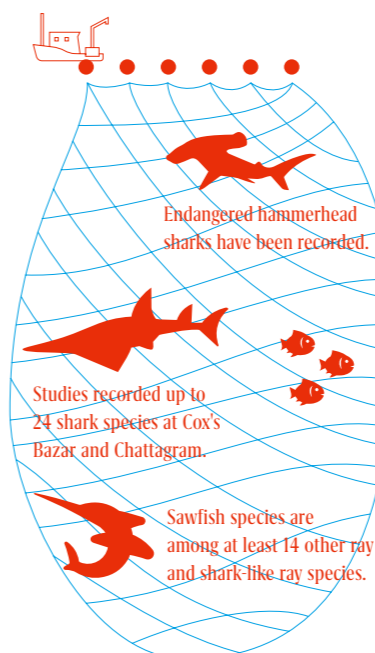
Bangladesh's 710-kilometre (440-mile) southern coastal zone hosts thousands of artisanal fishing boats, and industrial trawlers further offshore.





SHARKS IN FISHERIES

Even outside the targeted shark-fishing season, catches at Cox's Bazar bring in hauls of sharks and rays. Species are usually caught using modified large-mesh gill nets, but are also harvested by hook and line, set bag and trammel nets.



We visit the fisheries *ghat* behind the tourist town, a chaotic site that, in all its madness, is barely still tethered to the sea and serves simultaneously as a fish market, landing site and storage zone. Established in the 1980s, the dilapidated building looms tall next to the Baghkhalī River as it flows towards the Bay of Bengal. The unbelievable stench and noise hit me the moment I alight from the *tomtom* (a three-wheeled scooter that is the primary mode of transport here). Hundreds of artisanal trawlers dock daily and unload their catch at this site. We stand under the soft white sky while mayhem unfolds, the place abuzz with the cries of hundreds of fishermen, middlemen, workers, businessmen. Most are here to work, but some come to observe the drama unfolding or to sneak a piece of the fish being hurled around. We slosh through bloodied water past piles of fishes, moving through the mess of scales flying through the air.

It is not yet peak shark-fishing season. In fact, most of the market's front section is dedicated to sorting and packaging freshly caught *hilsha*, Bangladesh's national fish and the single most commercially important fish species here. But as we move to the back of the market I recoil in horror at the great, grey mounds of sharks and rays. This is Ground Zero, the corner of the *ghat* where sharks and rays are collected, preserved and distributed and where much of the trade in these species takes place. We watch fishermen unload their catches: hammerhead, pig-eye, tiger and spot-tail sharks, at least three different species of rays and, shockingly, Critically Endangered sawfishes and guitarfishes.



The sharks are caught and brought to landing sites, then processed.



Bangladesh's fisheries are dominated by men.

FROM SEA TO SLIPWAY: WHERE DO BANGLADESH'S SHARKS, SAWFISHES AND RAYS GO?

What happens to the sharks, rays, sawfishes and guitarfishes once they have been landed? It has taken Alifa three years of extensive interviewing to fathom this out. And we must follow her lead and start from the beginning. Bangladesh's fisheries are dominated by men. Men are the traditional fishers in Bangladeshi culture and they have sailed these rough seas for more than 50 years. Every day for decades, they have gone to sea and returned with their hauls. Years ago, traders realised there was a demand for shark parts, and this insight became the catalyst for targeted shark and ray fishing and the ensuing trade. The sharks are caught and brought to landing sites, then processed in one of the five different centres that have operated for nearly 40 years in the seaside town.

It was a lucrative business at first, when the catch was bountiful. But even as the catches declined over the years, newer businesses continued to emerge; some of these have been in operation for nearly 25 years. Many are opportunistic, focusing on fish exports but trading shark fins and other shark products when the occasion arises, an arrangement encouraged by shark traders. One of the oldest of these in Chattagram (Chittagong), 150 kilometres (93 miles) to the north, started business in the 1960s after he learned about the shark trade from an American buyer. Since then he has been exporting shark fins and other products to Japan, China and the USA.

In Cox's Bazar I witness the network of trust that Alifa and her colleagues have built with local fishers and traders, who relay reports of sawfish catches by phone. The pioneer traders provide Alifa with a wealth of information as they scour the town, checking landing sites and assigning workers to purchase the sharks each day. But landing sites are not their only source of sharks and rays; sometimes they collect them from opportunistic middlemen or other buyers. The size of the fin, quality of the skin or weight of the shark are all considered in determining the catch's price. Smaller sharks are set aside for drying while the larger ones are processed and distributed along a wide-ranging network of traders and exporters.



SAWFISH: CULTURAL SIGNIFICANCE

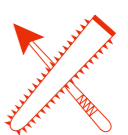
Sawfish are culturally significant in coastal communities around the world.

Illustration based on Jessica Berliner



Paintings and murals of sawfish have been found in several parts of the world, suggesting a historical significance in these places.

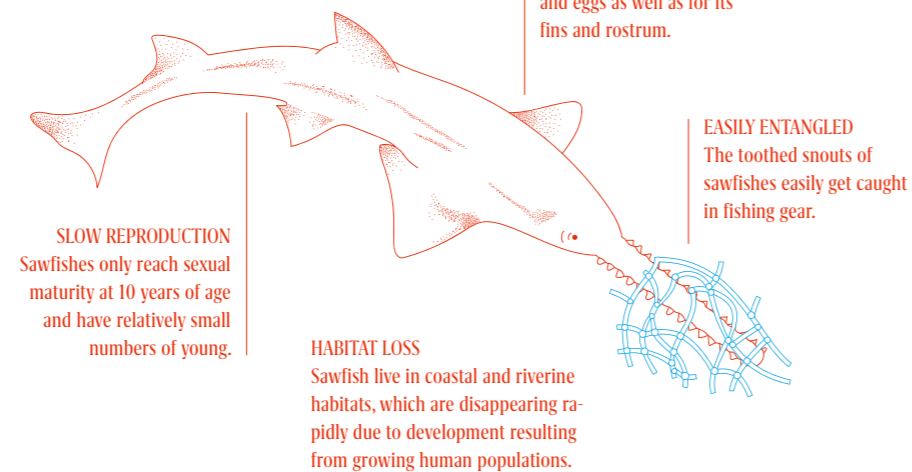
Sawfish rostra have been worn in aboriginal ceremonies and celebrations, hung in people's homes to protect them from evil spirits and even used as weapons.



Spiritual offerings of sawfish rostra have been uncovered in ancient ruins, including those of the Aztec empire.

SAWFISH THREATS

The unique biology and life-history traits of sawfishes make them especially susceptible to a host of threats from human activities.
Illustration based on Jessica Berliner



THE FIRST SAWFISH

Buoyed by a 2012 study that revealed that at least two species of sawfish were still present in Bangladeshi waters, Alifa also heard stories of encounters with sawfishes. Abdul Gani, an artisanal fisherman, told her about catching a giant sawfish in the shallow coastal waters of south-western Bangladesh in 2015. 'I had to call two other boats and 19 fishermen. We tried for hours to pull the giant out of the water. Then, as soon as we pulled it out, the sawfish gave birth to five pups. It was a giant of more than a ton in weight. When it's in the water, you must fight for hours to catch such a majestic animal.' The female and her pups were sold. Alifa recalls asking Abdul about the fate of those live pups. 'I saw remorse in his eyes. This was my first ray of hope that if these fishers could be made aware of the plight of sawfishes, they could become conservation pioneers for the species in Bangladesh.'

Stories like Abdul's are Alifa's inspiration for persisting in the search for sawfishes. She added more than 200 field days to her quest, continuing to scour all the landing sites and the fish markets for shark products. Her search was in vain, save for one find: a sawfish caudal fin and rostrum in one of the shark processing centres. But continued reports sent to her by traders now show that sharks and rays are landed in Chattagram, Teknaf and St Martin's Island as well as in Cox's Bazar, and in fishing ports in Barishal, Dublar Char in the Sundarbans and Khulna. She suspects that these landings are just a fraction of the bigger picture.

A RAPID DECLINE IN NUMBERS

Sawfish catches have decreased, which is why many fishers say they no longer target them, but the rays are still accidentally caught by fishers using drift gill nets. When one does become ensnared in a net, fishers rarely have reason

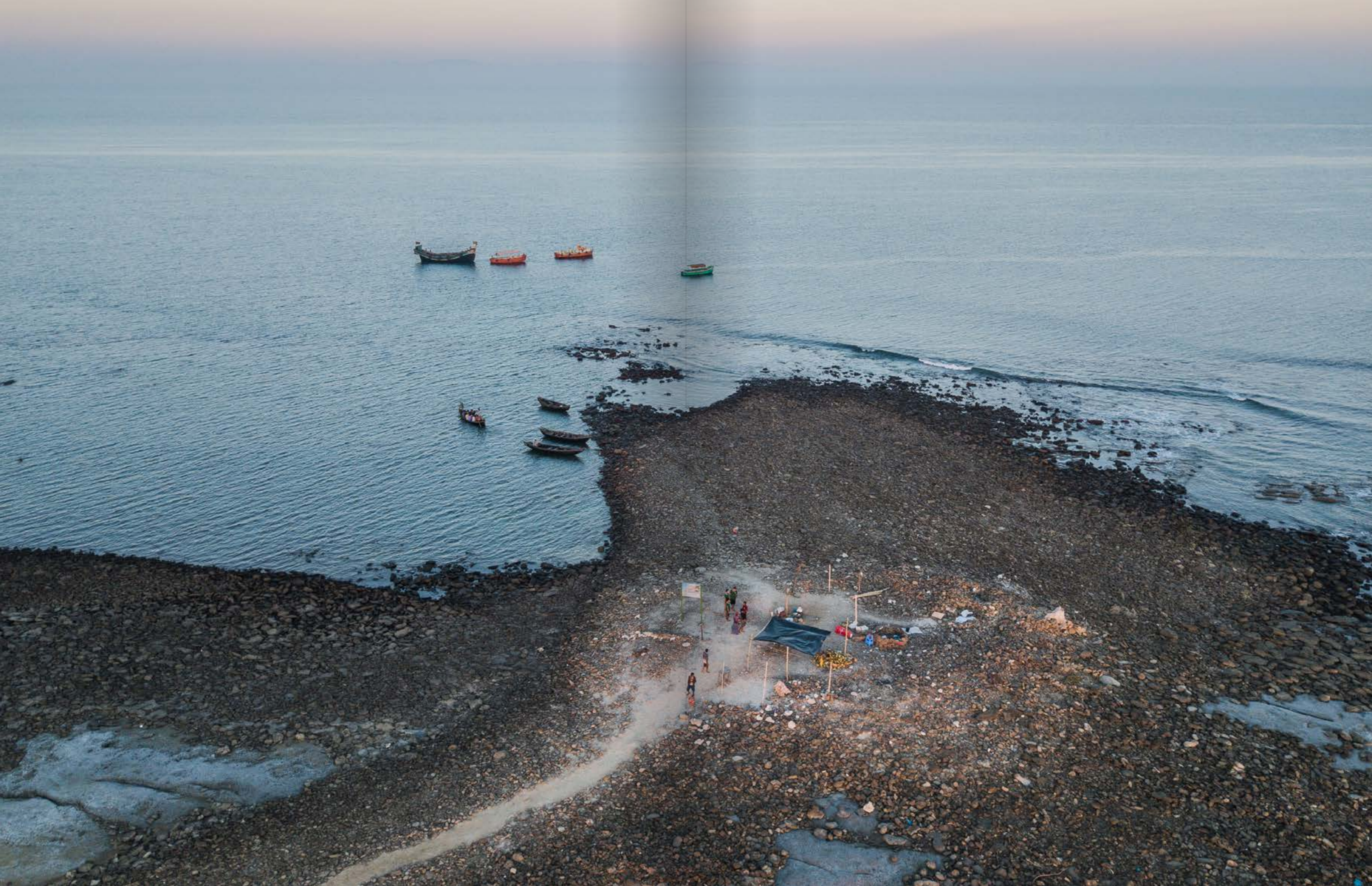
to voluntarily release it alive, even though the species' numbers are dwindling, since sawfish products are associated with many uses. Nowadays, sawfish catches may be few and far between, but one of the local fishermen, who has worked from this market for nearly three decades, tells of huge sawfishes he brought in by the dozen in his youth. His tales may be boastful exaggerations, but the data still suggest that the decline is significant.

Bangladesh is a country of rivers, with productive estuaries, shallow coastlines and the largest mangrove forest in the world, the Sundarbans. The land receives a huge influx of sediments and nutrients, while the estuaries are unique ecosystems with potential to host key habitat for sawfishes. Four species are believed to have been historically present in Bangladesh: the largetooth, the smalltooth, the green and the narrow sawfishes. The first three are listed as Critically Endangered by the International Union for Conservation of Nature (IUCN) on its Red List of Threatened Species, while the narrow sawfish is Endangered. The largetooth sawfish is reported to be extinct in many of its former range states: its geographical range has contracted by 61% and its population has experienced a decline of 80% since the 1960s. The extent of occurrence of the narrow sawfish has declined by 30%.

'According to a survey of fishermen in the coastal areas of Bangladesh, the number of sawfish encounters in the past two decades has seen a rapid decline. In the late 1990s, sawfishes were abundant in the coastal areas, but now the catch is significantly lower,' says Alifa. Over the years, this majestic creature of the ocean – it can grow to a length of seven metres (23 feet) – has entirely disappeared from 21 countries. Currently, sawfish species are protected in only 16 out of the 92 countries in which they are found. Overfishing in the Bay of Bengal, by both deep-sea vessels and artisanal



Understanding Bangladesh's fisheries takes years of building trust – and Alifa Bintha Haque has achieved this through patient interviews and countless conversations.





Previous spread: Finding four species of sawfishes on Bangladesh's coast may once have been a common occurrence, but numbers have crashed as both deep-sea and artisanal vessels overfished the region.

This page: Two sawfish species – the largetooth and the narrow – have been recorded in catches, which suggests they are still found in Bangladesh.



Over the years,
Alifa has given everything
to her work.

trawlers, is the main threat identified by researchers in a paper titled 'Sawfish exploitation and status in Bangladesh'. Even without targeted sawfish fishing, the very fact that fishing generally has escalated in the bay increases the likelihood that these rays will become bycatch. Once entangled in the nets, they are collected by the fishermen, who know that there is a demand for their products. This practice of illegal, unregulated and unreported fishing is, according to marine scientists, a major threat to marine life.

'There is also a belief among villagers in the coastal areas in Bangladesh that the meat and different parts of a sawfish have medicinal properties,' adds Alifa. 'In fact, in some areas, sawfish parts are bought for really high prices because of their perceived health benefits, such as curing cancer. This superstition has created a demand for sawfish meat, which can be sold for up to US\$35 per kilogram. But the local demand is quite limited because the catches are sporadic, so there is no dedicated market niche for sawfish products in the local markets.'

Three of the four sawfish species historically present in Bangladeshi waters – largetooth, narrow and green – are protected under the Wildlife Protection Act (2012) of Bangladesh and are also listed by the Convention on International Trade in Endangered Species (CITES) on Appendix 1. This listing prohibits international trade in sawfishes, except in extraordinary (and highly regulated) circumstances. But with few policing resources and multiple stakeholders in the trade to contend with, protecting and monitoring sharks and rays in practice is difficult. This appears to be a classic case of what noted conservationist Gerald Durrell said is giving an animal 'paper protection'.

ANOTHER THREAT LOOMS

With little capacity for protection and monitoring, it is likely that more marine species will face the same fate as sawfishes in Bangladesh. At the top of the list are guitarfishes, the sawfishes' close cousins. Noticing this species creeping into the catches, Alifa and her team started collecting detailed landing and trade data on guitarfishes too. When we visit the market together, we find eight guitarfishes. 'This is

alarming,' cautions Alifa. 'At one point, a large number of sawfishes were caught. But over the years that number dwindled to an average of one animal per month.' The landings of guitarfishes at all life stages (adults, juveniles and pregnant females all make it past the slipway and into markets) could be a warning sign to take immediate measures – or guitarfishes will suffer the same fate as sawfishes.

THE FIGHT FOR PROACTIVE MEASURES

Over the years, Alifa has given everything to her work. But if the fishing community is to be included in conservation, and the sharks and rays of Bangladesh are to be effectively protected, it is this kind of concerted effort that is needed.

She suggests that conservation organisations in the region should work together to set short-term and long-term goals. From discussions, solutions emerge. For example, a culturally appropriate social marketing campaign to dispel the superstitions around sawfish meat is a low-cost effort with the potential for high impact. Fishing practices in the artisanal sector also need to change and demand for sawfish products has to be reduced. Alifa has launched an assessment of what barriers exist to fishers' engagement in a live-release programme. She will use the information to create an incentive regime that encourages fishers to release sawfishes alive.

Alifa is inflexible in her belief that 'resilience, support to achieve common goals, the strength of true empowerment and appropriate dialogue can solve problems that otherwise feel unachievable'. Her work sets an example for inclusive conservation measures in resource-poor countries. She also believes that the case of sawfish conservation can be a blueprint for the conservation of the guitarfish. If sustainable fishing practices can be implemented, then we can stave off the extinction storm.

We return to Dhaka, the country's capital, with an understanding that action to stop trade should take precedence over further research. The volumes of fish being caught every day and the absence of sawfish catch hint that, without swift intervention, soon there may be no more sharks and rays to study at all.



stay home, stay safe

WORDS BY
Clare Keating

Although tiny specks in the Indian Ocean, D'Arros Island and St Joseph Atoll are home to a dazzling community of species. In March 2020, as the world took shelter from Covid-19, Seychelles declared a phased marine protected area around them.



ISLANDS IN THE SEA
PROTECTION ACROSS SEYCHELLES

The Republic of Seychelles is an archipelago made up of 115 islands. Its citizens rely on its 1.35 million square kilometres (521,238 square miles) of ocean for food and other resources.

St Anne Marine National Park comprises six islands off Mahé's coast and in March 1973 was the first marine park designated in the Indian Ocean.

Seychelles now has 22 MPAs totalling 410,000 square kilometres (158,302 square miles). Eleven of these are national parks.

The addition of the ocean around Aldabra and the Amirante Islands, as part of 13 new MPAs declared in 2020, takes protection in Seychelles to 30% of its exclusive economic zone. D'Arros Island and St Joseph Atoll form part of the Amirante island group.



Marine Protected Area

— Zone 1

- - - - Zone 2

30KM



St Joseph Atoll is remote and wild. Set in the farthest-flung reaches of the Amirantes island group, its lagoon is a critical nursery and breeding ground for sharks, rays, fish and turtles.

Map illustration: Thom design studio, from tnc.maps.arcgis.com

Photos: previous page, Daniel Beecham, above right LAND INFO Worldwide Mapping, LLC, and includes material Copyright © DigitalGlobe (Longmont, Colorado)

As I write this, I'm at home. And for much of 2020, and it's looking like 2021 as well, home has been everything. It's the office, the gym, it's where I go for happy hour and team calls. I'm guessing you're at home too, and if not, are heading back there soon. For many of us, the past year pushed us to both appreciate and lament aspects of home we'd never considered before: the arc of the sun travelling across the kitchen table, the thinness of the walls.

Staying put is not modern human behaviour. It's uncomfortable. Our cultures are set up around movement and we largely associate freedom with mobility: trips to the grocery store, site visits, long weekends away, visiting family across town or on the other side of the world. By and large, these things didn't happen in 2020. Today, immobility is a singular experience, shared worldwide. Wherever you were in March 2020, geographically, you're probably still there now. Cumulatively, how many miles or kilometres have you travelled since then? I'd bet it's a small number. Despite the trauma, the upheaval, the uncertainty of 2020, we're all stuck together, individually, at home.

But staying put is natural behaviour for much of the animal world. Although not specifically stated, a large part of the mission of the Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC) is to understand what home means to the myriad of life on and around the island and neighbouring atoll, St Joseph. Are D'Arros and St Joseph a childhood home, a nursery where a species is born and raised until heading for deeper waters in adolescence or adulthood? Are their reefs and lagoon a seasonal getaway, a place to visit when the winds shift, or to start a new generation? Or maybe they're a permanent residence? Is a fish's home a single reef or does home stretch across the wider Amirantes Bank?

In a way, 2020 tapped the latent scientist within each of us, waking us to observe movement patterns in our own

lives, across space and time, as what was once normal is now disrupted and interrogated and unclear. In the language of scientists and peer-reviewed journals, the year has drawn our attention to our own site fidelity, home ranges and spatial and temporal patterns. If you have travelled since March 2020 beyond your own well-defined home range, perhaps you feel a bit like a study subject, with officials and family alike wanting to know where exactly have you been and for exactly how long. Were you safe? What precautions were in place?

When working to protect species around D'Arros and St Joseph, many of which are threatened at various levels of extinction, these are exactly the questions we ask. And these questions are essential for the conservation of both migratory species that cross oceans and homebodies that maybe consider home to be a dark cave on a reef wall. It is our responsibility to understand what home means, what it takes for a fish to be safe at home.

MARINE PROTECTED AREAS: A FISH'S REEF IS ITS CASTLE

This is where the mission of SOSF-DRC comes into play; the research centre's core priority is to achieve and maintain protection for the marine ecosystems and life surrounding D'Arros Island and St Joseph Atoll. Behind every research project is the drive to ensure that when the animals of D'Arros and St Joseph return from a long absence or flow through yet another tidal cycle in their birthplace, they are safe.

Stay home, stay safe. The idea that home is a safe place, a place of sanctuary, is both a legal and a cultural part of modern life and dates at least as far back as the Romans. Castle doctrines, based on British jurist Sir Edward Coke's 1604 dictum 'Every man's house is his safest refuge; every man's house is his castle', are common sense to many. Yet this is not true in the natural world. Every fish's crevice is

How else are decisions made
about what's protected and
what's not?



Tracking different species
of rays and sharks around
D'Arros Island and St Joseph
Atoll has revealed that many
are real homebodies at heart.

*Photos: left, Byron Dilkes,
above, Rainer von Brandis*



not its castle, every fish's reef is not its safest refuge. In fact, the opposite is more often true. A fish's home is where the fisherman goes.

Marine protected areas (MPAs) are best practice for creating refuges and sanctuaries for marine animals and protecting ecosystems and habitats, the castles of the sea. Understanding home ranges, site fidelity and the spatial and temporal considerations of home is particularly important when designing and delineating these protected areas. How else are decisions made about what's protected and what's not? What do the boundaries encompass, whose home and what part of that home is protected? Importantly, do the protected area boundaries create a sanctuary that is equivalent to a safe living room, but where heading to the kitchen is a risk?

As a nation, Seychelles understands the importance of protecting the marine realm on which its economy and people rely. In March 2020, when much of the world was beginning to 'shelter in place', its government committed to sheltering a third of the ocean nation's territorial waters – 400,000 square kilometres (154,000 square miles) – in MPAs. That's nearly the size of California and twice the size of Great Britain. In every way, the decree that created 13 new MPAs in Seychelles is an enormous commitment to safeguarding the ecosystems and habitats that a staggering diversity of species call home.

Years of focused research and education initiatives of the SOSF-DRC, working in close collaboration with the Seychelles government, have resulted in the inclusion of D'Arros Island and St Joseph Atoll in the larger Seychelles MPA decree. The MPAs are driven to protect whole ecosystems, not just the living room, for multiple marine animals around D'Arros and St Joseph, including 15 species classified by the IUCN as Vulnerable or Endangered. This is largely because the SOSF-DRC's extensive research and outreach have led to an understanding of the region's critical importance as a sanctuary for countless species and habitats. The MPA declarations are like a castle doctrine for the ocean, making sure that home is a safe place for its residents.

Ongoing monitoring using scuba and acoustic and satellite tracking helps inform the design of new MPAs.

Photo: Ryan Daly



The MPAs are driven
to protect whole ecosystems
for marine animals.





Humphead wrasses mature late, change sex and live for up to 30 years, traits that make them vulnerable to overfishing. They are classified as Endangered.

Photo: Gregory Piper, Coral Reef Image Bank, next page Daniel Beecham

NO PLACE LIKE IT: CALLING D'ARROS AND ST JOSEPH HOME

There are species that pass by D'Arros and St Joseph that we'll never know about. When I lived on D'Arros, we had the unprecedented experience of watching a blue whale steam past the island. After years of wondering, we also finally confirmed that tiger sharks occur off D'Arros, although they remain elusive today. There are the wedge-tailed shearwaters and green and hawksbill turtles that return generation after generation to lay their eggs on the beaches and sandy soils of the island and atoll. And then there are the homebodies of D'Arros and St Joseph, the species whose lives are governed by the ebb and flow of the atoll tides and that mark their years by the shifts the monsoons bring to their reef and lagoon homes. These are the species that stay home and now, with the MPA declarations, stay safe in the waters of D'Arros and St Joseph.

SHARKS: THIS MUST BE THE PLACE

St Joseph Atoll is a critically important nursery habitat for two shark species, the blacktip reef and sicklefin lemon. Scientifically, a shark nursery is defined in space and time. First, it must be an area within which pups stay for an extended period of time. Ornella Weideli's multi-year PhD study on shark pups found that the majority of recaptured blacktip reef and sicklefin lemon sharks were found within 500 metres (1,640 feet) of their original capture location. Second, a shark nursery must contain multiple generations of young sharks, that is, sharks that stay in the area over an extended period of time. Ornella's study didn't just recapture sharks in the same season; some sharks were caught and released over multiple years, meaning that the sharks live out what is equivalent to their childhood years calling St Joseph Atoll home.

Another aspect of Ornella's study found that these shark pups have a unique advantage over their cousins in other parts of the world. In St Joseph Atoll they benefit from the abundance of food the atoll provides, illustrating how important the protection of a species' entire home is for successful growth into adulthood. Protect the place and the species within it will thrive. The near-pristine nature of St Joseph Atoll provides a fine-scale, spatially explicit opportunity for the meaningful protection of shark pups – and the MPAs make the most of it.

But blacktip reef and sicklefin lemon shark pups share the same space for more than brief moments of early life. The long-term research of the SOSF's CEO James Lea on sharks across the Amirantes Islands has shown that these two species probably call the lagoon and coastal reef habitats home for their entire lives. Again, while the declaration of MPAs around D'Arros and St Joseph was not a call for shelter in place, many species already use the area as a sanctuary. The declaration means that these sharks' home is safe.

HUMPHEAD WRASSE: OH, THE PLACES YOU'LL STAY

In the December 2018 issue of this magazine, I described efforts to acoustically tag 20 humphead wrasse. That 2018 SOSF-DRC survey remains globally the largest study of this charismatic but Endangered and conservation-dependent species – and for me personally one of the most fun research experiences ever. At the time of writing that article, we were awaiting results from the study, but field work had already determined that Seychelles, specifically the channel between D'Arros Island and St Joseph Atoll, may be home to the highest known densities of this species in the world. For an underappreciated species and one whose global



decline is being driven primarily by its delicacy status in the live food fish trade, the difference between conservation success or failure in Seychelles may rest on a clear definition of what home means to this population.

Consider the humphead wrasse a homebody. It appears to call the dark caves along the reef wall of the channel home, rarely venturing far during daylight hours and returning to the same cave at the end of each day. Over a period of nearly 500 days, not one of the 20 tagged individuals was recorded beyond a one-kilometre (1,093-yard) radius of D'Arros and St Joseph. Remember that number of miles or kilometres of travel from home you calculated earlier? I bet it was more than a humphead wrasse's cumulative movement over a 500-day period – and that's without travel restrictions. Humphead wrasse are model shelter-in-place practitioners, which in part makes protecting their immediate habitat easier. If they stay in one place, make sure that place is as safe as can be. The new MPAs ensure that these humphead wrasses' home is their safest refuge.

REEF MANTA RAYS: HAVE WINGS, WON'T TRAVEL

For four years the PhD study of SOSF-DRC researcher Lauren Peel tracked acoustically and via satellite reef manta rays around the Amirante Islands of Seychelles and built up a photo-ID database of individuals known to frequent the popular manta cleaning station off D'Arros. Were the manta rays merely stopping over as they moved through the territorial waters of Seychelles? Understanding where these manta rays travel to, and where they stay, is an important conservation strategy for a species that faces

global population declines based on its market value in the Eastern traditional medicine trade.

Lauren suspected that juvenile reef manta rays may stick around D'Arros and St Joseph more than adults and that there may be differences between male and female habits over space and time around the island and atoll. But the mantas gave surprising results over the four-year period: 89 per cent of all acoustic detections were within 2.5 kilometres (1.5 miles) of D'Arros and St Joseph, and tagged mantas were present 64 per cent of the days they were tracked, the equivalent of four and a half days a week. That rate well exceeds the minimum length of stay many countries require for a foreigner to claim residency. The manta rays are not just passing by; D'Arros and St Joseph are home.

PORCUPINE RAYS: WHEN THE GOING GETS TOUGH, THE TOUGH STAY HOME

It's a purely subjective opinion, but the porcupine ray is in tight competition with the humphead wrasse as the most charismatic study subject in the history of SOSF-DRC research. This staunch species is barbless, meaning that the capture method for Chantal Elston's PhD work on it entailed a gloved rodeo-style approach that rewarded stealth but, like handling anything spiky, required respect. As in the case of the humphead wrasse, it's possible that the porcupine ray population around D'Arros and St Joseph is one of the densest in the world. Understanding what habitats the porcupine ray calls home is, as for any Vulnerable species, a global conservation concern. Chantal's study monitored porcupine rays over two and a half years and



A marine spatial plan that considers the different habitats, regions and species across Seychelles – and the movement of animals across the archipelago – is about securing livelihoods right now. But, as our oceans and climate change, MPAs are also about security in the face of an uncertain future.

Photos: Left, Byron Dilkes, right, James Lea





Life on coral reefs is linked. Understanding where big, nomadic residents like reef manta rays and turtles travel to helps unlock the smallest details of very local ecosystems. Protecting the place these animals call home equates to resilience across the system.

Photos: Rainer von Brandis

determined that they too stay within what are now the boundaries of the newly declared MPAs. In particular, the majority of tagged porcupine rays were detected within St Joseph Atoll for close to or more than a year, once again highlighting the benefits that would accrue if the atoll were to be designated a multi-species sanctuary.

A NATION'S BLUE HEART

Perhaps most importantly, Seychelles is home to people who care deeply about the ocean now and for generations to come. It is because of these people, and the visionary actions of the Seychelles government, that D'Arros Island and St Joseph Atoll can act as a sanctuary home to so many important marine species. Uncertainty still lies ahead – external factors like climate change will increasingly impact ocean ecosystems – but taking the steps now to protect near-pristine and critical habitats like those declared as MPAs in Seychelles is an essential step towards ensuring best-possible outcomes for conservation in the future.

SPACE

WORDS BY

Lauren De Vos

The ancient art of tracking has taken a technological turn, changing the way that scientists follow animals around our planet. Lauren De Vos explores how technology is being harnessed to change our trajectory towards one of sustainability in our seas.

RACE

Many species are resident to a particular coral reef or a certain sea-grass bed. But many other animals, especially sharks, are wide-ranging, open-ocean nomads that move outside the safe bounds of MPAs. Understanding their movement patterns is key to protecting their populations.

Photos: Previous page, Alec Favale, right, Ryan Daly

It's a counterintuitive start for a talk by a travel writer. But when Pico Iyer, British essayist and the author of the book *The Art of Stillness: Adventures in Going Nowhere*, ruminates, 'I found that the best way that I could develop more appreciative and more attentive eyes, was, oddly, by going nowhere. Just by sitting still,' I pause. Revisiting Iyer's 2014 TED Talk in the year 2020 found me listening to his well-worn words anew.

If any year is going to give credence to the counterintuitive, it's 2020. The global Covid-19 pandemic forced more people into an uncomfortable stillness than any we have collectively known before. But Iyer's gentle assertions are more pertinent now than ever. He reminds us that 'still' isn't necessarily the same as 'static' or 'stationary' and that meditation doesn't preclude movement. Instead, reflection 'allows you to bring stillness into the motion and connection of the world'. As a biologist, I have long grappled with the idea that with movement comes momentum. And increasingly, much of our work is to understand what this unchecked momentum of humanity's innovation has meant for biodiversity and our sustainable future.

At some point in this forced global moment of pause, many of us reflected for the first time on what our connected and hugely consumptive lives mean for the earth. For most, it was a first glimpse at how the absence of a human footprint might appear. Photographs and reports abounded of wildlife reclaiming urban spaces, of wildness flooding back to fill the space vacated by human beings who had taken themselves hostage in their homes. Fanciful, false and often downright foolish, such claims seldom had any scientific basis.

And yet, there was an undeniable hopefulness that underscored the reports. Could it be that by removing ourselves from the wilderness for the equivalent of a geological blink of an eye, our momentary absence from many places had forced us to look with new eyes at the scale of our footprint? And perhaps we had started imagining where animals might move when the barriers to their movements are removed. Listening to Iyer again against the backdrop of a pandemic, I found myself revisiting the results of a marine study that had done precisely this

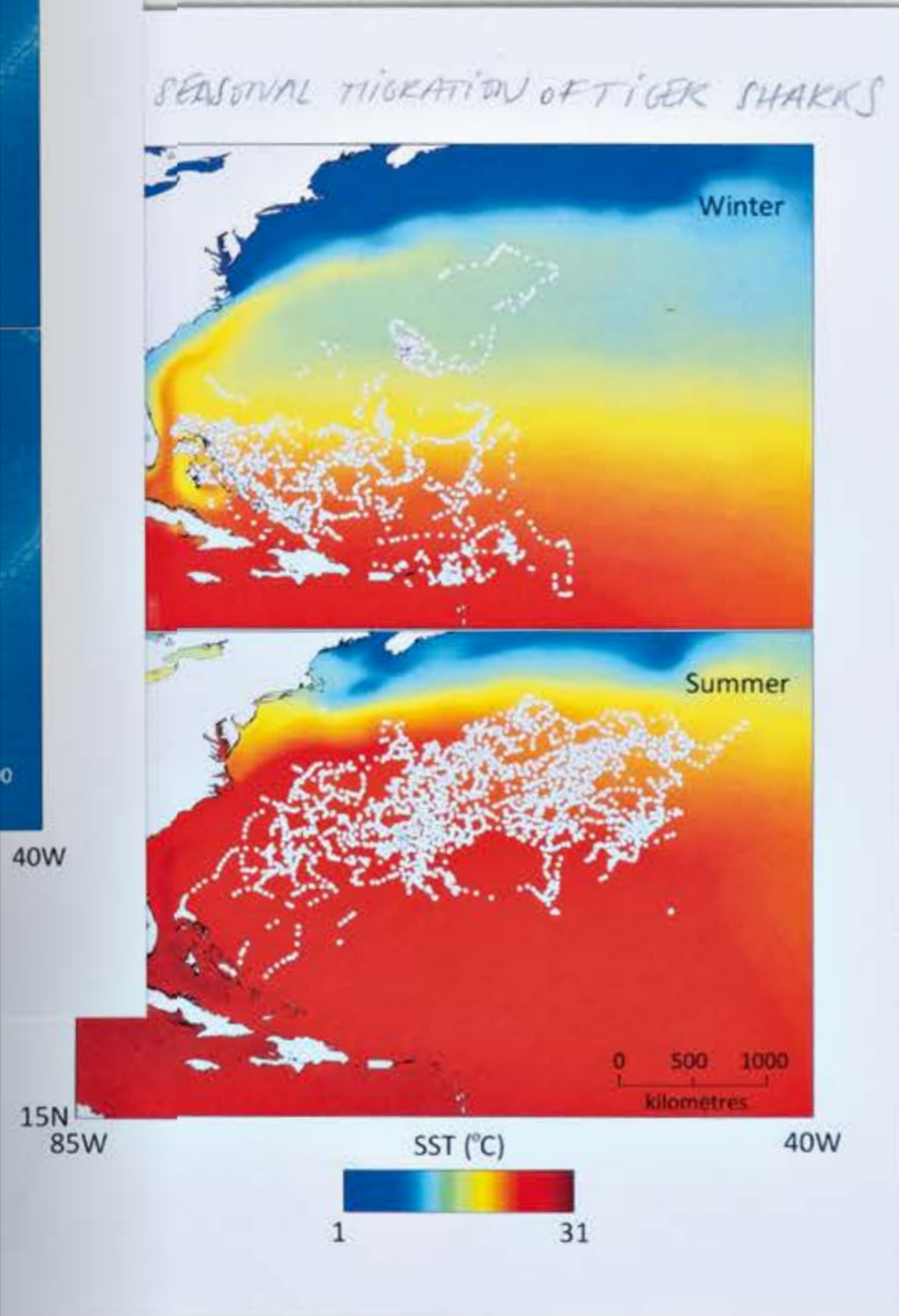
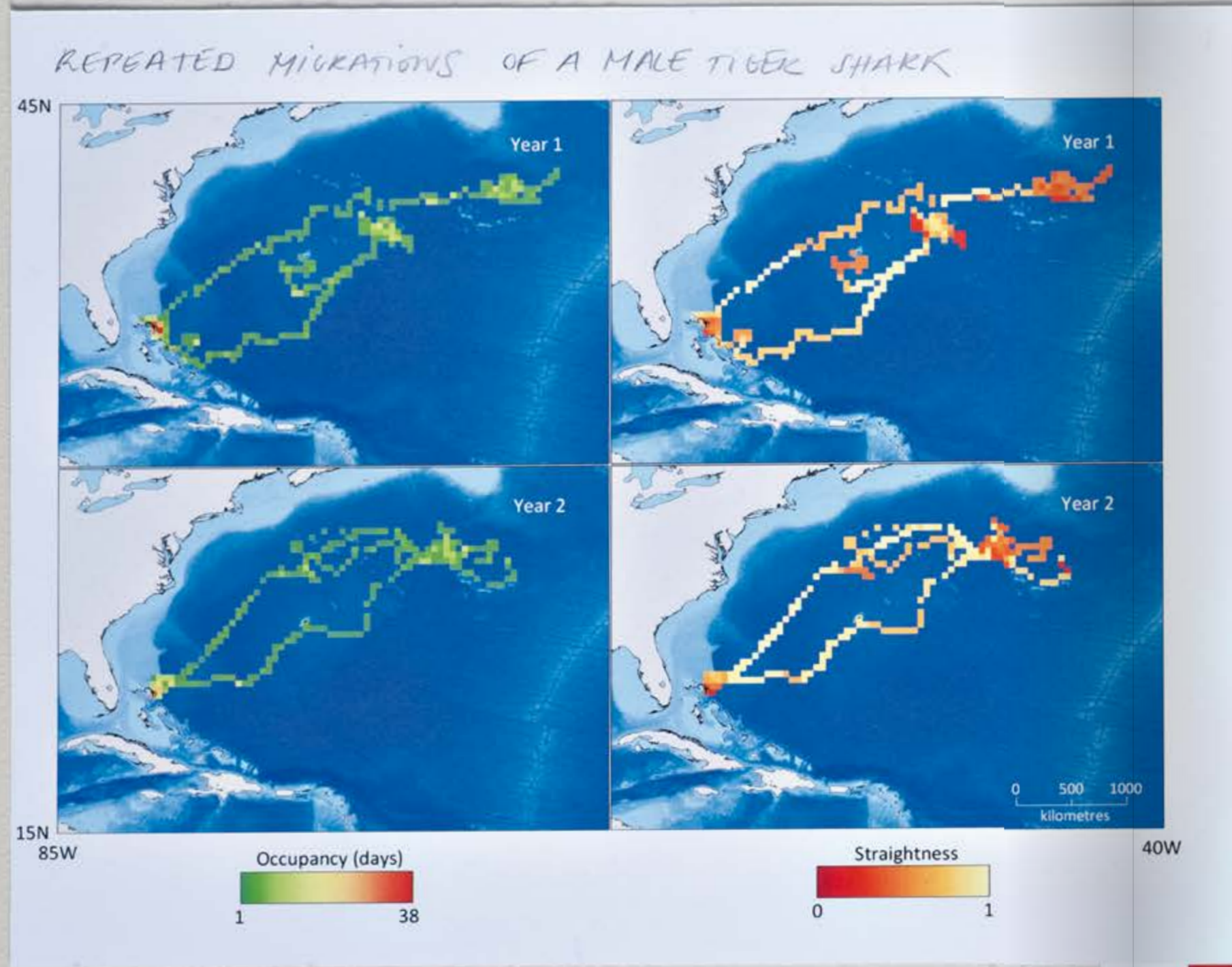
exercise one year previously. Where do we find ourselves spreading our impact across our oceans and what does this mean for sharks?

In July 2019, Dr Nuno Quieroz from Universidade do Porto in Portugal and Professor David Sims from the Marine Biological Association Laboratory in Plymouth, United Kingdom, published a paper in the journal *Nature* that made media headlines worldwide. Their research formed part of the Global Shark Movement Project (GSMP), a collaborative effort to understand how sharks are moving around the seas relative to changing patterns in climate, increasing pollution levels and how humans use the oceans for shipping, fishing and mining. Its findings were decided and divisive. According to the study, there is little refuge left for pelagic sharks, those mobile predators of the open ocean, because the footprint of industrial longline shark fisheries overlaps with critical pelagic shark habitats. Concerned reports flooded out and there was some quibbling with rebuttals on the niceties of grid cell sizes and statistical calculations. However, it was undeniable that Nuno Quieroz, David Sims (who heads the GSMP) and more than 150 scientists from 26 countries who had submitted their data for the study had forced us to reckon with the widespread nature of our footprint on the ocean.

Simultaneously, their results highlighted the global scale at which we need to be working to manage our impact on the ocean and its biodiversity. In Sims's own words for an interview with the Save Our Seas Foundation when the publication was released: 'The only way we can answer questions about shark ecology and the impacts of fisheries on shark hotspots globally is to work collaboratively on a global scale. No single research group could hope to collect sufficient data to undertake the analyses that are needed to provide sound scientific evidence to inform shark conservation on the high seas. It's something for which we all need to work together.'

But how does one begin to grapple with collecting data about where sharks – and shark fisheries – are moving around the globe? For this, the scientists turned to space. Using the data collected from satellite transmitter tags





Previous page: The occupancy and mean straightness of movement for shark 7 (384 cm male) for the first and second year of its track (measured from tagging date). Data from Lea *et al.* 2015 <https://doi.org/10.1038/srep11202>. Maps created in ArcGIS, using GSHHG coastline data and ETOPO2v2 bathymetry data.

This page (below): SPOT tags are attached to animals that come to the ocean's surface. Dolphins, seals and turtles all come to the surface to breathe, and a shark's dorsal fin often sticks out above the water.

Photo: Chelle Blais, right, Brendan Talwar

Right: Pop-up tags are attached to animals that don't often surface and they record things like depth and temperature before detaching, floating to the surface and transmitting their data.

Photos: Brendan Talwar



placed on 1,804 individual sharks representing 23 species across the Atlantic, Pacific and Indian oceans, they mapped ocean 'hotspots' – areas that sharks were using frequently or where they were aggregating. To figure out the extent to which these shark hotspots overlapped with the areas worked by longline fishing vessels, the researchers needed to overlay information on where the fishing vessels were – in ocean space, that is. For this they used information beamed from ship Automatic Identification Systems (AIS). These systems transmit a ship's position to satellites orbiting the earth and are mandatory for vessels over 300 tonnes in size that traverse international waters. Their use? To prevent ship collisions at sea. Their incidental value to conservation science? Researchers can use these 'satellite tracks' in the same way they use the data transmitted from shark tags.

By effectively overlaying two transparencies – one showing where sharks were moving and the other where fishing vessels were moving – David Sims and his team were able to calculate the percentage overlap of fishing with their identified shark hotspots. To his disappointment, the level of overlap was more than David had anticipated. 'We didn't realise the sheer scale of the overlap and fishing effort centred on shark hotspots, resulting in a near entire overlap of the tracked range of two species, the blue and shortfin mako sharks, which are commercially important and account for more than 90% of the pelagic sharks caught by longline fisheries,' he explained.

The art of tracking is certainly nothing new; it's as ancient as our own human histories and is a fundamental part of how we've always related to other animals. But it's only since the 1960s that scientists have been tracking animals to answer ecological questions on a larger scale, and they've been using different kinds of tags and receivers. Acoustic tags send a signal to underwater receivers, usually set up over a set area as an 'array' that records a 'ping' each time a tagged animal swims within range. The results give scientists insight into where, when and over what distances different sharks or rays are moving. This was how Dr Chantel Elston from Rhodes University in South Africa was able to identify a potential nursery site for porcupine rays *Urogymnus asperrimus* by tracking 22 individual rays around St Joseph Atoll in Seychelles. And how Dr Lauren Peel figured out just how important D'Arros Island

and the very same St Joseph Atoll are for reef manta rays *Mobula alfredi*.

However, many sharks and rays range widely across the oceans and several species undertake phenomenal migrations. When the Russians launched Sputnik into space on 4 October 1957, the potential opened for a very different kind of 'array' to track movement patterns on earth. By employing a different kind of tag, one that uses the constellation of satellites that now orbit our planet, researchers like Dr Tristan Guttridge could work out that a great hammerhead shark *Sphyrna mokarran* he called Gaia swam from Bimini in The Bahamas to South Carolina and back, a round trip of 1,600 kilometres (994 miles). Uncovering the story of Gaia and other great hammerheads like her who call The Bahamas their home revealed that these sharks make epic journeys of up to 3,030 kilometres (1,883 miles).

Satellite tags zoom our vision of animal tracks out to the widest possible extent; they are used to follow the large-scale movements of ocean animals from whale sharks to tiger sharks and giant trevally fish to manta rays. Pop-up satellite archival tags (PSATs, or PAT tags as scientists dub them) transmit data to scientists via the Argos satellite system. The tags are attached externally (usually to the dorsal fin in the case of sharks) and there they log information about location, water depth, sea temperature and oxygen levels as the animals swim across the ocean. After a specific period, the release section of the tag is popped off or corroded, releasing the PAT tag to the sea's surface for retrieval.





Left: As the dorsal fin of a great white shark breaks the sea's surface, signals of its travels are sent to a satellite.

Photo: Alessandro De Maddalena/Shutterstock

Next page: Hammerhead sharks are among the ocean's greatest nomads and tracking the journeys they make is especially important for two Critically Endangered species: the great hammerhead and the scalloped hammerhead.

Photo: Sarah Dauphinee

SPOT TAG

DATA RECORDED

Senses temperature: range (°C) -40 to 60 (resolution 0.5)
Conductivity (wet/dry): 0.1 to 5 S/m

WHAT IS IT?

A small satellite tag (50-170g, depending on battery) that can be attached to marine animals to reveal their location.

WHAT IS IT USED FOR?

Tracking movements for up to three years of any marine animal that comes to the surface.

HOW DOES IT WORK?

When at the surface, the wet/dry sensor causes the tag to transmit its ID code to passing satellites. The location of the tag is inferred from the doppler shift of transmissions received by the satellites. Researchers receive location data via e-mail.



And so, the GSMP team is using satellite tagging to compile a database that holds information about the ocean-wide movement patterns of 23 shark species over more than 280,000 tracking days. Other researchers around the world deploy satellite tags to add to our growing awareness of the scale of connectedness across our oceans. Dr Ryan Daly from the Oceanographic Research Institute, for example, tracked a tiger shark called Sereia a staggering 6,500 km (4,039 miles) from Mozambique to Indonesia. The finding set the record for the longest known transoceanic journey for her species and changes the face of how scientists recommend managing sharks that clearly flout international borders drawn in faint lines on maps spanning our seas.

But what should we do with these data and how best can they contribute to changing policies and improving protection? This was the question posed by a recent assessment published in *Trends in Ecology and Evolution*, written by Graeme Hays and a host of contributors, including Anna Sequeira, a lead researcher on the GSMP project. Satellite tracking is expensive and a necessarily more invasive research method initially than more remote methods like underwater cameras and photo identification. Nuno Quieroz and David Sims's study reminds us that we need to be thinking about the movement patterns of sharks in relation to our own. Tangible evidence of policy shifts makes a stronger case for continued investment in research and technology that should not only astound us and challenge our thinking, but help change the trajectory of our future.

In 2001, David Sims embarked on a different kind of study using PSAT tags that ultimately showed that basking sharks *Cetorhinus maximus* can move thousands of kilometres in mere weeks, but return faithfully to the local feeding grounds that sustained them. These landmark findings helped re-interpret what the impact of fishing could be on these populations and helped to make the basking shark one of the ocean's most protected sharks. It is now listed on Appendix II of both the Convention on International Trade in Endangered Species (CITES) (a first for a commercially fished species)

and the Convention for the Conservation of Migratory Species of Wild Animals (CMS).

Graeme Hays, Anna Sequeira and the other authors of the paper 'Translating Marine Animal Tracking Data into Conservation Policy and Management' unpack cases where tracking seabirds, marine mammals, fish and sharks has changed the ways we relate to them in policies, laws and protocols. But one of their most interesting suggestions speaks to a concept that undoubtedly resonated in our collective consciousness in the year 2020. The word 'connection' has taken on new gravity during a pandemic that saw us leaning heavily on our technological crutch to relate to everyone from family and friends to colleagues and school-teachers. And yet it is precisely this concept – connection – that underscores so much of what we still need to achieve in conservation.

The researchers suggest that tracking data can change decision-making through what is called 'the web of influence'. Open your smartphone, connect to any social networking app and you'll see neon lines spread like veins across ocean maps to keep us connected to the unfolding stories of sharks like Sereia and Gaia. Satellite-tagging scientists increasingly share their research, often in near real-time, on their social media pages and on project apps like the Guy Harvey Research Institute's Shark Tracker and Osearch. The celestial array that tracks all our movements connects all of us: sharks, those of us who follow their stories and the ships that traverse the seas in search of them. The increasing transparency of these satellite tracks and the ease with which we can all connect to the different components of this story – of people and of sharks – might help us to visualise a world where we share ocean space. Perhaps this is exactly what the GSMP and projects like it are prompting us to see. It's not our absence from wilderness that should encourage us to reimagine our impact, but rather a continued reminder of just how we move across this planet alongside the myriad other species that call it home.

So as much as tracking animals has been about knowing where to find resources or how to hunt food, there has always been a more ethereal element that keeps us entranced.



POP-UP TAG

DATA RECORDED

Depth: 0-1700m (0.5m resolution) Light levels: $5 \times 10^{-12} \text{W.cm}^{-2}$ to $5 \times 10^{-2} \text{W.cm}^{-2}$ Temperature: (°C) -40-60 (0,05 resolution) Sense conductivity (wet/dry): 0.1 to 5 S/m

WHAT IS IT?

A small (60g) satellite tag that can be attached to an animal to record depth, temperature and light levels.

WHAT IS IT USED FOR?

Studying broad-scale migrations and dive behaviour of marine animals that rarely surface.

HOW DOES IT WORK?

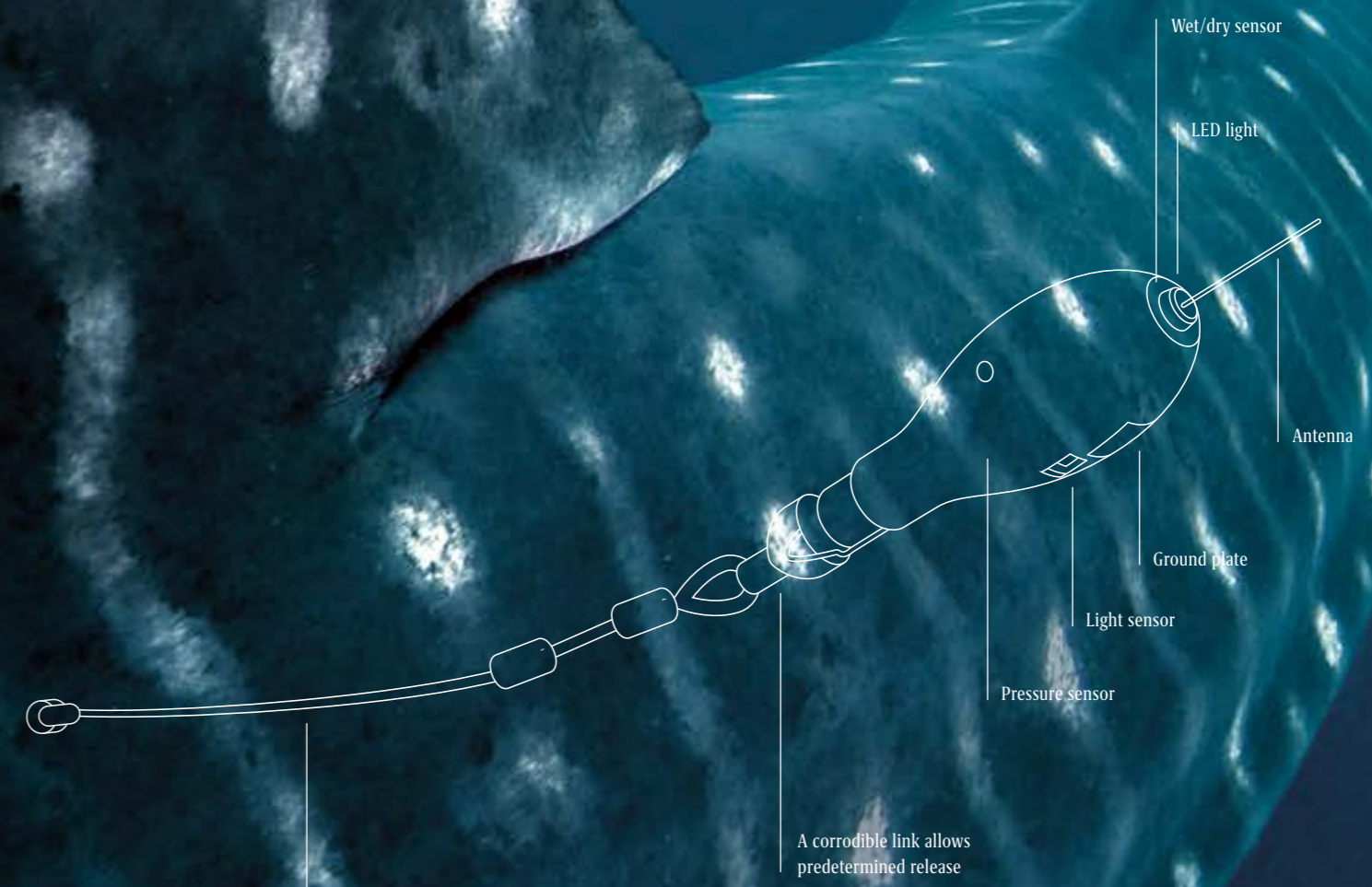
Once attached, the tag sits recording sensor data for up to two years. It then releases from the animal via a corrodible link, floats to the surface and transmits its data to the researchers via satellite.



467
 W/cm^2
RECORDS LIGHT LEVELS

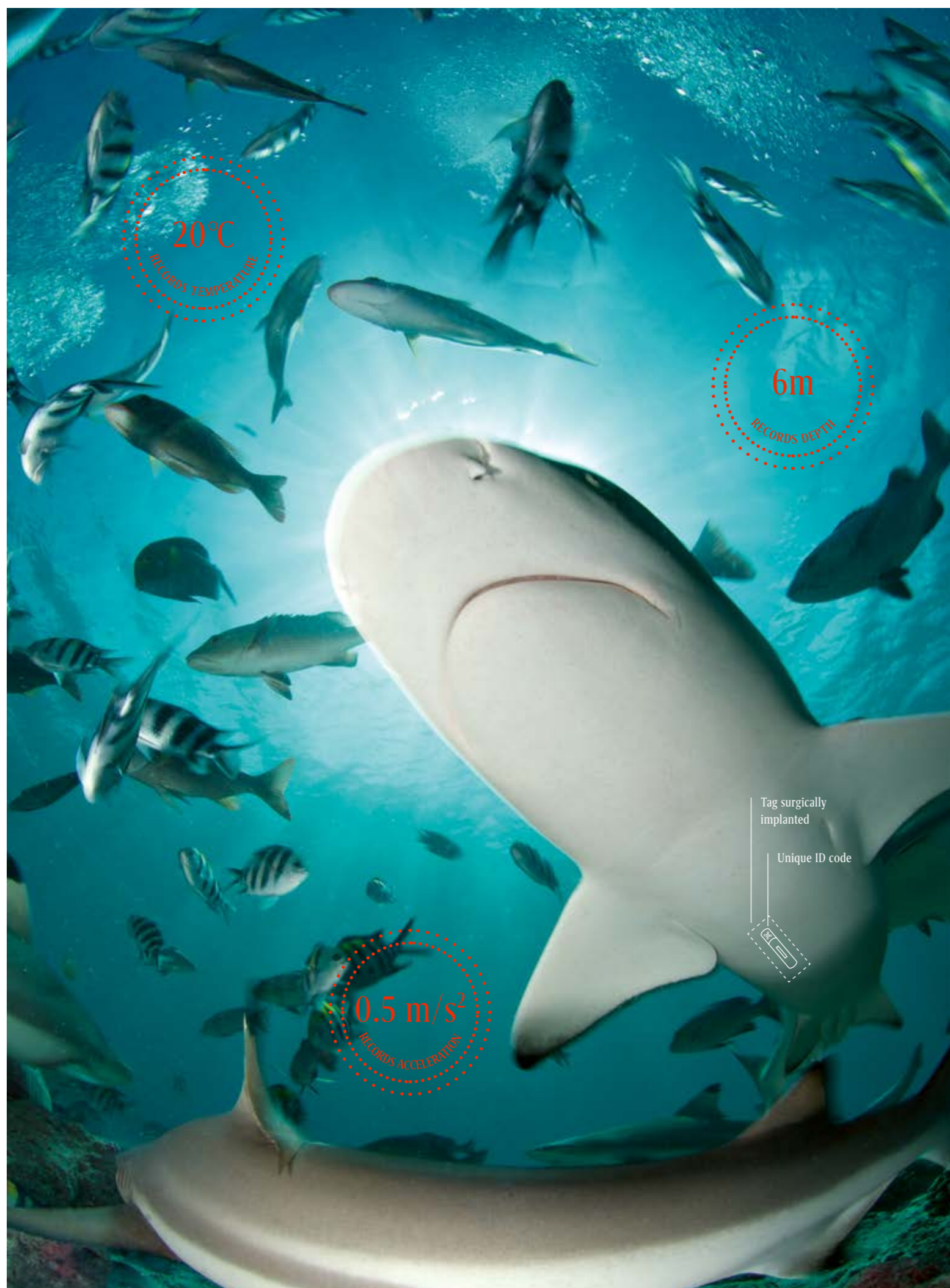
-100m
RECORDS DEPTH

20°C
RECORDS TEMPERATURE



Tether, anchored with a small barb

5 S/m
SENSES CONDUCTIVITY



Previous page: Whale sharks may cross paths with fisheries, where they risk being caught, or traverse shipping lanes, where they are in danger of being struck by a ship. Tracking the movements of these Endangered sharks helps scientists to tailor conservation strategies specific to their needs.

Photo: previous page, James Lea

Left: We know much about the movement of blacktip reef and lemon sharks around Seychelles thanks to acoustic tags.

Right: A listening station anchored to the sea floor will be retrieved by divers and the secret movement patterns of tagged sharks that have swum by will be analysed.

Photos: left, Rainer von Brandis, right, Chelle Blais

ACOUSTIC TAG

SPECIFICATION

Frequency: 69, 180 or 307 kHz (ultra high to beyond animal auditory range)
 Unique ping ID that receiver recognises
 Tag size: 7-16mm
 Battery: up to 10 years
 Range: up to 1000m

WHAT IS IT?

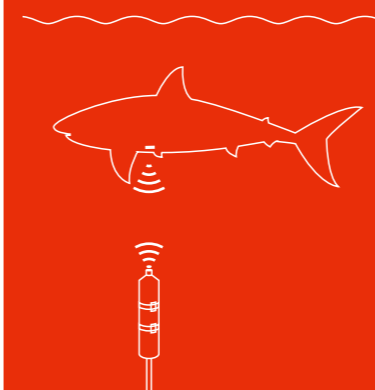
A small acoustic transmitter that transmits a unique ultrasonic code to identify the animal it's attached to. This code is picked up by receivers (listening stations) that researchers place underwater.

WHAT IS IT USED FOR?

Studying movement and behaviour of marine animals in coastal waters, as data need to be downloaded directly from the receivers.

HOW DOES IT WORK?

The small tag transmits a unique code that the receivers (essentially underwater microphones) listen out for. The movements of the animal are reconstructed based on when it is heard on each receiver within a larger array of receivers. These tags are typically surgically implanted to prevent them being lost, and can be set up to also record things like temperature, depth and acceleration.



Perhaps it lies in a bid to gauge our place on this planet as part of a matrix of life. And it is in a conversation with Lauren Peel about the range of findings her tracking has yielded about manta rays that an interesting idea crops up. While it is undoubtedly important to understand how sharks and rays are moving relative to us in the ocean, it's equally important to know how they move independently of us – to give flight to our imagination and perhaps rekindle in us a sense of awe at what we can still learn from the stories that ocean creatures have to tell.

'Animal tracking breaks the water barrier. It gives us a unique way of connecting to ocean creatures in today's world without necessarily getting underwater or even speaking the same language as the researcher who is trying to describe that animal's story,' reflects Lauren. I pause to imagine what her words are painting, remembering the stories that satellite tracks etched onto computerised maps can tell us about the secret, but spectacular lives that sharks lead.

'To understand where these huge animals are going takes serious technology,' Lauren continues, her voice earnest. 'We can't simply chase after a manta ray; as soon as it swims away from a cleaning station, our diving fins and even

our boats can't keep up.' With satellite tracking, she has visualised how manta rays are moving in order to manage them better, 'to get a feel for the scale of movement that we're looking at; to get an idea of whether small marine protected areas around key islands are sufficient or whether we need to investigate protection across the whole Amirantes Bank in Seychelles.'

There is exciting potential in what every technology offers us. Databases logging information from space that come from shark tags, from vessel monitoring systems and from AIS provide the momentum to propel us towards whichever future we choose to imagine. But momentum is not the same as direction, and if there is anything we might have learnt from 2020, it is that technology is not the end in itself. Rather, it is a means to an end. Where we go from here depends on how wisely we learn to harness its power as a tool. 'Almost everybody I know has this sense of overdosing on information and getting dizzy living at post-human speeds,' Pico Iyer reminds us. Perhaps this is our chance to reflect on those little digital tracks that blink back at us from our computer maps and the speed at which we race to overlap in space. If this could help us notice what our presence means and not what our absence suggests, a new direction might bring renewed hope of shared ocean space.





RIPPLE EFFECT

Impacts of Covid-19 on coastal communities and conservation

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As Covid-19 swept around the world, humans' lives changed significantly, as did the lives of many other species. But was the pandemic good news for the oceans' inhabitants or is the real story more complex?

In need of good news as many of us struggled to adapt to a vastly different reality of restricted movements and working from home during the height of the pandemic, we may have been buoyed by stories of wildlife taking to empty streets in cities around the world. In Japan, sika deer wandered through streets and subway stations. Mountain goats roamed a town in Wales, while in Argentina sea lions appeared on the traffic-free roads of a seaside port.

But Covid-19 was not all good news for wildlife and many conservation efforts in low-income countries have been hard hit. Estimates of its impacts suggest a 75–90% decrease in international tourism in 2020. This has put as many as 120 million jobs at risk around the world. For people living in low-income countries where furlough payments or unemployment benefits do not exist, the loss of work threatens their very survival. As lockdowns resulted in the disappearance of previously reliable forms of casual employment, like driving a taxi or serving in a shop, a large number of people may have turned to the natural world as the only source of food or income. In addition, many conservation groups, especially those in poorer countries, depend heavily on the money and involvement of volunteers to keep their programmes running. Pandemic-related travel bans resulted in the drying up of this source of income and labour.

The effects of the global pandemic on our oceans and their inhabitants have clearly been diverse. Here we examine some of the reports of the many impacts, positive and negative, that the virus – and especially the halt to marine tourism – has had on sea life and marine conservation efforts.

The Bazaruto Archipelago, a group of five white-sand islands surrounded by sparkling turquoise waters, is a popular high-end tourism destination in southern Mozambique. The tiny village of Mangalisse lies just south of the archipelago, on the mainland. Until two years ago, fishing was the only real livelihood there for most of the community. The shallow sand banks are exposed at low tide, enabling women to walk far out to sea-grass beds where they collect oysters, while men take their wooden dhows (sail boats) out to deeper waters to catch whatever they can: fish, crabs and, sometimes, what the locals call 'diamonds', or seahorses.

Not long ago, every one of the 120 or so families in Mangalisse was poaching these tiny animals, which are protected by law, and selling them for considerable sums to visiting buyers. Dried seahorses are exported to Asia, where they are used in Chinese traditional medicine to treat conditions such as asthma and arthritis. For most families in Mangalisse this was the primary source of income and far more lucrative than selling seafood. In 2018 the local environmental NGO ParCo launched an educational campaign about seahorse conservation in Mangalisse. It also worked with the community to develop a seahorse

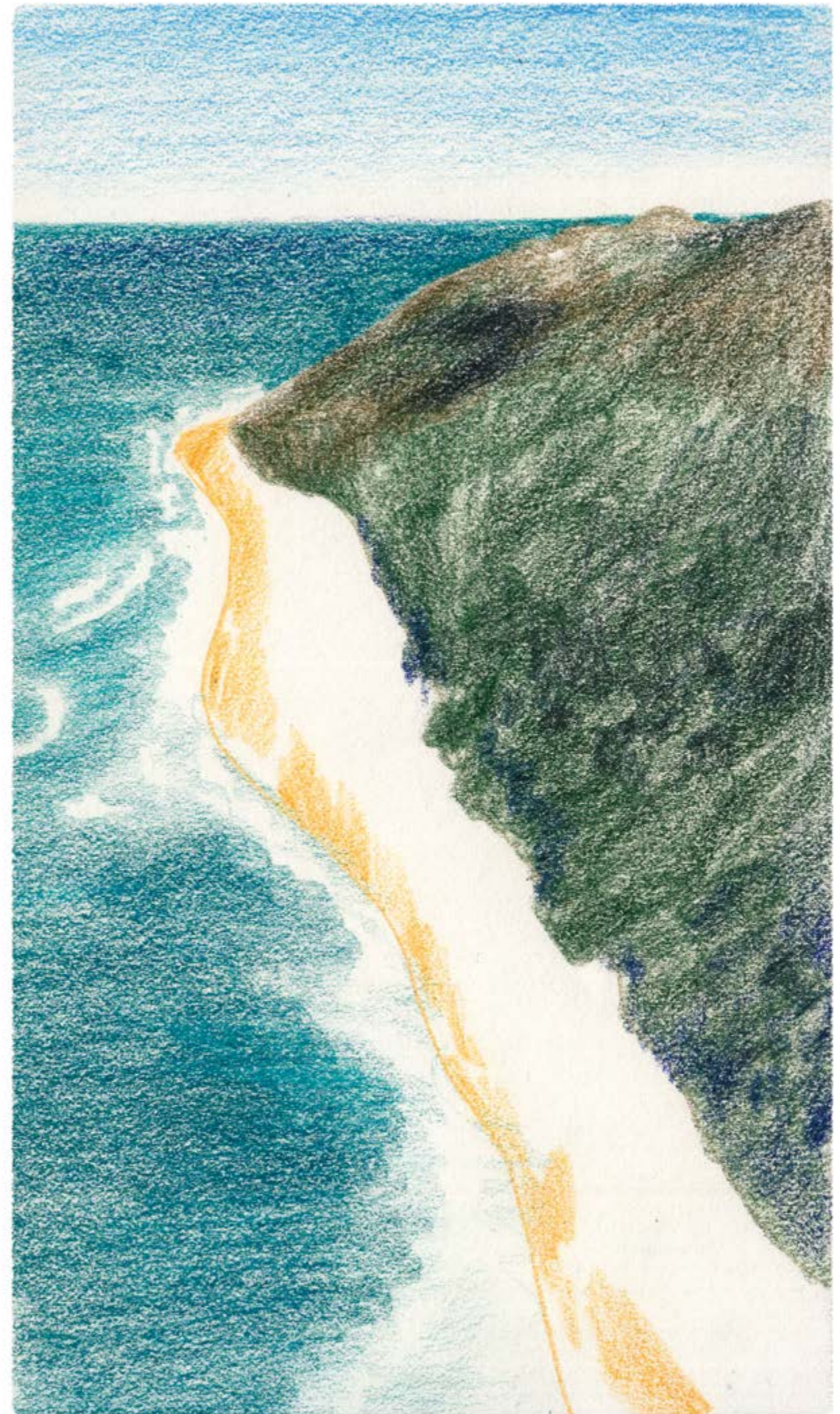


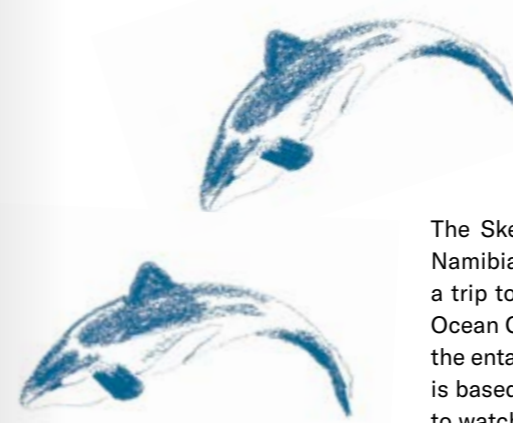
Mozambique

snorkelling safari business: local fishers took visitors out by dhow to see seahorses in their natural habitat. The community came to appreciate that seahorses could be valuable alive as well as dead. Ruben Afonso, a fisherman from the village and former poacher, noted that after the seahorse tours took off, each family could count on an occasional financial boost from a safari and didn't have to worry so much about getting all their income from their fish catch.

But when Mozambique closed its borders in March 2020 and tourism disappeared, the entire community of Mangalisse was left without this source of income. Whether this encouraged the resumption of seahorse poaching is unknown, as anyone who may be involved is now more secretive about their activities than in the past. Certainly, without tourism many members of this community face difficult decisions, in which their basic needs may appear to be in conflict with the goals of seahorse conservation.

Olinda Joaquim is a Mangalisse resident who buys fish from the local fishers and sells it in the neighbourhood. But the impact of the pandemic meant a huge change in the local market for seafood, as the nearby town of Vilankulo, usually a tourism hotspot, became empty. 'The bars we used to sell squid to have closed,' she said. 'The fishermen don't go out every day because they know they won't be able to sell what they catch. The price has gone way down and no one is buying. I am doing about 20% of the business I used to do.' Olinda also used to be involved in the seahorse safaris, preparing a traditional Mozambican lunch to serve to visitors after their trip. This significantly improved her earnings, enabling her to work on her home. 'Since coronavirus, no one comes for lunches. I used to make plans to finish my house. But now there are days I don't eat lunch because money is short,' she added.

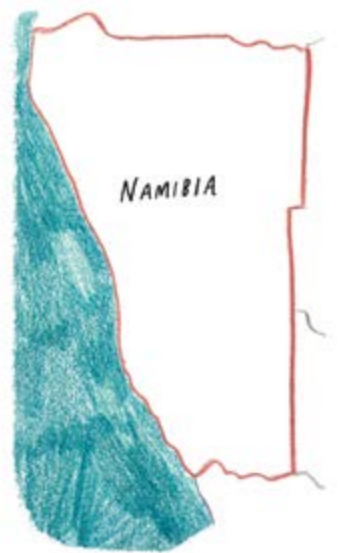




The Skeleton Coast is a wild and lonely place most of the time, but Namibia is a popular niche tourist destination and many visitors take a trip to the starkly beautiful coastline. Naude Dreyer is the founder of Ocean Conservation Namibia, a non-profit organisation that aims to end the entanglement of marine wildlife along the country's coastline. Naude is based in the town of Walvis Bay, where tourists are taken out in boats to watch the noisy and playful Cape fur seals that inhabit Pelican Point, a long sandspit at the bay's western edge, and the bottlenose dolphins and Heaviside's dolphins within the bay.

While Namibia was in lockdown, Naude went out to Pelican Point at least five times a week and from March onward he and his team caught and disentangled well over 500 Cape fur seals, usually from fishing line and plastic packaging. He noted that the lack of boat activity in the bay and of cars driving on Pelican Point gave them more opportunity to do their disentanglement work, which was good news for seals that would otherwise have suffered long-term and increasing discomfort and sometimes physical disfiguration.

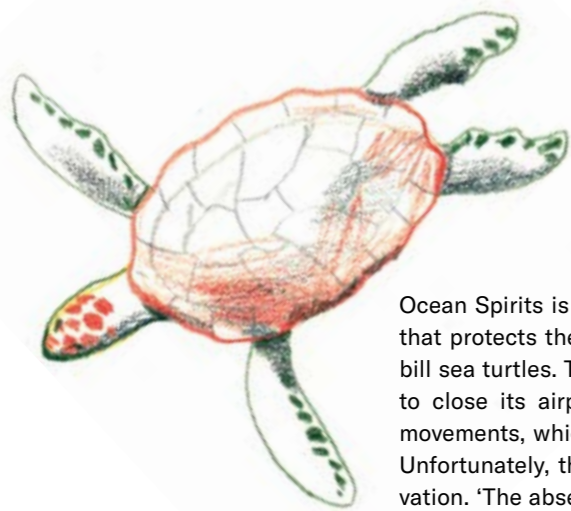
Namibia



In his frequent trips to the sandspit, Naude began to notice other changes in the area's wildlife. 'About a month into the lockdown I started seeing brown hyena tracks again at Pelican Point. This is the first time in at least three years I've seen the tracks there,' he commented. The brown hyena is one of the rarest of Africa's large carnivores and populations are declining across the continent. The hyenas still live in the delta area to the south of Pelican Point, but had stopped visiting the point itself, perhaps to avoid the many cars and people who fish from the beach. 'There are now two sets of tracks heading to and from the point every morning when I get out there,' he said, clearly enthusiastic that these rare and shy animals were taking back their territory in the absence of humans.

Meanwhile, things also changed for the bay's aquatic residents. 'We've been having the most amazing sightings of Heaviside's dolphins from the beach, almost daily,' Naude remarked. 'Usually, the area where we're seeing them is full of tour boats and we don't often get to watch them just hanging around, doing their own thing.' Although the lack of research in Walvis Bay during lockdown means we can't know for sure what might have changed the behaviour of these charismatic dolphins, undoubtedly there has been a reduction in underwater noise caused by boat motors. Research has shown that noise from boat engines can cause stress and mask communication signals among dolphins, so they may have welcomed the quiet. Whatever the reason, it apparently put Walvis Bay's most striking little inhabitants in a good mood.





Ocean Spirits is a conservation NGO working on the island of Grenada that protects the nesting and foraging sites of leatherback and hawksbill sea turtles. The Grenada government decided early in the pandemic to close its airports and enact strict regulations restricting people's movements, which were effective in controlling the spread of the virus. Unfortunately, the measures had unforeseen impacts on turtle conservation. 'The absence of international volunteers meant a loss of funding and a lack of personnel to patrol the beaches where turtles nest,' noted Kate Charles, the project manager for Ocean Spirits. Initially, they had to stop their beach patrols completely, which put the turtle nests at risk from those who dig up the eggs to sell for local consumption.

'Eventually, we were allowed to resume our beach patrols, but were restricted to only two hours per night when we are accustomed to patrolling for 10 hours,' Kate continued. This left turtle nests vulnerable to exploitation for long periods during the hours of darkness. Ocean Spirits teams have documented that at least 20% of turtle eggs have been collected this year, which is concerning given that they usually record levels of about 3%.

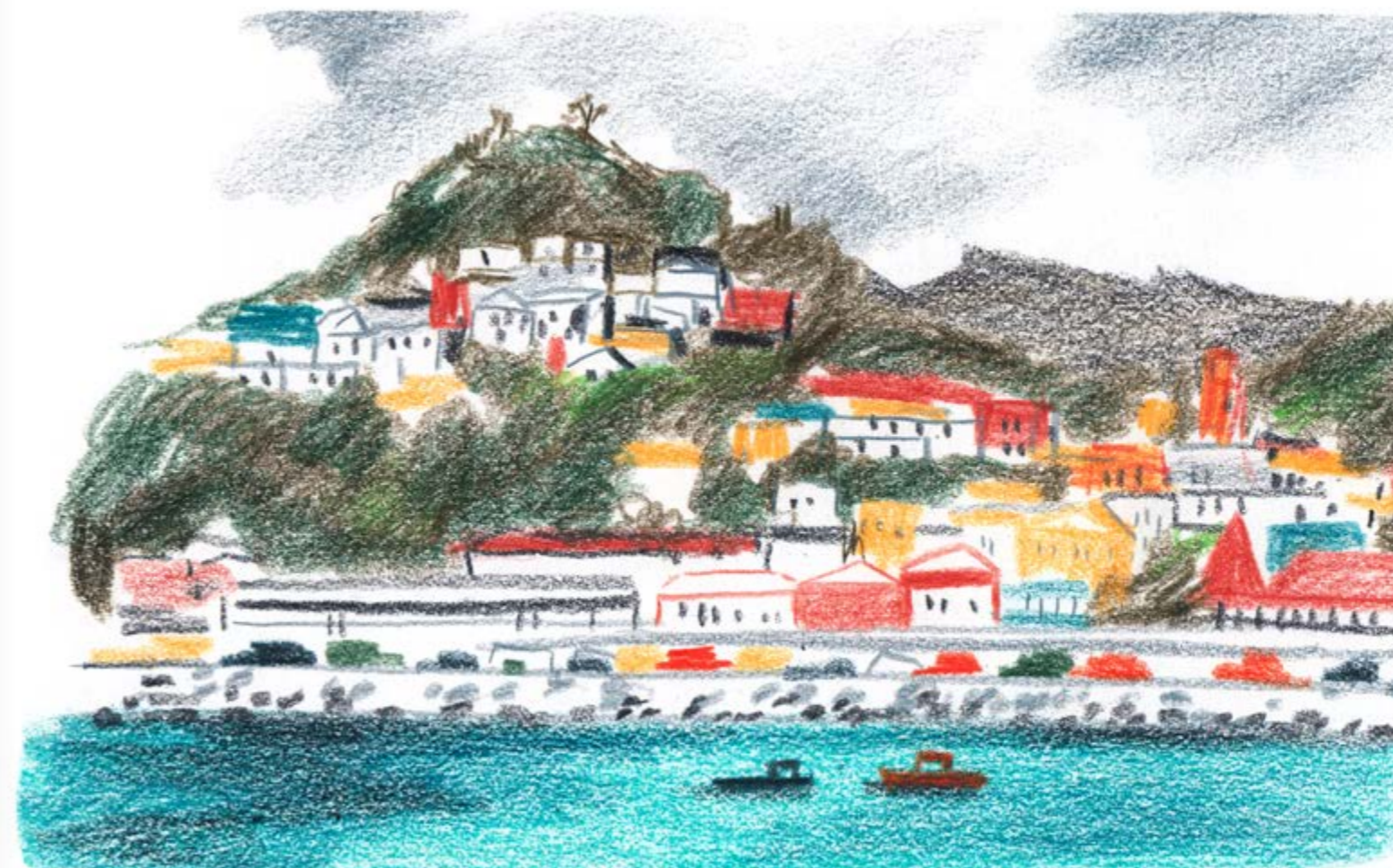


Caribbean

In response to the pandemic, some funders withdrew their support for conservation projects, which resulted in Ocean Spirits losing its funding to monitor the small offshore island where hawksbill turtles nest. Without the resources to travel to the remote site, they were unable to maintain a presence there and now know that turtle eggs were harvested and turtles were killed for their meat. The presence of local NGOs at remote sites can be critical for the protection of the lives of endangered animals.

Didiher Chacon, executive director of Latin American Sea Turtles, and his team had similar experiences in their efforts to protect turtle nests in Costa Rica. 'Many communities are facing loss of employment and income, especially in the most rural areas, and we have seen an increase in egg poaching as people struggle to sustain their families. Eggs are being taken not only for consumption, but also for sale on the black market. Many people who have lost their jobs due to the pandemic are returning to this practice to make ends meet,' he explained.

But on a more uplifting note, he noted that the pandemic has also revealed a sense of stewardship for turtles that has developed in communities, even when times are hard. 'The people of Pacuare, despite not receiving a salary from the project, have continued to support and assist our staff with night patrols and nest monitoring. This indeed is a testament to their commitment to the environment and the protection of the nesting turtles that visit their beach.'



Blue Ventures, an NGO working to rebuild small-scale fisheries in coastal communities throughout the tropics, has been documenting the variety of impacts that the pandemic has had on the people its teams work with. As fish populations have declined in recent decades, many coastal communities have attempted to diversify their livelihoods and become less reliant on fishing. Some turned to tourism, providing home-stay accommodation and developing small businesses that supply services to tourists. But with the collapse of tourism worldwide, these small business owners may have lost their sole source of income, or at least a significant one. Blue Ventures documented that as the pandemic caused job losses in the tourism industry, many people in Tanzania turned to fishing to earn a living. Indeed, this is likely to have occurred in many coastal communities that were once reliant on tourism, but in areas where fish populations are already depleted, such additional fishing pressure could now undo local efforts to manage fisheries sustainably.

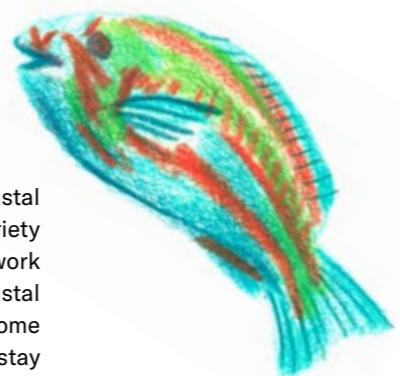
The collapse of tourism also had a significant impact on Blue Ventures' work in Madagascar. Until 2020, the NGO ran a marine eco-tourism programme in the village of Andavadoaka. Expedition volunteers stayed in the village and were trained in coral reef monitoring. They then spent several weeks diving the region's reefs and collecting valuable

Madagascar

information on the corals and other marine life at both protected (no fishing allowed) and fished sites. These data provided valuable insight into the effects of the management decisions communities were taking. For example, more fish, bigger fish or healthier corals in areas closed to fishing suggests that no-take zones may bring about more healthy marine ecosystems and eventually better fish catches.

As data accrue over years, communities can learn which management activities are helping them to reach their goals of healthy fish populations and resilient marine ecosystems and they can make informed decisions about their future. The forced closure this year of the volunteer programme could have meant no data on coral reefs in 2020, or perhaps even an end to monitoring. Instead, the Blue Ventures team turned the challenge into an opportunity: they launched a new programme to train local community members to collect the much-needed data.

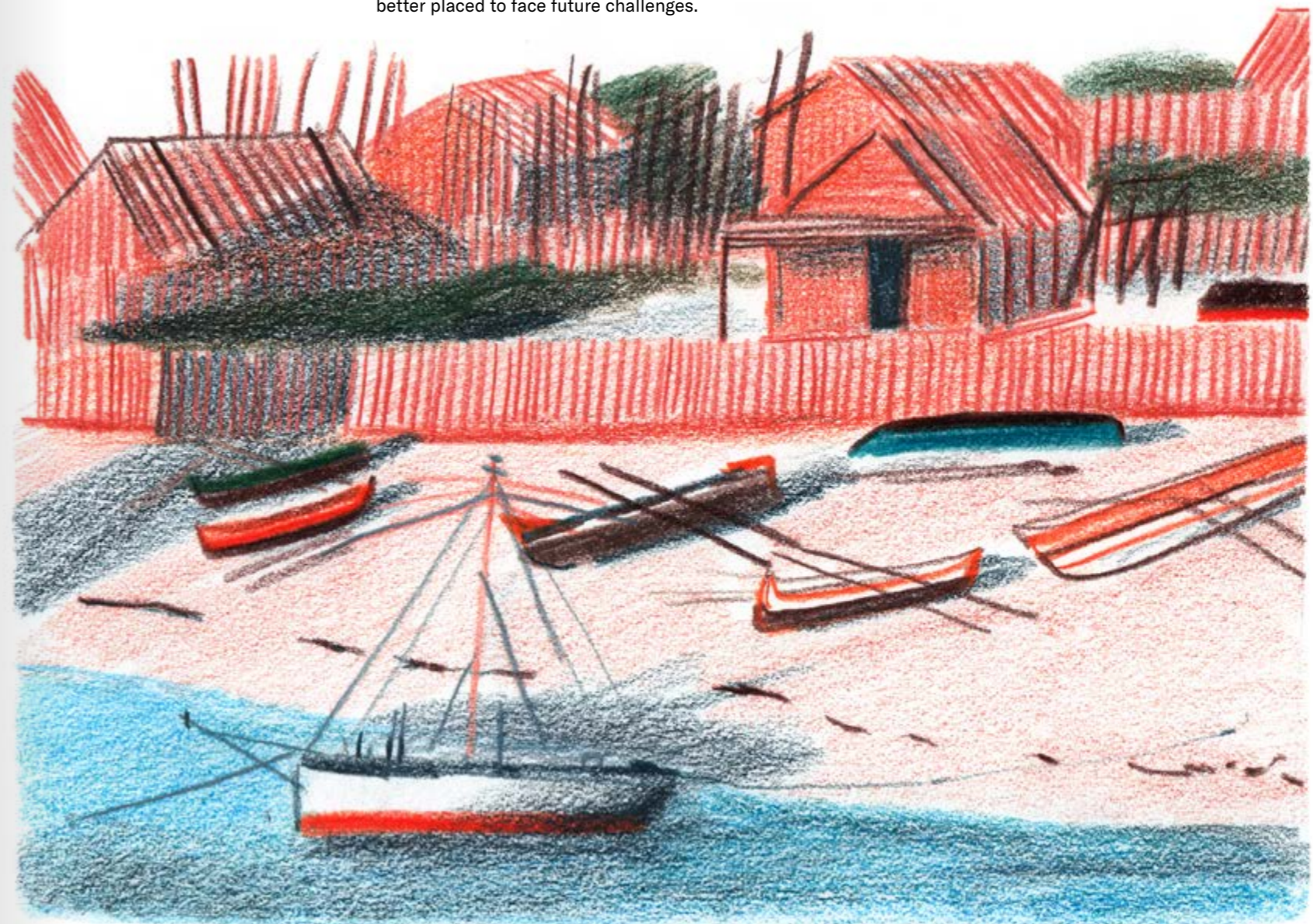
Having a local monitoring team has reduced reliance on visiting volunteers to provide the data for management decision-making. This in turn ensures the long-term resilience of the community to any potential future changes in the tourism market, such as that caused by Covid-19. It has also reduced the gap between data collection activities and the sharing of those data with the community, because data are collected, processed and explained to the community by the same local team, in the Vezo language and using terms that everyone understands.



'For people living in Andavadoaka, life is not easy. Many families rely on fishing as their main livelihood, but income from fishing is not always guaranteed. Being involved in ecological monitoring has not only meant earning a stable income, but has also given these men a voice,' noted Javier del Campo Jimenez, the science coordinator in Andavadoaka.

Transferring these monitoring skills to a local team also places the responsibility for stewardship of these reefs completely in the hands of the local communities, and may even encourage other community members in Andavadoaka and elsewhere in Madagascar to develop their own ideas and plans for future research and management. In this case, the pandemic brought about a fundamental change in the way that critical data for managing fisheries are collected and shared and has placed the local community firmly at the heart of the scientific as well as the management process. 'Marine conservation is extremely important to my future,' commented Ronaldo, a member of the new monitoring team. 'If we can increase the number of fish, it will be easier for the Vezo people to live here in a more sustainable way.'

Critically, Blue Ventures' teams have seen that alternative livelihood initiatives, such as their seaweed and sea cucumber farming programmes in Madagascar, can increase local resilience to economic shocks. The NGO and its partners also support the establishment of low-tech community-led savings and loans groups, which enable people to save money and access credit in remote areas where there are no banks. These have provided a buffer against financial difficulties. More diverse livelihood options and greater financial security are some of the many ways in which rural communities can become more resilient and better placed to face future challenges.





These stories illustrate the many ways in which the global pandemic has impacted the oceans, the lives of coastal communities and marine conservation efforts. The intimate links between the well-being and livelihoods of coastal communities and the state of our oceans have never been more apparent. The absence of human disturbance is undoubtedly beneficial for marine wildlife and habitats.

But conservation is costly and in many places is reliant on philanthropy and Western visitors. The pandemic has revealed the fragility of some existing conservation models and has motivated organisations and communities to rethink their dependence on a limited range of options for funding and livelihoods. Rather than simply having provided a brief respite for wildlife, perhaps Covid-19 will bring about a whole new approach to monitoring, managing and protecting our oceans. Local communities and visitors can clearly be drivers of positive change, but innovation and creativity will be needed to build new conservation approaches to withstand whatever challenges the future brings.



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Understanding the splendid hammerheads

Recognising a hammerhead shark is easy, thanks to the distinctive shape of its head; learning about its biology and behaviour is quite another matter, yet essential if the imperilled three largest species are to be protected.

WORDS BY MAHMOOD SHIVJI

Hammerhead sharks possess one of nature's most distinctive anatomical features: a weirdly sideways expanded head. There are now 10 known hammerhead shark species – our genetics research revealed the 10th relatively recently – and the head of each has its own characteristic shape. They range from the bonnethead shark's modestly expanded head (like a small shovel) to the winghead shark's, which projects so far on each side that it look like the shark has 'wings'.

These curious head shapes are thought to give the sharks an advantage when hunting prey by increasing their fields of vision, smell and electromagnetic detection and allowing them to turn more sharply. There is also a suggestion, although it is still debated, that they may give the hammerheads extra lift in the water, reducing the energy they need to keep constantly swimming.

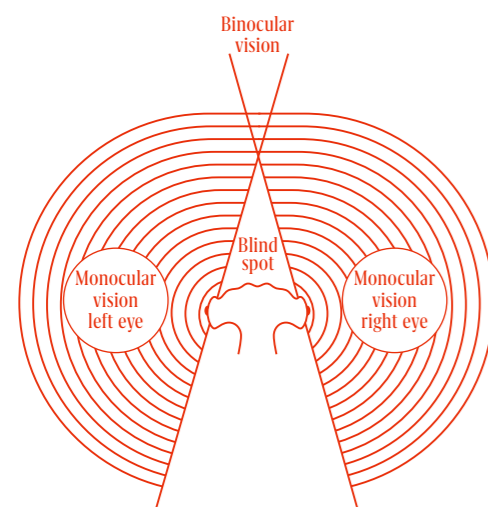
At the Save Our Seas Foundation (SOSF) Shark Research Center, investigating the biology of hammerhead sharks has been one of our major initiatives, not only because of their unique functional and anatomical features, but because several of the species are on the verge of extinction from overfishing. In fact, the three largest hammerheads – smooth, scalloped and great – are particularly imperilled and urgently in need of science-based management.

Our earlier research was instrumental in demonstrating that fins from these three species were prominent and highly valued in the global fin trade. To make matters worse, the hammerheads' need to swim constantly to get enough water flowing over their gills to acquire sufficient oxygen means that they succumb quickly after being hooked. The combination of these factors in the face of high fishing levels has resulted in the scalloped and great hammerheads being classified as Critically Endangered by the IUCN, and the smooth hammerhead as Vulnerable. This means that all three are facing a high risk of extinction in the near term if strong conservation measures are not implemented quickly.

SUPER VISION

The cephalofoil, or hammer-shaped head that gives hammerhead sharks their name, confers on these sharks exceptional depth perception.

Illustration: Thom design studio



The SOSF Shark Research Center has helped discover that smooth hammerhead sharks migrate between New York and North Carolina in search of warmer waters and food.

Genetic insights into populations of scalloped hammerhead sharks show that fishery managers will need to pay individualised attention to, and find unique solutions for, the management of their populations, which are divided into three previously unrecognised stocks.

Photos: previous page, left Brandelet/Shutterstock, previous page right, Christopher Vaughan-Jones, right, Sophie Hart

SMOOTH HAMMERHEAD SHARK

To obtain robust scientific information about the smooth hammerhead, we established a novel collaboration involving university and private enterprise researchers to determine its migration patterns in the western Atlantic Ocean. This shark, which can grow to a length of 14 feet (4.26 metres), remains one of the least understood of the large hammerhead species because of the difficulty of finding individuals to study.

After satellite-tagging smooth hammerheads off the US Mid-Atlantic coast with fin-mounted trackers, we monitored them for up to 15 months in near-real time. Getting these long-term tracks was key to revealing seasonal travel patterns and where and when the sharks were resident between their migrations. These data led us to identify and propose two conservation strategies for the species in the western North Atlantic.

We discovered the sharks migrate between the coastal waters off New York, where they are resident in summer, and North Carolina, where they spend the winter. Their residency in these locations coincides with two environmental factors: warmer surface water temperatures and high productivity resulting in an abundance of food. The high-resolution movement data obtained over long periods showed these wintering and summering habitats off North Carolina and New York to be prime ocean 'real estate' for smooth hammerheads, thereby identifying them as important areas to protect for the species' survival. Such protection could be provided by designating them as 'Essential Fish Habitat', an official title established by the US government. If formally adopted, the areas can be subject to special limitations on fishing or development.

The tracking data revealed a second strategic target for conservation. In winter, the hammerheads are resident in a management zone known as the Mid-Atlantic Shark Area (MASA), which is closed to commercial bottom long-line fishing from 1 January to 31 July to protect the dusky shark. However, the tracking data showed that the smooth hammerheads arrive in the MASA in December, while this zone is still open to fishing. Therefore, extending its closure by just one month, starting on 1 December each year, could reduce the fishing mortality of smooth hammerheads even more.



SCALLOPED HAMMERHEAD SHARK

The scalloped hammerhead can reach up to 13 feet (4.2 metres) in length and occurs in warm oceans worldwide, but has shown alarming population declines of 75–80% in several areas. Despite being recently afforded protection by a few countries, it is still captured for its valuable fins by illegal and unmonitored fisheries.

To guide regional management and recovery efforts, it is essential to know how many distinct genetic populations of this hammerhead exist, so together with Brazilian researchers we conducted a genetic survey of the species in the western Atlantic. This was the first investigation of the scalloped hammerhead's DNA using multiple genetic tools in both northern and southern hemispheres of this part of its Atlantic range. The results were novel. Although they can migrate long distances and genetically 'mix it up', the sharks demonstrated that they come from three distinct gene pools across this north-to-south spectrum. Thus, each of these previously unrecognised genetic stocks will require individual attention by fishery managers and conservationists to prevent the loss of one or more populations and their genetic uniqueness.

GREAT HAMMERHEAD SHARK

At 20 feet (6.1 metres), the largest and most majestic of the hammerheads is also one of the most imperilled sharks in the world. The great hammerhead has been hunted almost to extinction because of the very high market value of its enormous fins. It is also one of the most difficult of sharks to research on account of its size and because it is so rarely encountered. We know nothing about the genetic properties of this species, but urgently need data to assist with conservation and recovery plans.

A current focus of the research centre's scientists and an international team of collaborators is the use of powerful genetic technologies to study the great hammerhead's biology. We are conducting research on several fronts, including mating behaviour, the identification of the species' population-level gene pools around the world and the deciphering of its entire DNA blueprint to reveal the genetic basis of its novel anatomy and the heightened sensory abilities associated with its expanded head shape. This research is ongoing and we look forward to reporting exciting biological and conservation-relevant discoveries about this magnificent marvel of evolution.



Opposite: An educator gently introduces learners to a sea hare – a sea slug commonly found on the rocky shores in the tidal pools in front of the SOSF Shark Education Centre.

Increasing the number of opportunities available to children to engage with the natural world in a guided experience is important for the uptake of conservation ideas. But gauging the level of comprehension of those key messages, and tracking behaviour and attitude changes as a result of these experiences, is vital.

Measuring our impact

Creating lessons and programmes for school groups visiting the Save Our Seas Foundation (SOSF) Shark Education Centre is all very well, but it's also important to know to what extent they are effective and how to improve them.

WORDS BY WISAAL OSMAN AND CLOVA MABIN
PHOTOS: SOSF SHARK EDUCATION CENTRE

The aim of the Save Our Seas Foundation (SOSF) Shark Education Centre in Kalk Bay is to connect people to the ocean through experiential education programmes that focus on sharks and local marine ecosystems in order to nurture awareness, encourage environmentally responsible actions and develop a healthy respect for sharks. But how do we know whether we are attaining this goal?

The impact of an educational programme goes beyond keeping a detailed list of the number of visiting schools, schoolchildren and members of the public. Since 2018 we have been taking a more thorough approach that involves an ongoing process of Monitoring, Evaluation and Learning (MEL). This very important process, which specifically targets the education centre's audience and facilities, took considerable time and effort to develop. It has been instrumental in shaping the current education programme and the future design of all physical exhibits at the centre.

The first step was to evaluate the 2018 status quo and in particular the messages communicated by the education programme and in the exhibition spaces in the centre. This allowed us to develop a theory of change framework, which identifies short-, mid- and long-term outcomes. Indicators that would enable us to assess whether we are achieving the required impact – a healthy, functioning ocean – were assigned for each of these outcomes.

Various data tools, including a knowledge questionnaire, were developed to assess the short-term outcomes. Learners in visiting school groups were asked a set of eight questions at the start and end of their visit:

- Do you like sharks?
- Do all shark teeth look the same?
- Are all sharks big?
- Do humans need the oceans to survive?
- Can some animals live out of the water at low tide?
- Do humans harm the animals that live in the oceans?
- Are sharks threatened?
- Do sharks help to keep the ocean healthy?



These eight questions were selected specifically to address the education centre's mission statement and ensure that certain key messages are conveyed. With these key messages in mind, the education team was able to design lessons and activities to ensure that the children were given the required information. It should be noted that Question 1 is subjective and is therefore not used in the analyses, but rather to assess the learners' attitudes towards sharks. The two sets of answers (recorded as pre- and post-experience) were then scored and compared as indicators for short-term outcome 1: People know more about ocean life and function, and short-term outcome 2: People are more aware of their dependence on the marine system.

Between March and December 2018, 33 school groups visited the education centre. They ranged from Grade 1 to Grade 11 and comprised 1,690 students in total. The data collected indicate that there was a considerable increase in knowledge and awareness after the visits. This is evidence that we were reaching our short-term outcomes 1 and 2.

A closer look at the data revealed the questions or topics that did not score very well (questions that learners answered incorrectly). This enables us to identify weak areas that may need more work in order to improve the communication and learning of key messages. It was also clear that some of the questions were unclear or ambiguous, thereby skewing the data. Those questions were modified and the lessons adapted accordingly in 2019.

Between January and December 2019, we conducted interviews at 36 schools that had sent groups to the education centre. The groups ranged from Grade 1 to Grade 12, with 31 of them comprising learners up to the age of 12. Multiple classes in the same grade at the same school were grouped together in these analyses. When comparing pre- and post-experience correct answers across the two years, we established that questions 2, 6 and 7 scored better in 2019. More emphasis will need to be placed on the content addressing questions 3, 4, 5 and 8, as these scored slightly lower than in 2018.

After analysing the 2018 data, we made the decision to modify some of our content and teaching methods. The data collected in 2019 show improvements in the target areas (content relating to shark diversity and threats), but there is still room for improvement in future lessons. In particular, it is clear that we need to concentrate on the role sharks play in our marine ecosystems. We are now in the process of revisiting the suite of programmes on offer at the Shark Education Centre to assess whether they could be designed so as to increase our mid- and long-term goals. This initial assessment over 2018 and 2019 has given us a good understanding of how much knowledge is transferred to visitors and it can be used as our baseline for MEL processes going forward. It is also important to develop indicators that can be used to evaluate whether the knowledge gained by visitors translates into sustained behavioural change and this will be our focus in future years.

Cultivating curiosity



Surprisingly in a nation whose territory comprises 99.3% ocean, few of the Maldives' citizens know much about the marine world. For the Maldivian Manta Ray Project, connecting young people to the sea is a first step towards conservation.

WORDS BY FLOSSY BARRAUD





Do you remember why you fell in love with the sea? Was it the reflection of the moon dancing on the water's surface, discovering alien critters while rock pooling or staring, mouth agape, at a shark in the local aquarium? In an increasingly urbanised world, many people struggle to fall in love and connect with nature: it's out of sight, so out of mind.

MOODHAH DHIYUN

In an island nation of about 540,000 inhabitants, with a territory made up of more than 99% ocean, the Maldivian culture is intrinsically linked to the sea. Visit the beach at dusk and you will see people relaxing in the shallow lagoons. In the harbour, they socialise while catching fish. Ask any Maldivian and they will tell you how proud they are of their abundant marine life, especially the manta rays and whale sharks that help to draw in more than 1.5 million tourists annually.

In the local language, *moodhah dhiyun* is a common expression that translates as 'going to the sea'. Hussain Shameem, the founder of the open-water swimming group Swim Maldives, says, '*Moodhah dhiyun* means hanging out, diving, jumping off boats, dipping, fishing and eating on, or near, the beach. But it doesn't include swimming. People don't necessarily know how to swim. Yet the Maldives is 99.3% water, so knowing how to swim is not only a skill, but should be a basic requirement for every citizen.'

Unfortunately, many of the locals, especially the women, spend little time snorkelling, diving or swimming beyond the lagoon. Research conducted with the students I teach has shown that girls are 50% more likely than boys to have never snorkelled before, and three times more likely to lack confidence when swimming in the sea. How can we hope to instil in the next generation a desire to protect their precious marine resources when so many are disadvantaged in their access to the ocean?

You protect what you love and you love what you know. My role as the education manager for the Manta Trust's founding base, the Maldivian Manta Ray Project (MMRP), is to improve marine education by increasing the connection that young Maldivians have with the ocean.

MOODHU MADHARUSAA

The MMRP's 60-hour marine education programme is called Moodhu Madharusaa, meaning 'ocean school' in the local language. Moodhu Madharusaa aims to build upon *moodhah dhiyun* by embracing snorkelling and conservation-awareness activities. As well as teaching students to swim beyond the confines of the lagoon, Moodhu Madharusaa empowers young people by giving them the information they need about environmental breakdown. Our students then transfer what they learn to their parents, shifting the beliefs of the older generation.

I work with a different island school every six months, inviting up to 60 students to participate. Core modules are designed to foster the skills and behaviour that are most important in the context of conservation in the Maldives. Their subjects include marine ecology, coral reef ecosystems, marine megafauna, sea-grass and mangrove habitats and ecosystem conservation. Into the modules we weave presentations, film screenings, guest speakers, practical activities, field trips and snorkelling sessions. Students get to deploy a remote underwater video camera in a hotspot for juvenile blacktip reef sharks and learn how to record data. They visit marine research centres and find out about jobs they could aspire to. Within each module, there is a community engagement aspect: poster presentations, a film project or a mock research conference. In the coral reef module students are tasked to design a class for primary school children. These activities elicit high engagement and instil in the young people the belief that they, as individuals, can create change in their schools, their communities and even their country.

During theory classes, the learners are equipped with the knowledge to interpret what they see. We discuss the appearance of healthy and unhealthy ecosystems and interspecies relationships. Then we challenge the students to observe these things happening 'in real life'.

The Moodhu Madharusaa syllabus focuses on outdoor experiential learning as a priority. Every fortnight we set out in a traditional Maldivian boat to discover something new. Sometimes this is an unwelcome crown of thorns starfish, sometimes a purple jellyfish with a turtle-shaped bite from its mantle, occasionally a huge manta ray, gliding centimetres under the students' fins as it somersaults backwards and engulfs hundreds of tiny copepods.

Last year, we took 60 Moodhu Madharusaa students to an uninhabited island and trekked through jungle until we came to a mangrove swamp. I had planned various educational activities, but suddenly the students waded into the swamp, sinking into the thick, smelly mud at the bottom and screaming with laughter. They said that, coming from a developed island with few trees, they had never had the opportunity to experience anything like this. They were truly connecting with nature. Offering these awe-inspiring experiences in local, previously unexplored marine ecosystems helps us to effectively foster the students' passion for their environment.



Learning to engage with the ocean through play, recreation and relaxation adds to the richness of what the ocean provides us - and makes it worth protecting. This extends to its different ecosystems, including the mangrove forests that many marine animals use as nurseries.

Photos: previous page, left, Flossy Barraud, right, Kaitlyn Zerr. This page, left, Thoriq Abdul Rahman, top right, Flossy Barraud, bottom right, Thoriq Abdul Rahman

THE FUTURE

Our long-term goals for the programme are far-reaching within the Maldives and beyond. When Moodhu Madharusaa comes to a close, we are both heartened and sad when many students comment, 'We want more opportunities to go snorkelling.' On last year's Moodhu Madharusaa island, 12 local women were trained as swimming instructors. One of our goals is to source funding to replicate this around the Maldives. The presence of instructors on each island would give communities opportunities to swim regularly and safely and snorkelling would become a more commonplace recreational activity.

We have partnered with the Maldives Ministry of Education to run a series of workshops in Malé, the densely populated capital, to broaden the scope of the course and build local capacity to sustain the programme going forward. We are also working with teachers to create ocean education teaching packs to donate to schools in developing countries worldwide. In this way, we can ensure Moodhu Madharusaa reaches as many communities as possible.

I plan to further research gender roles in ocean engagement. As a woman, I find it difficult to witness the inequality females face in enjoying the ocean here and elsewhere. If half a nation's population is not engaged with the marine environment, surely there would be long-term implications for conservation? This demands further investigation. For now, I will continue to teach, learn and enjoy the salt and mud with the incredible ocean school students.





The traditional measures of the scientific field – grades, publications and funding – no longer address the opportunities available to, and the retention of, historically underrepresented or excluded groups.

Towards better marine science

The prevalence of unhealthy and abusive cultures in marine science, especially shark research, has been described before. For years, conversations about building a more diverse and equitable future have yielded limited results. Why, and how can we move beyond talk?

WORDS BY CATHERINE MACDONALD
PHOTOS: FIELD SCHOOL

In marine science, acknowledging that too few opportunities and resources are allocated to historically excluded and underrepresented groups is often met with muttering about maintaining scientific 'standards' and 'quality'. We've built a 'meritocracy' based on grades, publications and funding, even as we recognise these metrics reflect not just ability, but privilege. Evidence has repeatedly shown that discrimination and bias limit who has opportunities in science and who is welcomed and given the chance to succeed.

Last summer, I wrote an article for *Scientific American* about my experiences as a woman in science. I expected some hate mail and I certainly got it (along with some heart-breaking stories and vital encouragement). A few male scientists reached out to me to express their support, though more were silent. The loudest criticism I received from men in my field focused on my legitimacy as a scientist, on whether I do (or should) have the professional standing to say what I said.

I have been in my field for a decade, have a PhD, publish scientific papers regularly and teach well-reviewed graduate-level courses at a major research university. If I am vulnerable to this criticism, how can students hope to be heard?



Much in science, particularly biology and conservation science, speaks about the concept of diversity. But translating that into a diverse representation of players in the scientific field requires

listening, resource allocation and a serious look at our collective priorities.

Photos: Previous page, Christopher Brown, this page left, Cat Schultz, top right, Christopher Brown, bottom right, Julia Wester.

hire, promote, select for opportunities, recommend to our colleagues? It's time to start suggesting other scientists, who aren't white men, for some of the opportunities we're offered. It's past time to recognise that gender inequality can look like a male-run lab full of women never promoted beyond assistant and subordinate roles.

We must make the time and find the energy to nurture students even when we're exhausted; to put in the effort on that letter of recommendation or forward that potentially relevant grant opportunity. We should be working our networks and hustling for what our students need. It might be time to take a pay cut, so there's money to pay interns who are making our research possible or to fund scholarship or research opportunities. At minimum, we should thank our students for their work and mean it. We should invest every day in their well-being and success, and care about what's good for them as much as we care about what serves us.

Donate generously to organisations like Minorities in Shark Science (MISS) that are working to make science a better place – and when you do, think about what they tell you they need, not about what you want to give. It isn't enough if what we do to support diversity is painless, costs us nothing or offers PR benefits equal to the cost. Nor is it enough if behind the scenes we aren't quietly doing more than we're publicly taking credit for.

We need more representation of how diverse science and scientists could be if we are to overcome stereotypes about who belongs in our field. We need to find ways to provide scholarships, internship funding and truly equal access to opportunity for students from all backgrounds. We need to listen to feedback about how we can create a more welcoming and inclusive scientific community, and constantly try to do better.

We need more grant-making organisations and graduate schools that aren't focused on flawed, privilege-driven meritocratic metrics to assess applicants. We need processes that protect subordinates from abusive supervisors and mentors, taking action on their behalf and shielding them from retaliation when they report problems. We need to value their safety and well-being at least as highly as we value the prestige or productivity of their supervisors. We need to see our students as people before we see them as tools or resources. But most of all, we need to stop pretending the problem doesn't lie with us.

It is hard for someone outside science to understand the power that senior scientists, especially advisors, wield over students. With little oversight, they play the role of boss, teacher and mentor. They can freely use their professional networks, publishing connections, funding or letters of recommendation to help or harm a student's career. They can find their mentees jobs or quietly sabotage their applications. Yet our system offers students little protection from their mentors because we have long assumed, erroneously, that they will not need it.

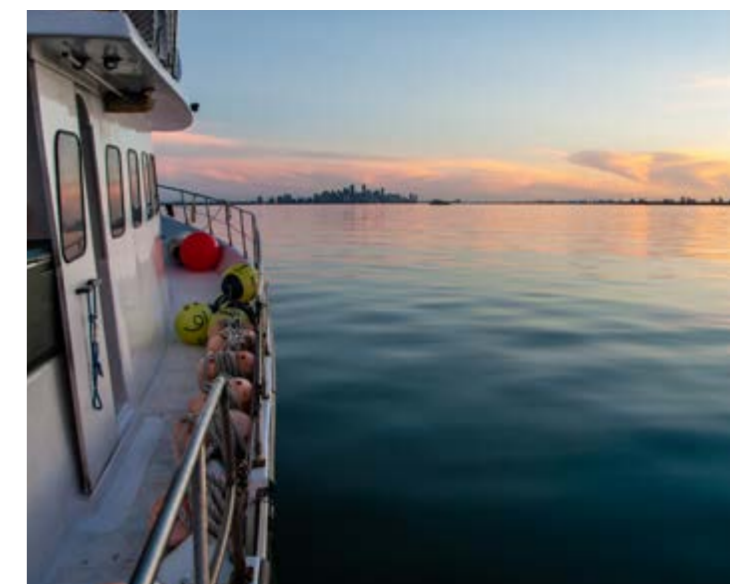
Experiences of harassment, sexism, racism, ableism, queerphobia, classism or some intersectional combination of the above often disappear, or go uncounted, when the young people who experience them leave (or are driven out of) science. These trainees become 'leaks' from the STEM pipeline and there is a general shrugging acknowledgement that the system often fails students, with no thought given to how, why or what that has to do with us.

I am not an expert on diversity, equity and inclusion and I do not wish to speak for (or over) more qualified scholars. Whereas they are skilled doctors, I'm a poorly trained medic, offering practical insight drawn from efforts to read and learn in my free time and from years of working in marine science and trying to do what's right. I've listened to students'

stories, cared and done my best to shelter them. I've argued with my superiors on their behalf, begged for favours and resources they needed, and some nights I've failed, gone home and cried. In 2020, many universities began investing in diversity training or anti-racist reading groups, strategies that are necessary but insufficient. Serious approaches to our problems ask much more of us than we have been willing to give so far.

Every scientist I know feels powerless sometimes against the system within which they work, struggles with a lack of funding and resources and is short of time and energy. Regardless of where we may be in our careers, most of us will never feel like we have enough (resources, influence, power) to invest generously in others, fight battles we don't have to fight or risk ourselves to change things. Most of us will never experience a single, clarifying moment when we realise that we've arrived, professionally, and that we are now ready to work towards justice. That means we should start right now, from wherever we're standing.

We should spend our resources – our social capital, our funding – to make things better for the people who have been excluded from our field in the past. We should look around the rooms we occupy and notice not only who is there, but who isn't – and ask ourselves why. Who do we



Scientists are quick to blame 'the system' for a lack of diversity, equity and inclusion, for a lack of funding to support graduate students and their projects, for a lack of time to devote to nurturing our students. These problems are indeed 'systemic', but the system we're decrying is made up of people. The system is made up of all of us. If we aren't currently rewarded for prioritising the important things, the answer isn't to wait until the system is corrected and will reward us. It's to do the right thing now, unrewarded, and be willing to bear the costs. It's past time that we place the humanity of our students and colleagues at the centre of our personal and institutional decision-making. It is past time to take in the scope of the problem and choose to act.

IN CONVERSATION WITH *Pippa Ehrlich* OSCAR – WINNING FILM DIRECTOR OF
My Octopus Teacher WORDS BY JADE SCHULTZ



AS A FIRST-TIME NATURAL HISTORY FILMMAKER, PIPPA EHRLICH TOOK ON THE CHALLENGE OF CO-DIRECTING A FILM ABOUT AN OCTOPUS. THE RESULT, *MY OCTOPUS TEACHER*, HAS WON ACCLAIM AROUND THE WORLD. PIPPA TALKS TO A FORMER COLLEAGUE AT THE SAVE OUR SEAS FOUNDATION.

How did you get involved in *My Octopus Teacher*?

Five years ago a friend of mine, Ross, showed me a San-Bushman painting that depicted connections between people and animals and it just blew my mind. He'd come across the painting through his work with a filmmaker called Craig Foster. After asking if I may join them on their regular dives, one day I found myself on a False Bay beach with Craig and Ross. I have been diving in the Great African Sea Forest since my early 20s, but on that day I felt I was entering a brand-new place – as if I'd put on a pair of magical goggles.

I then started diving regularly with Craig, allowing my body to adapt to the cold and learning to track animals underwater. After about six months, Craig told me he wanted





Craig's story suggests
there is so much magic
right in front of us.



to what's going on in the world. But we also desperately need to grab the attention of people outside the scientific community and, as Jane Goodall says, if you want to change people's behaviour you have to speak to their hearts. These biologists had such incredible stories, but they weren't comfortable speaking from their hearts. That's what made this film so exciting for me: it was an opportunity to tell an emotional story about a human's relationship with a marine creature.

Why do you think this film has resonated so strongly with viewers?

I think it's partly because of the time we are in. People are feeling disconnected and afraid and are questioning where they find meaning in their lives. Craig's story suggests that there is so much magic right in front of us, if we take the time to look. We made the film with the intention of giving our audience a glimpse of the experiences we have when diving, so we made it as immersive as possible with everything we did, from the way we shot to the sound and music we used. I think it helped viewers to journey beyond their four walls at a time when many people in the world needed that.

It's also the subjective, emotional approach. We knew audiences would fall in love with the enchanting and intelligent octopus star and be moved by her story, but she is really a symbol of the natural world. Human beings have had a love affair with nature since before we were even human and the film triggers that ancestral memory. We may forget from time to time, but we depend on nature for our survival. Connection to nature has always been a critical part of not just our physical well-being, but our mental and spiritual well-being too.

How conscious were you of anthropomorphising the octopus, and the relationship between it and Craig?

We were very conscious of this. We were lucky in that we had a human character who could tell his story. Everything unfolds through Craig's voice and the story you see is an interpretation of what he saw and felt during this year of his life and how he interpreted the animal's behaviour and her responses to him. The film is not scripted and we are clearly telling a subjective story. Craig didn't name the octopus because he felt this would undermine her wildness.

We also did our best to get the most appropriate experts involved. We had numerous scientific advisers and a wilderness psychologist on the project, and we flew Professor Jennifer Mather, a leading cephalopod specialist, to Cape Town. She is an 'octopus psychologist' and she watched the entire cut with us, commenting on all the animal behaviour she saw. She also shared her views of how an octopus experiences the world. There are certain facts that we know: this is a creature that has lost its shell in evolution, allowing it to grow a bigger brain. This tells you that it has a huge capacity for curiosity, but is also very vulnerable. An octopus's whole life is a balance between curiosity and fear, so it has developed ingenious tools for protecting itself, like the amazing armouring behaviour we see in the film. Because octopuses only live for a year and a half, they need to be learning machines.

The temperate kelp forests on the southern African Cape coast host a diversity of life. This includes the predatory pyjama sharks, complex characters through which the filmmakers hope viewers will learn to respect all life in the kelp forest, as much as they do the film's singular star.

Photos: previous page, Craig Foster, this page top left, Pippa Ehrlich, bottom left and top right, Craig Foster

to make a new film and asked if I would like to help. He'd mentioned his experience with the octopus, but hadn't said too much about it. When I read the treatment for the film I knew there was a special story here and that I really wanted to be part of the project.

What was your role in it?

Initially it was a loose collaboration. I thought I'd just be carrying Craig's tripod, but soon I sat down with Edit Suite and after going through all the footage I became the editor. The octopus story had already been shot, but we also needed general visuals of the kelp forest and other animals. And we needed to put Craig in the environment. So I started shooting. Later, when we decided to tell the story through Craig's interview, he became more of a subject than a director. And I took over the directing with James Reed.

Did your experience at the Save Our Seas Foundation influence your approach to the film?

Absolutely. If I hadn't had those four years at the Save Our Seas Foundation, I could never have made this film. Firstly, talking to the foundation's project leaders around the world was like taking a crash course in marine biology. Learning so much about the ocean and its creatures prepared me to tell an in-depth story about the natural world.

The other thing I realised at the Save Our Seas Foundation – and it saddened me a little – was that in my conversations with scientists they would share their experiences in wild, incredible places with all kinds of creatures. Their eyes would glisten and their voices would crack, and I could feel that they genuinely loved what they were doing and the creatures they worked with. But when it came to writing, they often struggled to express such feelings because they felt safer in the realm of facts.

Science is absolutely crucial. It's a foundation for our understanding of nature and it's critical for finding solutions



Diving regularly in the cold waters with Craig brought a new awareness to Pippa's experience of the Cape's kelp forests.

Photo: Faine Loubser

Now that the film is out, is there anything that you would like to have done differently?

I do have one regret. I love pyjama sharks. They are my kelp forest spirit animal, but I'm afraid the film has tarnished their image a bit. We cut a beautiful scene of a pyjama shark pup growing inside its egg and then hatching, which we'd hoped would stimulate some empathy for these beautiful but vulnerable sharks. They are also the reason for the octopus's ingenious defence strategies: it has to deal with predators like pyjama sharks. If there were no pyjama sharks, there would be no armouring behaviour. People have criticised Craig for not protecting the octopus from the shark, but when you spend as much time underwater as he does, you learn to respect and have empathy for all the creatures of the kelp forest. You might have a personal relationship with one special animal, but is it fair to undermine another one? That's what we want people to ask themselves.

This is an unusual conservation film in that it doesn't have an overt call to action. Why is that?

This was the biggest debate during the filmmaking process. At the time, there was an issue in False Bay where the octopus lived: octopus traps were entangling and drowning young whales. This made for a strong conservation story, but I felt it would make the film too issue-driven, we would be creating an enemy for the audience. That means that people can take themselves out of the story and blame other people for the environment being destroyed. But actually this is something we are all part of. We all need to take responsibility.

That said, there are many films that do tell issue-based conservation stories, like David Attenborough's excellent *A Life on Our Planet*. We just had a different goal. We wanted to leave people walking away from their screens with a sense of awe and wonder, and motivation to build their own connection with nature in whatever way they choose. We've been very surprised by the film's performance in impact award categories around the world. This is not a traditional impact film, but these ideas around connection and love and the fact that we need nature are very powerful and for some audiences quite novel. I hope this film has had some impact on the world and how we think about ourselves in relation to nature.



OCEAN FUN

SNAP FACTS

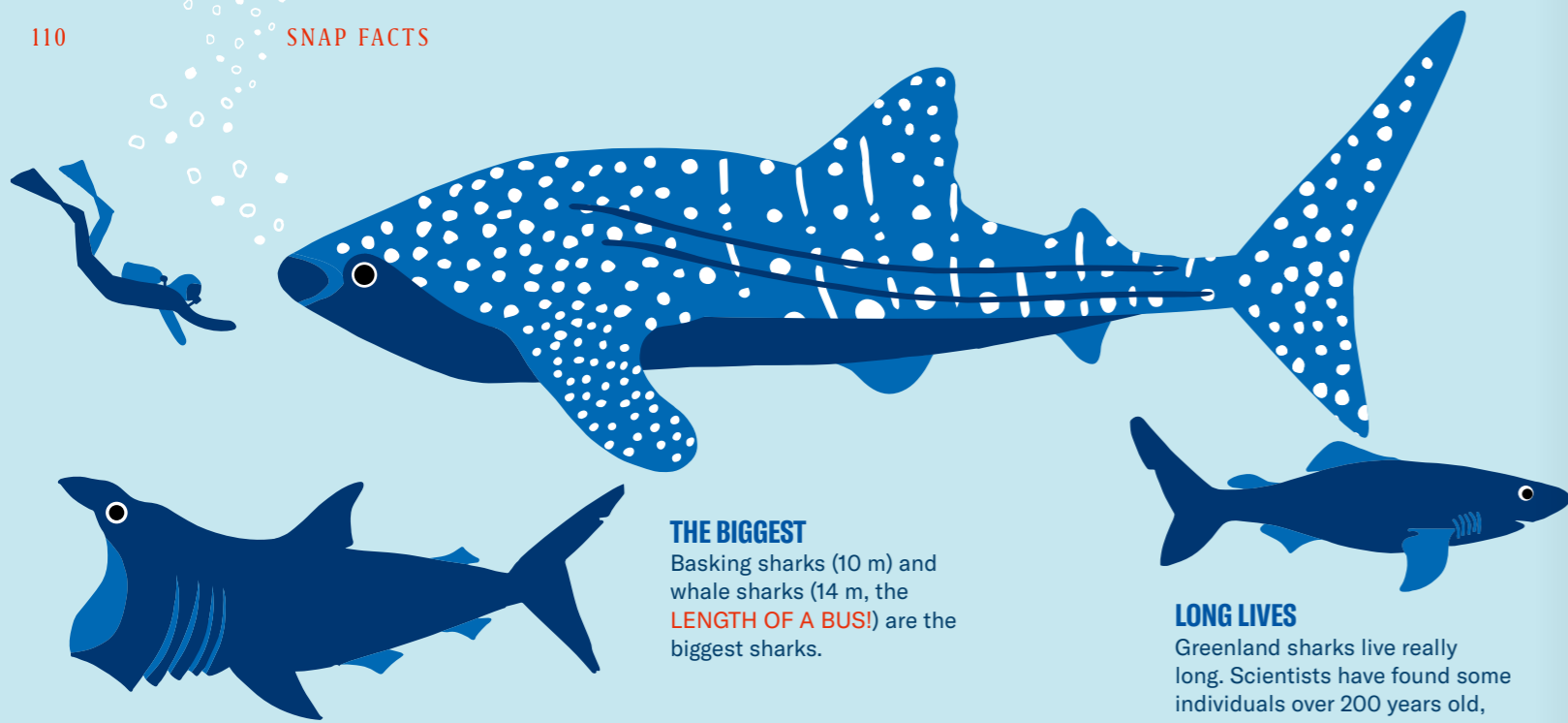
110 - 111

*From the biggest to the smallest,
the fastest to the oldest
– once you learn more about
sharks, you will see why
they're so important for our
healthy oceans!*

SUPER POWER SENSES

112 - 116

*How does a shark see its ocean
home? How does it hunt
for food? Learn all about shark
super senses and how
these amazing animals use them
to rule our oceans.*



THE BIGGEST
Basking sharks (10 m) and whale sharks (14 m, the **LENGTH OF A BUS!**) are the biggest sharks.

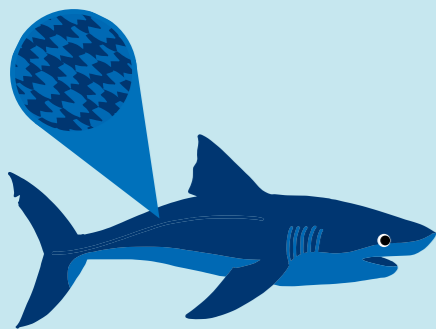
LONG LIVES
Greenland sharks live really long. Scientists have found some individuals over 200 years old, and think they may actually live up to **500 YEARS!**

THE SMALLEST
Dwarf lanternsharks (19 cm) are the smallest sharks in the sea and they **GLOW IN THE DARK.**

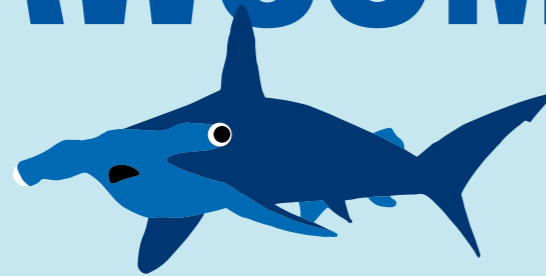
SHARKS ARE JAWSOME!



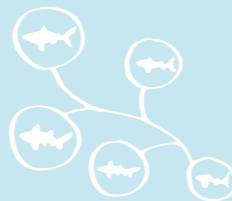
SHARKS ARE PREHISTORIC
having lived through **5 MASS EXTINCTIONS**, including the one that killed the dinosaurs.



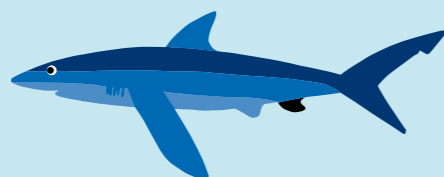
SMART ADAPTATIONS
Shark's skin is made up of **DERMAL DENTICLES**. They look like tiny teeth when viewed under a microscope. These help sharks glide in the water. Humans have copied this material to reduce drag.



360-DEGREE VISION
Hammerhead sharks have hammer-shaped heads that give them 360-degree vision and which they use to pin stingrays against the seafloor.



ANCIENT VARIETY
Sharks have lived on planet earth for more than 400 million years. And there are over 500 different species (types) of sharks alive today!

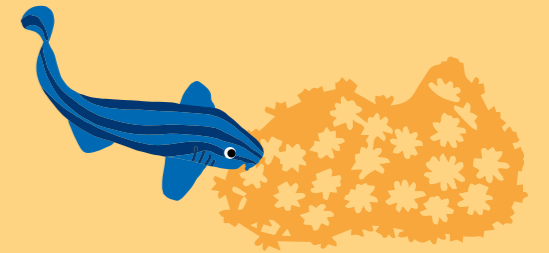


FAST, LIKE A TORPEDO
The blue shark's streamlined shape moves fast, like a torpedo in the water.



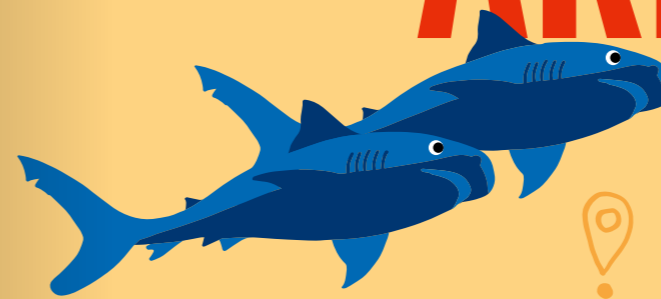
THE 'GENTLE GIANTS'
are whale sharks, basking sharks and manta rays that grow to their enormous size by eating the microscopic ocean plants and animals called plankton!

HEALTHY SHARKS = HEALTHY OCEANS
AS PREDATORS, sharks can play a **CRUCIAL** role, **HELPING MAINTAIN A DELICATE ECOSYSTEM BALANCE** that keeps our oceans healthy. And we need healthy oceans! Our oceans provide over 72% of the oxygen we breathe, regulate our climate, are a large source of food, and play a part in our water cycle.



SOME SHARKS ARE FOUND ONLY IN ONE PLACE
in the whole world – and nowhere else. This is called **ENDEMICISM**. The pyjama catshark is endemic to South Africa. This makes it important to protect these sharks; if they disappear from this one country, they will **DISAPPEAR FROM OUR OCEANS ENTIRELY!**

SHARKS ARE KEY!



OCEAN TRAVELLERS
SOME SHARKS MOVE LARGE DISTANCES across the sea to eat, breed or have their pups. We call this **MIGRATION**, and it connects distant ecosystems. Tiger sharks, great white sharks and hammerhead sharks can move thousands of kilometres. One great white shark called Nicole swam from South Africa to Australia – a distance of 11 000 km – and back again!



SOME SHARKS ARE APEX PREDATORS.
They sit at the **TOP OF THE FOOD CHAIN**, like the great white shark that hunts seals by ambushing them from deep below the ocean's surface.



SHARKS LIVE ALL OVER OUR OCEANS;
in different places we call **HABITATS**. Some, like sixgill sharks, live in the dark, deep sea. Others, like angel sharks that live camouflaged on the sand where divers swim right over them, live in shallow seas.

SHARKS' SENSES N°1

SIGHT

Shark eyes are positioned on either side of the fish's head so that they can see in several directions. They have a special layer of reflective cells at the back of the eyeball called the tapetum lucidum. This helps sharks to see when light levels are low, for example at night or in deep water.

SHARKS' SENSES N°2

SOUND

From the outside, shark's ears look like two small holes behind the eyes. But inside the ear are fluid-filled tubes, which are lined with fine hairs. The hairs vibrate when a sound wave hits them and are very sensitive, allowing sharks to hear sounds several kilometres away.

SHARKS' SENSES N°4

SMELL

Sharks have an excellent sense of smell, with the majority of their brain dedicated to picking up signals from their nostrils. They use this sense to find other sharks to mate with, avoid predators and also to detect their prey.

SHARKS' SENSES N°3

TASTE

Little is known about sharks' sense of taste. They often use their mouths to feel things in the water, so scientists have found unusual items like old shoes, bottles and cans in the stomachs of dead sharks. However, that doesn't mean they like the taste of these things!

SHARKS' SENSES N°5

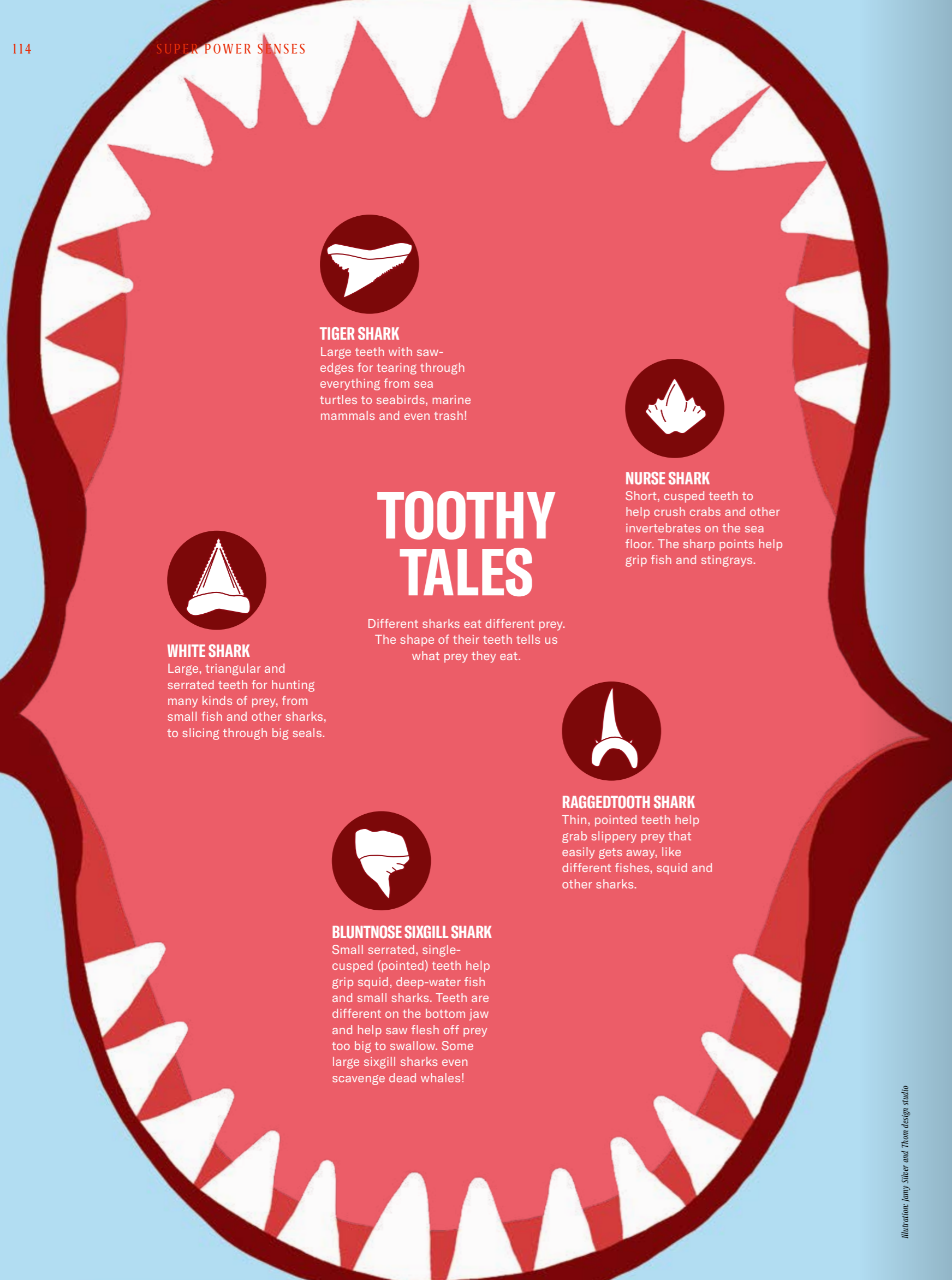
MOVEMENT DETECTION

The lateral line is a fluid-filled line of pores that run from the snout to the tail of the shark. Just like in a shark's ears, these pores are lined with hairs, which vibrate with pressure changes. This allows the shark to pick up movements of other animals (predators, prey or mates) in the water.

SHARKS' SENSES N°6

ELECTRO- RECEPTION

Sharks have fluid-filled cells around their head and snout that can sense electricity. These cells are called the ampullae of Lorenzini. All living animals (and other objects, like boats) produce small electrical fields. The ampullae can help sharks find prey up close, even when the target animal is buried in the sand.



TIGER SHARK
Large teeth with saw-edges for tearing through everything from sea turtles to seabirds, marine mammals and even trash!



NURSE SHARK
Short, cusped teeth to help crush crabs and other invertebrates on the sea floor. The sharp points help grip fish and stingrays.



WHITE SHARK
Large, triangular and serrated teeth for hunting many kinds of prey, from small fish and other sharks, to slicing through big seals.

TOOTHY TALES

Different sharks eat different prey. The shape of their teeth tells us what prey they eat.



RAGGEDTOOTH SHARK
Thin, pointed teeth help grab slippery prey that easily gets away, like different fishes, squid and other sharks.

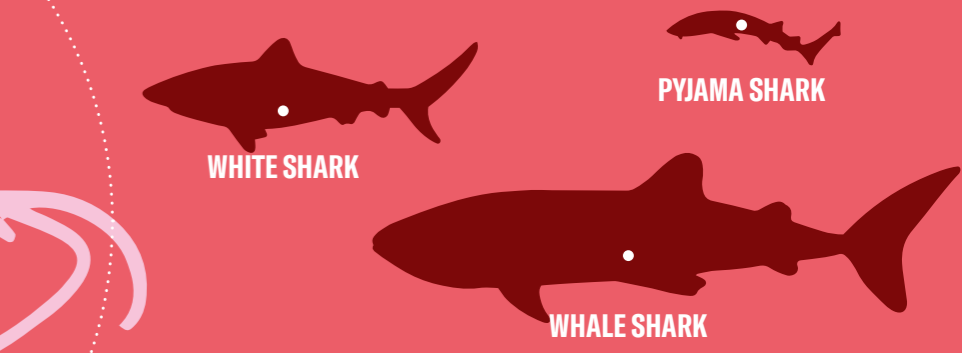


BLUNTNOSE SIXGILL SHARK
Small serrated, single-cusped (pointed) teeth help grip squid, deep-water fish and small sharks. Teeth are different on the bottom jaw and help saw flesh off prey too big to swallow. Some large sixgill sharks even scavenge dead whales!

Illustrations: Jany Silver and Thom design studio

LET'S MATCH!

Match the shark in the circle to the animals you think are inside its stomach. Can you trace a line to the right shark's diet?



WHITE SHARK

PYJAMA SHARK

WHALE SHARK



To help you, here is the list of animals you can see: Crabs, dolphin, fish, krill, octopus, penguins, shark eggcases, small fish, smaller sharks, zooplankton.

Answers: stomach N°1 is the pyjama shark, N°2 whale shark, N°3 white shark.

WHAT CAN YOU DO

Many shark populations have declined by over 90% from overfishing, pollution and habitat loss. It is estimated that as many as 100 million sharks may be killed each year from fisheries alone.

CHOOSE REPUTABLE ECO-TOUR OPERATORS

Sharks are worth more alive than dead. It has been estimated that a single shark may be worth over \$1 million to tourism over the course of its life, but may only earn \$100 if fished. Support sharks in the protected areas that keep them safe by visiting parks and paying reputable tour operators.

BE A SHARK'S BEST FRIEND

Many people are still afraid of sharks, but you can help change this. Share your new knowledge about why sharks are critical to ocean health. You might just shift their misperceptions and get more people to care about them!

KEEP IT CLEAN FOR SHARKS

You can share easy ways to help sharks and the oceans they rely on:

- 1 Avoid single-use plastics
- 2 organise beach and river clean-ups and
- 3 remember to refuse, reduce, re-use and recycle!

BE SMART ABOUT THE SEAFOOD YOU EAT!

Ensure you know what it is, where it comes from and how its family is doing. Look for labels of sustainability on any seafood you buy.

Illustration: Thom Design Studio

ABOUT THE SAVE OUR SEAS FOUNDATION

A commitment to protecting our oceans and their rich biodiversity is at the heart of the Save Our Seas Foundation's (SOSF) work. To achieve this, the foundation offers funding and support to research, conservation and education projects that focus on charismatic, threatened marine wildlife and its habitats. From its origins as a small not-for-profit organisation, the SOSF has grown from funding just five projects to supporting almost 400 projects in more than 80 countries worldwide. It functions not as a research institute itself, but strives to sustain the many and varied efforts of scientists, conservationists and educators through generous contributions of financial, practical and scientific support. The SOSF funds three permanent centres, works with five long-term partners and now funds more than 40 projects annually. It is proud to form part of a growing and committed community of ocean stewards and, through its work, to help shape a sustainable future for our seas.

To find out more about the foundation, visit saveourseas.com

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