THE SAVE OUR SEAS FOUNDATION MAGAZINE

saveourseas

ARABIA'S SEAS | SHARKS | TURTLES

CONTRIBUTORS

NICK PILCHER
Executive director of the Marine Research Foundation, a private non-governmental organisation that Nick established with his wife in 2003.

DEMIAN CHAPMAN
Assistant professor at Stony Brook University's School of Marine and Atmospheric Science, Demian has pioneered the use of genetics in monitoring the shark-fin trade.

SONJA FORDHAM
Founder of Shark Advocates International and deputy-chair of the IUCN Shark Specialist Group, Sonja is a global advocate for vulnerable shark and ray species.

ELEANOR YELD HUTCHINGS
Manager of the SOSF Shark Education Centre, which focuses on spreading environmental education and shark awareness in False Bay, South Africa.

RIMA JABADO
Fisheries expert at the Ministry of Water and Environment in the United Arab Emirates. Rima has dedicated the past eight years to sharks in the Arabian Seas.

Silvertip shark (front cover) & blacktip reef shark (back cover), Aldabra Atoll, Seychelles, Indian Ocean. Front cover, back cover and Our Ocean photos (4) by Thomas P. Peschak

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Photo by Thomas P. Peschak

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‘As long as there ar
we can and will ma

e people who care,
ke a difference.'

The Founder – Save Our Seas Foundation

From July to October, when the south-westerly monsoon hits the Maldives, manta rays congregate in huge numbers to feed in Hanifaru Bay. Not only regular, the mass feeding events are predictable too: when strong lunar tides overcome the force of the prevailing monsoon current, plankton is trapped and concentrated in the shallow bay, providing a feast for as many as 250 manta rays and half a dozen whale sharks.

Kenya's coast is one of the most densely inhabited shorelines in Africa, with millions of people relying on the ocean for sustenance. Every day coastal fishermen set out in traditional dhows to fish these waters with hand lines, spears, baskets and nets.

Of all the temperate marine realms in the world, the north-eastern Pacific Ocean harbours the highest diversity of sea stars. More than 40 species thrive in this venerable hotspot, occurring in water less than 200 metres deep. The ochre sea star *Pisaster ochraceus* is a common keystone predator; feeding on mussels, it determines the structure of the community that exists on exposed rocky shores.

Free diver Hanli Prinsloo mingles with blacktip sharks in the Aliwal Shoal Marine Protected Area off the east coast of South Africa.


GLIDE FIN

Editorial

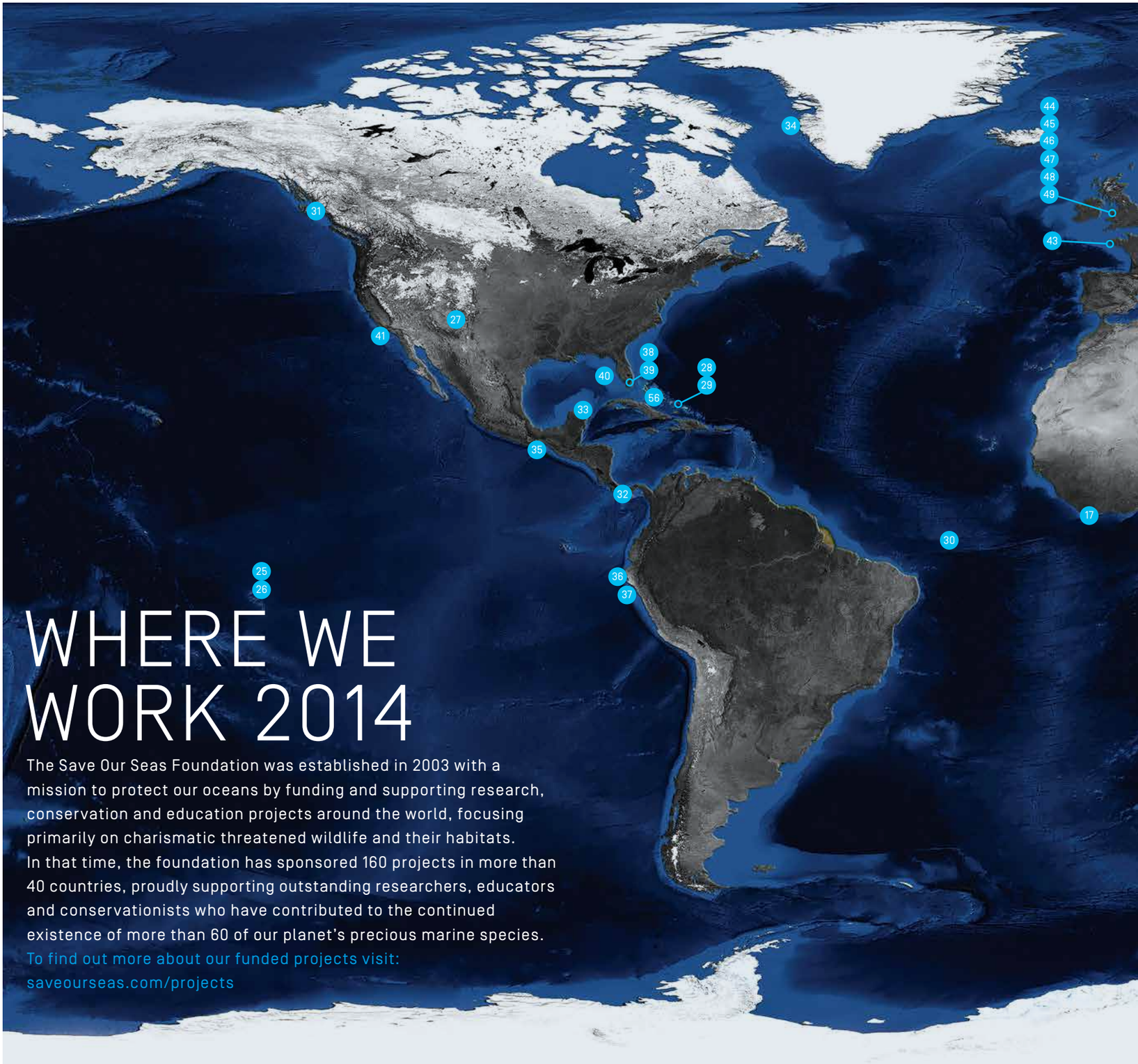
Photo by Sheikh Sultan Mohamed Bin Mejren

A few years ago, I was fortunate to have the opportunity to sail along the eastern coastline of the Arabian Peninsula with a team of passionate explorers from the United Arab Emirates. We travelled along the coast of the Sultanate of Oman to the formidable island of Socotra. This odyssey was an exploration of cultures and places, but more importantly it represented an inner journey. The warmth and generous hospitality of the people was unsurpassed. We were the first to explore many of the dive sites, which is a rare experience in our world today. This second issue of the *Save Our Seas* magazine celebrates Arabia's seas, places still full of beauty and diversity.

The mystery and wonder of our sharks and rays is another theme in this issue. Last June, the second Sharks International conference was held in Durban, South Africa. Scientists and conservationists from around the world met to present and discuss advances in our knowledge and understanding of elasmobranchs. I am fortunate to be able to meet and collaborate with the world's best scientists, conservationists and educators and to nurture this individual contact that is so dear to the heart of the foundation. The ambition of the *Save Our Seas* magazine is to share these personal and passionate stories through text, pivotal imagery and artwork, and modern graphic design.

My vision of the world has changed dramatically over the two years as CEO of the Save Our Seas Foundation. I see our planet not only through my eyes, but also through the eyes of my two-year-old son. His unfolding perception constantly reminds me how lucky we are as humans to be able to share and take part in this planet's wealth of biodiversity. I hope this sense of wonder comes across in the magazine and its stories.

Michael C. Scholl | Chief Executive Officer | Save Our Seas Foundation



WHERE WE WORK 2014

The Save Our Seas Foundation was established in 2003 with a mission to protect our oceans by funding and supporting research, conservation and education projects around the world, focusing primarily on charismatic threatened wildlife and their habitats. In that time, the foundation has sponsored 160 projects in more than 40 countries, proudly supporting outstanding researchers, educators and conservationists who have contributed to the continued existence of more than 60 of our planet's precious marine species.

To find out more about our funded projects visit: saveourseas.com/projects

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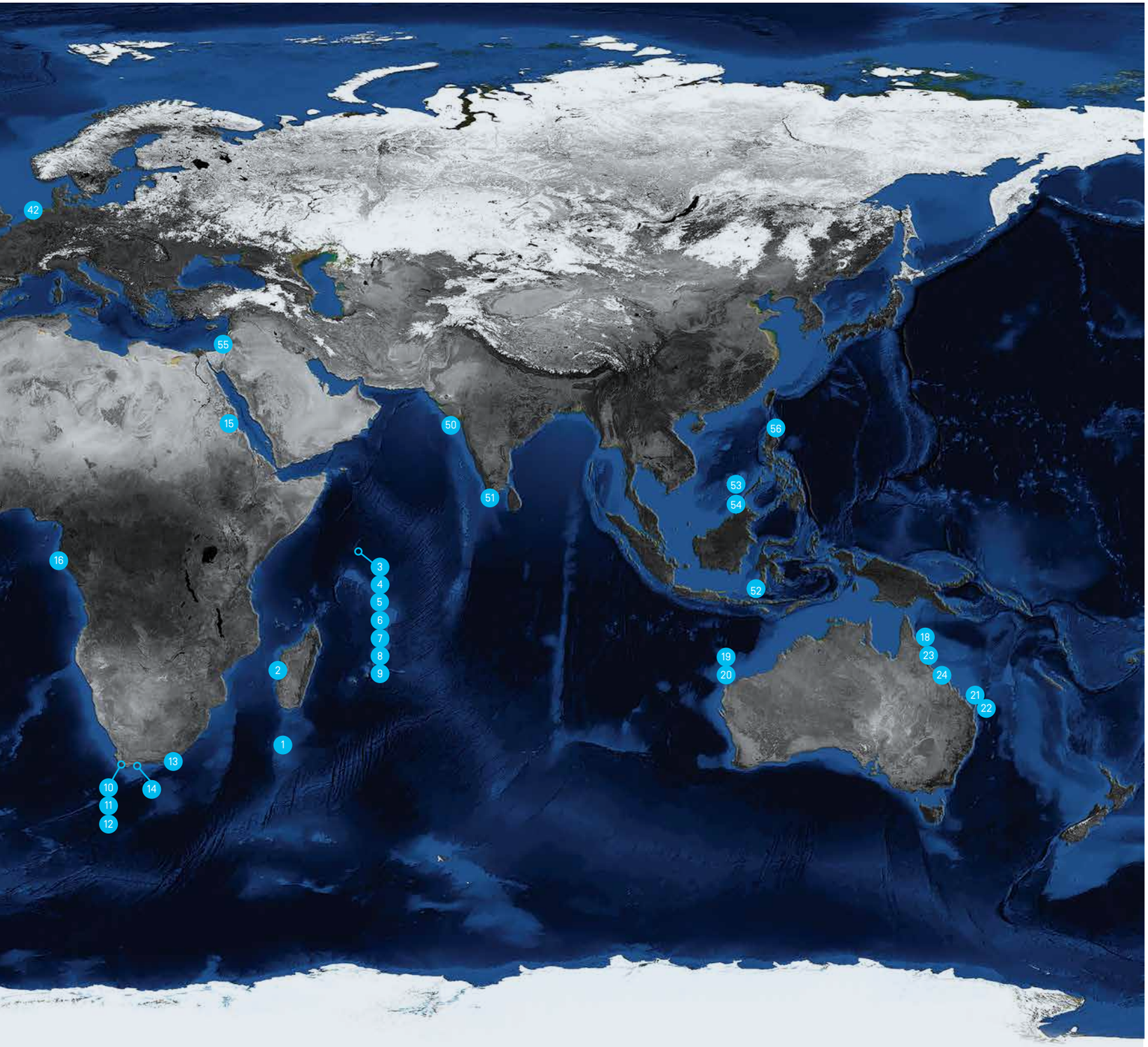

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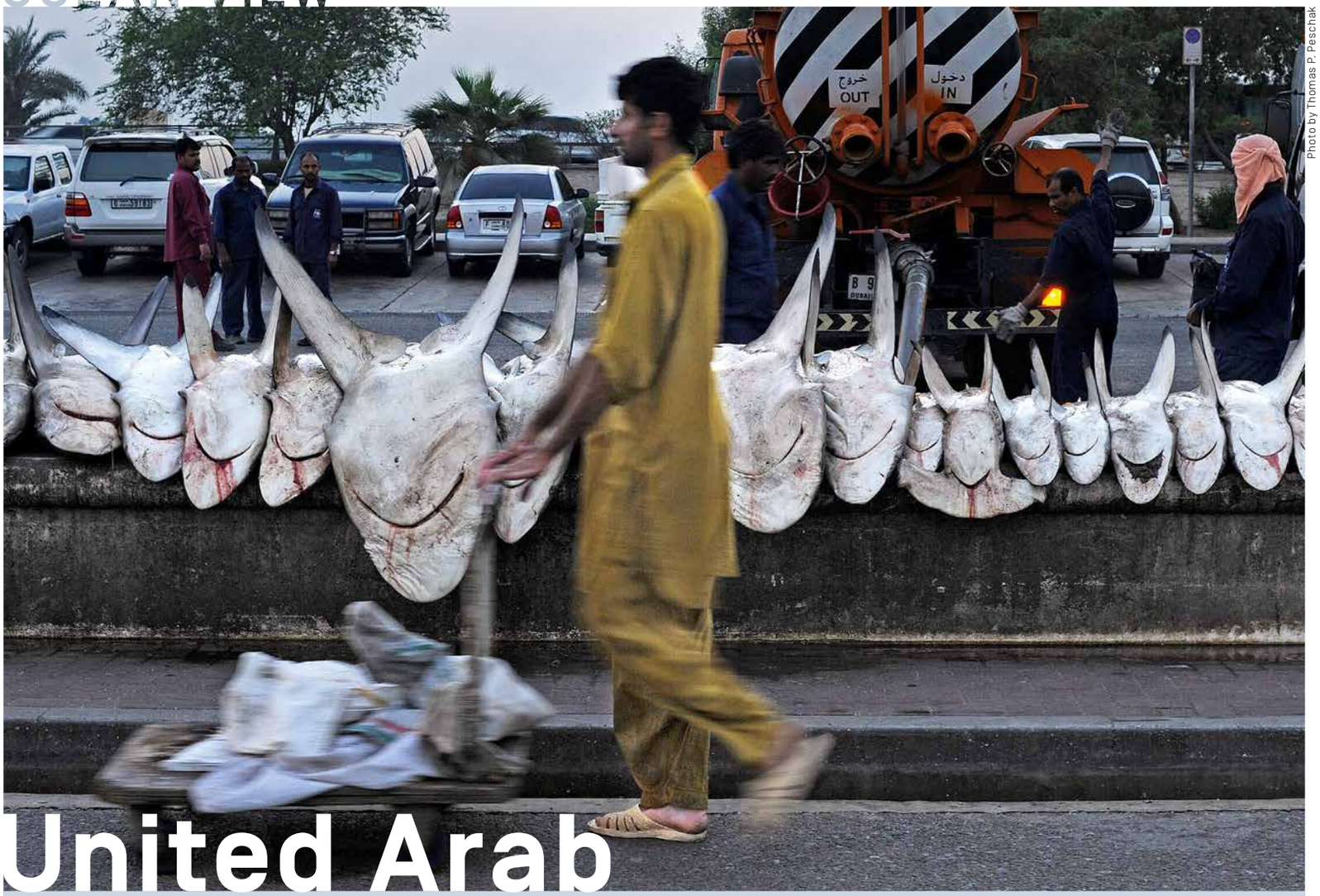


Photo by Thomas P. Peschak

United Arab Emirates steps up its shark protection

All three hammerhead shark species, the oceanic whitetip shark and manta rays are now fully protected in United Arab Emirates' (UAE) waters – and this is just one of the measures the country enacted in September to protect its sharks and rays.

The UAE has also strengthened protection for its other shark species by extending the closed season for shark fishing to five months a year between 1 February and 30 June, the time when most species breed, and by creating a buffer zone around the coastline where fishing for sharks is not allowed (within five nautical miles of the mainland and three nautical miles of the country's islands).

The new rules aim to regulate the shark trade by banning the export of all products derived from sharks caught in the UAE, as well as the re-export of shark fins from other countries.

These rules are in addition to the protective measures for sharks and rays that the UAE already had in place, which include a ban on shark finning and a limit on fishing that targets sharks. The UAE had already protected sawfishes and whale sharks, so it has now effectively banned the fishing of all CITES-listed species that occur in its waters.

Rima Jabado, the founder and lead scientist of the Gulf Elasmo Project, sees this as a great step forward in the Arabian Sea area and hopes 'that other countries in the region will follow suit to ensure that these vulnerable species are protected'.

Stingrays, scallops and scapegoats

Certain stingrays that are found in subtropical and temperate waters around the world have an ability shared by few other marine fish: to crush through the protective shells of creatures like clams, oysters, scallops and snails, and eat them. These rays, which include eagle and cownose rays, are durophagous, or 'hard-eating' – a word used to describe any animal that consumes hard food, like the hyena with its bone-crushing eating habits.

But the shell-encased food that durophagous stingrays are after is not only essential to the rays; it's also desired by humans. Because they eat shellfish that are economically valuable to fishers (think scallops and oysters), the hard-eating stingrays are often considered pests, and they have been blamed for preventing the recovery of shellfish in parts of their range. This has led to 'kill tournaments', culling and campaigns to promote eating them – all aimed at reducing their numbers, even though these marine fish are among the slowest at reproducing and there is minimal evidence to support their bad reputation. It is within this context that Matt Ajemian, an assistant research scientist at the Harte Research Institute for Gulf of Mexico Studies, dedicated seven years of research to understanding the effects of durophagous stingrays on shellfish. In 2013, with the support of the Save Our Seas Foundation, Matt organised a symposium at the annual American Elasmobranch Society meeting to collate scientists' knowledge of these misunderstood rays. The result was published in September 2014. The symposium also provided an opportunity for the participants to draft a science-based conservation plan in response to the rapidly growing fishery for cownose rays along the US Atlantic coast.

To date, few studies have shown that durophagous rays have a negative effect on shellfish resources. Matt hopes to change the perception of rays as scapegoats for the declines in shellfish and to ensure that they are managed in a sustainable way.

Environmental Biology of Fishes 97(9) *Special Issue:* Biology and Ecology of the Durophagous Stingrays. *Issue Editors: Ajemian M.J., Neer J.A. and Noakes D.*

Photo by Chris Burville

GOOD SHARK KARMA

On 7 December 2013, 'shark hybrids' glided through a crowd of about 3,500 astonished beach-goers in Cape Town, South Africa. The elaborately painted 'whale shark' and 'leopard shark' were the emissaries of the Save Our Seas Foundation's *#goodsharkkarma* awareness campaign, and they moved across the beach handing out shark-fact fortune cookies and engaging in constructive conversations about sharks. Along South Africa's coastline, the perception of sharks centres mostly on great whites and shark attacks. The campaign aimed to broaden this view by educating people about some of the elasmobranch family's most fascinating attributes and thus inspire a more balanced public image.

Clifton Beach Night is the flagship event of the Wavescape Surf Film Festival and is attended by surfers and their families from across Cape Town. The SOSF team was assisted by volunteers who surf some of Cape Town's sharkiest beaches. The foundation will continue to spread *#goodsharkkarma* in the summer of 2014.

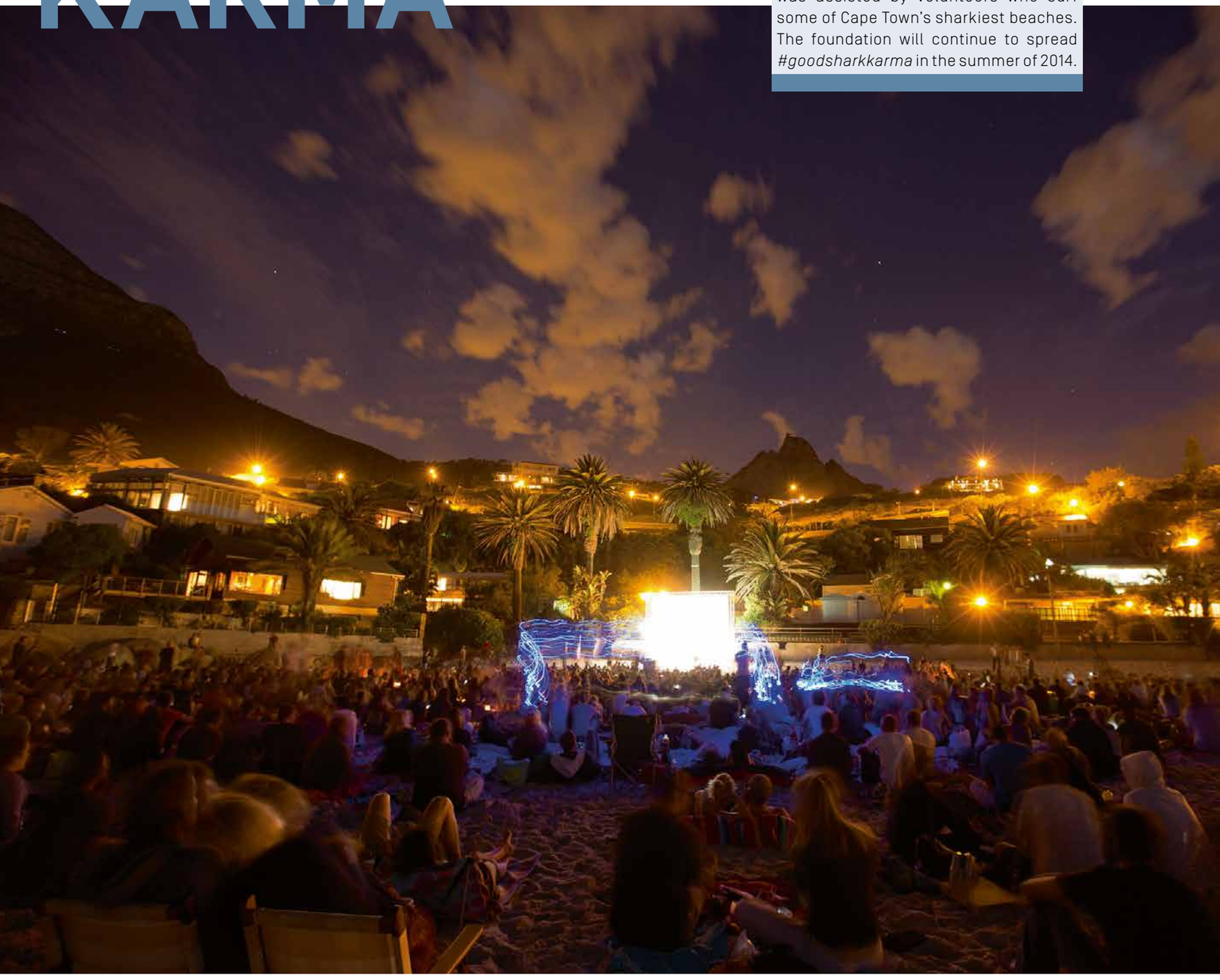


Photo by Discovery Channel

Discovering deep-sea sharks

Spending weeks in the bowels of a massive fishing vessel dissecting hundreds of sharks in a particularly stormy and remote section of the Southern Indian Ocean requires some motivation. For 29-year-old graduate student Paul Clerkin, the promise of discovering new shark species was a very powerful incentive. In June this year Paul returned from his second 60-day expedition aboard the F/V *Will Watch,* a 65-metre commercial trawler.

On both trips, Paul first flew from California to the tiny French island of Mauritius, where he met the rest of the crew. From here they travelled 16,000 kilometres south to beyond the island of Madagascar, where submerged mountains rise from the inky depths of extinct undersea volcanoes. These underwater pillars act just as islands would above water, providing critical homes for near-ranging, deep-sea species that are isolated from the wider ocean ecosystem. Because of this, these steeply sloping sea mounts and ridges are hotspots for biodiversity and endemism.

Paul calls the Southern Indian Ocean 'the last frontier of ocean exploration and discovery'. For hundreds of years, this treacherous and remote section of ocean has remained unfished, unexplored and highly productive. Even today, only a few commercial fishers are brave enough to trawl its waters for deep-dwelling species like orange roughy and alfonsino. When the net is hauled up from two kilometres deep it contains many other alien-like fish, including deep-sea sharks. As the nets are emptied, Paul examines all the sharks caught as by-catch. He then returns the live ones to the sea and carries the dead ones to his workstation, where he identifies them, takes measurements and collects samples for genetic analysis.

From demon catsharks with glowing eyes to purple-finned chimaeras and huge, flabby, torpedo-shaped false catsharks, these are some of the oddest creatures known to science – and many of them weren't even known before Paul began his research. During his 20 weeks aboard the F/V *Will Watch,* he discovered an estimated 15 new shark species, including a small sleeper shark – the find that excites him most.

Paul already has his sights on another, longer trip when he will spend 100 days at sea in a different area of the Southern Indian Ocean. But before that he has a lot of data that needs to be written into a Master's thesis, and he will be submitting papers describing two new species of ghost shark.

Roundup of Sharks International 2014

In June 2014 delegates from all over the world flew into Durban, South Africa, for the second Sharks International conference. Over a period of five days participants presented and debated the latest findings in elasmobranch research and attended shark-focused networking events and workshops, including a photography exhibition and social media workshop hosted by the Save Our Seas Foundation.

First held four years ago in Cairns, Australia, Sharks International was initially a once-off event but is now a regular forum for the world's leading shark and ray researchers and conservationists. Its aim is to provide them with a platform to interact, share findings and initiate collaboration. And by that measure, Sharks International 2014 was a resounding success. In all, 270 people from 37 countries attended. Scientists from Canada's Simon Fraser University in Burnaby travelled the furthest – more than 16,000 kilometres.

Next time the shark and ray community will be heading to Joao Passoa, Brazil, where the Brazilian Society for the Study of Elasmobranchs (SBEEL: Sociedade Brasileira para o Estudo de Elasmobrânquios) will host the third Sharks International. We look forward to another memorable conference in Joao Passoa in 2018.

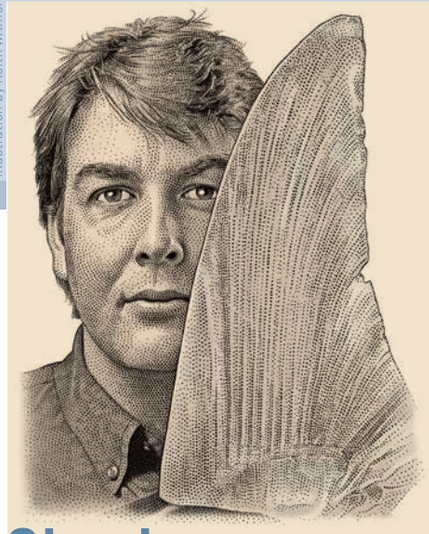
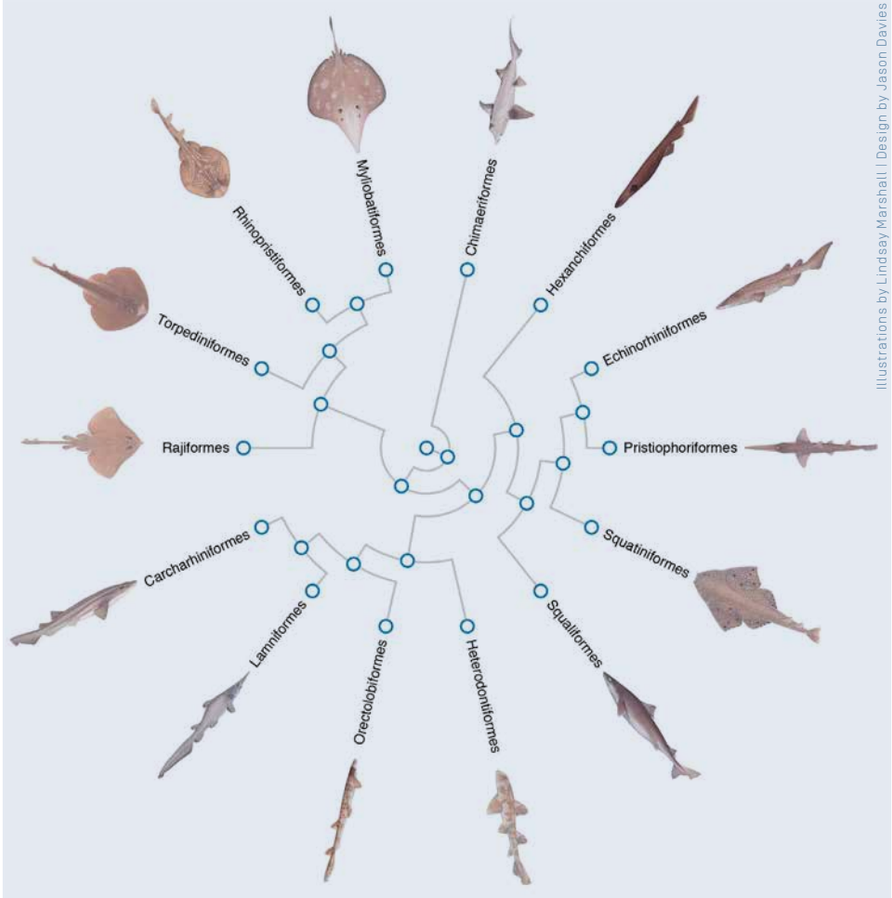


Illustration by Keith Witmer

Shark Fin ID Guide

Among the millions of shark fins traded around the world each year are the fins from five species that are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): the oceanic whitetip, the porbeagle and the scalloped, smooth and great hammerheads. The Appendix II listing means that when fins from these species are transported across international borders they must be accompanied by an export permit certifying that the specimen is being legally and sustainably traded.

The Shark Fin ID Guide, recently developed as a collaborative effort and presented at Sharks International 2014 by Demian Chapman and Debra Abercrombie, helps wildlife inspectors, customs personnel, researchers and fishers to distinguish the fins of these protected species among the many thousands that they come into contact with. The easy-to-use guide breaks down the process into manageable steps and uses conspicuous fin markings and characteristics to consistently identify fins from the CITES-listed species. The guide is available at *sharkfinid.com.*



Illustrations by Lindsay Marshall | Design by Jason Davies

Putting sharks on the map

The presentation that arguably caused the most jaws to drop came from Gavin Naylor, from the College of Charleston in South Carolina, who introduced the varied and intricate facets of a new online resource, the Chondrichthyes Tree of Life *(sharksrays.org)*. Its name notwithstanding, this database does so much more than map the shark and ray family tree. It offers information on species distribution (what occurs where), phylogenetic relationships, regional guides to sharks (print your own!) and digitised shark and ray anatomies that can be virtually dissected and even 3D-printed. It will also house DNA sequences and illustrations. With implications for so many areas of shark research, the possibilities seem endless.

Illustration by Marc Dando

How to save sawfishes

Having disappeared from most of the countries where they were historically found, sawfishes are possibly the most endangered of all marine fish. At the Sharks International conference, the IUCN Shark Specialist Group released its strategy for conserving these species, in parallel with the announcement that two countries in West Africa – Guinea and Guinea Bissau – are proposing that sawfishes be listed under the Convention on Migratory Species. To learn more about these enigmatic and endangered animals, see our infographic on page 106.

SHARK NIGHT

As part of the conference proceedings, the Save Our Seas Foundation hosted Shark Night, a photography exhibit featuring the spectacular images of Thomas P. Peschak in his book Sharks & People, *which presents the complicated relationship between humans and the most feared marine fish.*

Photo by Thomas P. Peschak

Photo by Gilbert Woolley

FROM THE FIELD

A short interview with Nicolas Pilcher

How did you get hooked on sea turtles?

I was working on a beach in Saudi Arabia in 1987 when turtle KSA4811 was having difficulty laying eggs. I crawled up behind her and saw she was missing a rear flipper and could not dig a nest chamber. So each time she went to use the flipper stump I dug down with my hand to help out. Her flipper, my hand. Her flipper, my hand. Slowly we dug the nest and she laid 104 eggs. I helped her three more times that year, and have been helping turtles ever since.

Describe your average working day.

There is no such thing! In the office an average day is writing proposals, writing reports, analysing data and preparing manuscripts for publication, interspersed with ever-present accounting paperwork, bills to pay, items to purchase and field-work plans to manage. But in the field things are different: I'm out on our boat chasing turtles, catching them for laparoscopy and genetic studies; I'm up in airplanes documenting turtles via aerial surveys; I'm walking nesting beaches with local community members, protecting adult turtles and safeguarding their nests. Or I'm meeting with senior government officials devising management plans or working alongside fishermen, getting Turtle Excluder Devices installed on their boats.

Does your family share your passion for turtles?

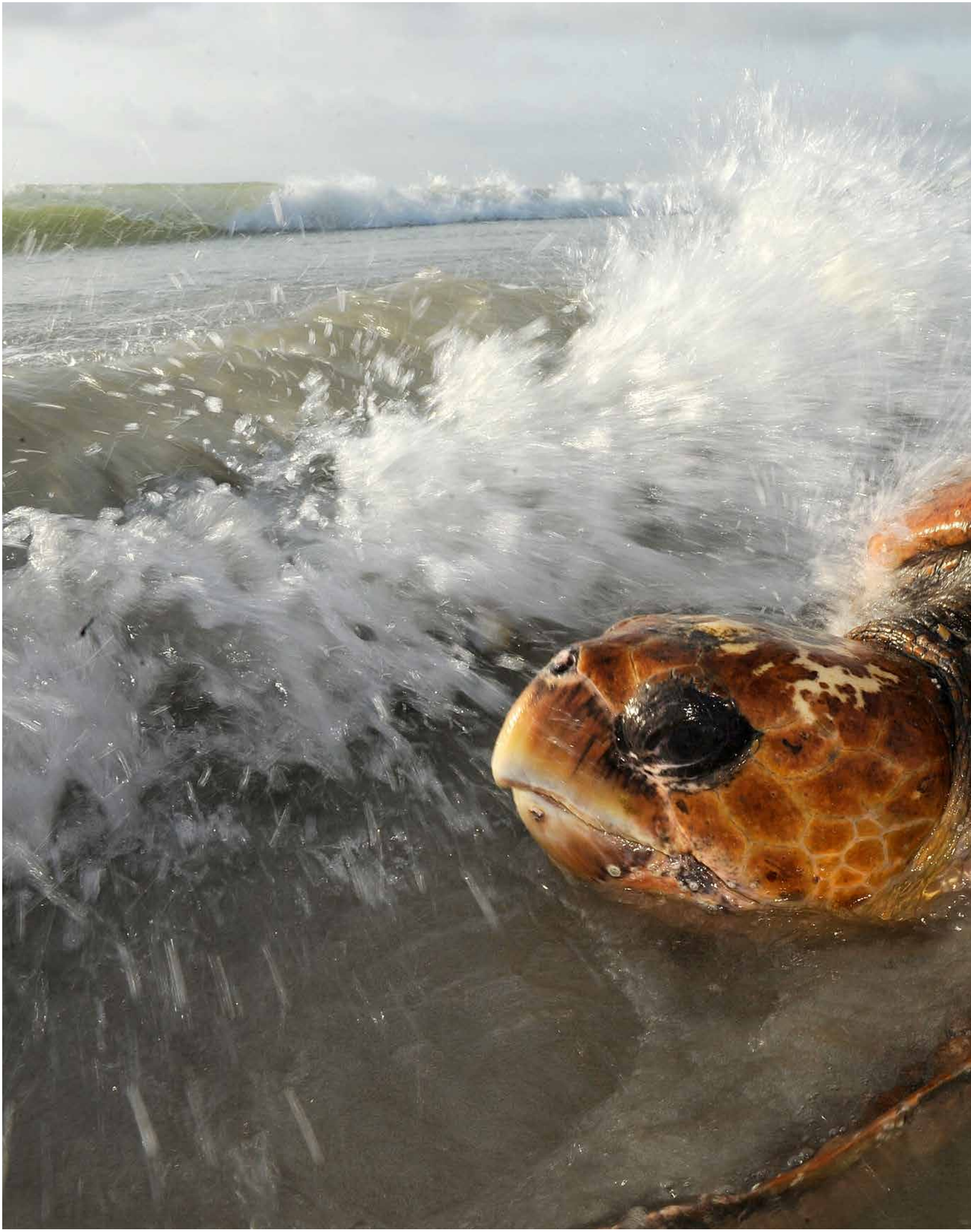
Absolutely! My wife and three daughters are all turtle fanatics too. My two eldest daughters, Danielle and Francine who are (now) 23 and 20 years old, are my two best turtle wranglers. They dive and catch turtles like pros. Leilana, the small one, uttered 'turtle' as her very first word. And my wife Carmen is my biggest supporter. She's with me on field trips, helps with project administration and logistics and keeps me balanced. If it were not for their passion for turtles, I'd never be able to do what I do, travelling far and wide across the Indo-Pacific on multiple projects.

Are you optimistic about the future of sea turtles? If yes, why?

Yes, of course I am. A pessimist is never going to get the job done right. And anyway, we're 50 years or so down the turtle conservation road and we're seeing successes all over the world. The world's largest market stopped importing tortoiseshell back in the '90s. Hawksbill turtles in many places are on the road to recovery today because of this. The leatherback, once Critically Endangered in the Atlantic, is rebounding in exponential fashion. So much so that the IUCN recently reassessed its status and it soared from Critically Endangered to just Vulnerable. The Hawaiian green turtle has gone from Endangered to Least Concern. Populations are showing they can recover if afforded protection over long periods – and the world is doing just that. We just need to keep doing it.

ARABIA'S

A small flock of Socotra cormorants roosts deep in a fjord along Oman's dramatic and rugged Musandam Peninsula.



A loggerhead turtle returns to the sea early one morning after a strenuous night of digging a nest and laying eggs. More than 30,000 loggerheads nest on Oman's Masirah Island each year, making it the world's largest turtle nesting site.

At Saudi Arabia's Wedjh Bank the fringing coral reefs originate in less than one metre of water and drop almost vertically to great depths. Diverse assemblages of hard corals stud the reef crests, which are pounded incessantly by waves during the windy winter months.

For two short months every year fierce desert winds whip up a thick plankton brew, attracting hundreds of juvenile whale sharks to the south-western reaches of Djibouti's Gulf of Aden. Most whale sharks encountered here are about two years old and less than three metres long.

Thomas P. Peschak sheds light on the three distinct marine realms that wash the shores of the Arabian Peninsula.

Words and photos by Thomas P. Peschak

For centuries the Afar people of Djibouti have told stories of a sea monster that lives in Goubet al-Kharab (the Pit of Demons), a loch at the western end of the Gulf of Tadjoura. Jacques Cousteau visited the region in the 1980s, investigated the legend and disclosed that he saw the dark shape of a gigantic fish at great depth. He reportedly placed a dead camel in a shark cage and lowered it to the bottom of the gulf. When he raised the cage it was crushed and the camel was gone.

Thirty years later I am in the same spot – alone, underwater and in total darkness. A narrow beam of light descends from the ship and I am just outside it. Dark shapes appear and disappear, like ships looming in and out of fog.

This was not my first encounter with sharks in Arabia's seas; my relationship with sharks and this fascinating region goes back a long way. I first came across sharks at the age of 16, off the southernmost tip of Egypt's Sinai Peninsula. A huge school of barracuda was circling like an overcrowded carousel along the wall of Shark Reef and weaving in and out of the mass was a trio of blacktip sharks. I tried to get close, but the current held me at a distance. The sharks were mere specks in my photographs, but the seed had been planted: I wanted to get closer. This, my first visit to Arabian waters, proved to be life changing, for it was here that I fell under the spell of sharks and this extreme realm where the desert meets the ocean.

Every year between November and February the Gulf of Aden attracts hordes of whale sharks; in just 11 days I encountered more than 100 different individuals. The Gulf of Tadjoura, at its western end, is the temporary home of sharks of about two years of age and less than three metres in length. A mere 100 kilometres from the entrance to this gulf, across the Strait of Bab-el-Mandeb from Djibouti, lies the coast of Yemen, home to Arabia's most industrious shark fishermen.

A set of whale shark fins is worth at least US$10,000, so the Gulf of Tadjoura whale shark population can be estimated to be worth more than US$1-million. Nevertheless, the whale sharks off Djibouti remain unmolested by shark fishermen. This is due mainly to the presence of a large multi-national military force involved in the global fight against terrorism and, more recently, Somali piracy. The shape of the gulf is such that any boat has to pass through or under a gauntlet of foreign naval vessels, fighter jets and patrolling helicopters. Greater protection for whale sharks is an unintended – even an odd – side effect of surges in terrorism and piracy, yet the presence of the armed forces also poses a threat to these giant fish: more than 50% of them bear propeller scars caused by speeding military boats.

Arabia's seas have been written about prolifically since biblical times, but more recently they seem to have fallen into obscurity. Many of the region's coastlines are off limits to foreigners and the threats of terrorism and piracy, together with harsh climatic conditions, have kept most visitors away. The Arabian Peninsula today is better known for oil, conflict and terrorism than for coral reefs, sea turtles and sharks. Few people know that the seas surrounding it form one of the most diverse bioregions in the world, comprising three distinct marine realms: the Red Sea, the Arabian Sea and the Arabian Gulf. Despite being situated in close proximity to one another, each is so different from its neighbour that they could be located on opposite sides of the planet.

Inaccessible to foreigners to a large extent, the Red Sea off the Kingdom of Saudi Arabia is one of the most heavily restricted marine realms in the world. Whereas the Egyptian waters of the opposite shore have been visited by millions of scuba divers, the 1,770-kilometre stretch of Saudi Arabian coast is uncharted territory for underwater photography. Corals thrive in the crystal-clear, nutrient-poor waters of its northern section, where the Wedjh Bank and the recently discovered offshore 'Saudi Great Barrier Reef' are considered a global coral reef hotspot, with the level of reef fish endemism approaching 70%. Signature species are the Arabian surgeonfish, the Koran angelfish and the newly described Red Sea silky shark. Further south, nearer the border with Yemen, nutrients swept into the Red Sea from the Indian Ocean fuel

The Arabian surgeonfish is equipped with an orange-coloured, razor-sharp scalpel that is embedded in the caudal peduncle. Individuals use these formidable weapons in territorial bouts with other surgeonfish, competing for the best grazing territories on the reef flat.

In the steep fjords of the Musandam Peninsula, sheltered ledges provide space for luxuriant corals to grow just before the rock walls plunge into deeper water. These vibrant coral communities thrive on the shallow shelves.

productivity levels. The waters grow murky and sea-grass beds and mangrove forests replace corals. These injections of nutrients attract shoals of fish, whale sharks and manta rays.

The juxtaposed Arabian Sea is unique in that it provides seasonal cold-water habitat nestled between tropical seascapes. When the south-west monsoon blows from May to September, along the southern coasts of Oman and Yemen there is an upwelling of cold, nutrient-rich water from great depth. The water temperature drops from 28 °C to 15 °C and kelp and seaweed forests thrive. Surprisingly, coral somehow survives the cooler months and for part of the year these two opposing ecosystems occur side by side. The kelp jungles are inhabited largely by coral reef fishes such as porcupine fish and angelfish, but also by temperate species that otherwise occur as far away as South Africa.

Humpback whales take advantage of this seasonal boost in productivity. After giving birth off the coast of Oman, they forage locally for food rather than undertake the arduous migration to Antarctica. In fact, this is the only population of humpback whales in the world that does not migrate. Large numbers of sperm whales also occur and, thanks to the proximity of the continental shelf to the shoreline, may be seen within five kilometres of the coast. In addition, the beaches adjacent to the Arabian Sea host some of the global hotspots for nesting sea turtles. The island of Masirah is the world's largest nesting site for loggerheads, while the Damaniyat Islands have the highest density of hawksbill turtle nests in the world.

The third marine realm, the semi-enclosed Arabian Gulf, is the most extreme shallow-water marine environment on the planet. In its western reaches off the coast of Bahrain, the sea-surface temperature sometimes exceeds 40 °C in summer; in winter it can drop below 10 °C. And yet the corals endure without bleaching, even though the region experiences temperature and salinity fluctuations that are extreme for a coral reef ecosystem. When the salinity level rises to more than 80 parts per thousand, first green algae beds and later salt crusts called *sabkha,* which are dominated by blue-green algae, replace the corals.

Despite harsh environmental conditions and an average depth of less than 30 metres, the Arabian Gulf harbours unique marine wildlife. Ten species of sea snake occur in it, and the Hawar Islands off Bahrain host the world's second-largest population of dugongs and the largest colony of the endemic Socotra cormorant in the world – all of which contribute to making the Arabian Gulf a global hotspot for marine species.

The socio-economic landscape of Arabia is no less extreme than the region's natural environment. The coast exhibits a mix of affluent development, rural fishing villages and patches of uninhabited land. Less than 50 years ago Dubai was a quiet fishing village; today it is an exponentially expanding hub of industry. In an effort to diversify from a petroleum-centric economy, fisheries, tourism and real-estate development are booming. The reclamation of land has destroyed much of the natural coastline and places a heavy burden on the marine environment.

If conservation measures are not introduced quickly, Arabia's seas are poised to become some of the most threatened and heavily degraded ecosystems in the world. The transition to a consumer society is creating a massive plastic refuse load that accumulates on the beaches. Fishing is the life-blood of many communities in poorer countries such as Yemen and, with international markets now accessible, they are becoming major exporters of shark fins and reef fish.

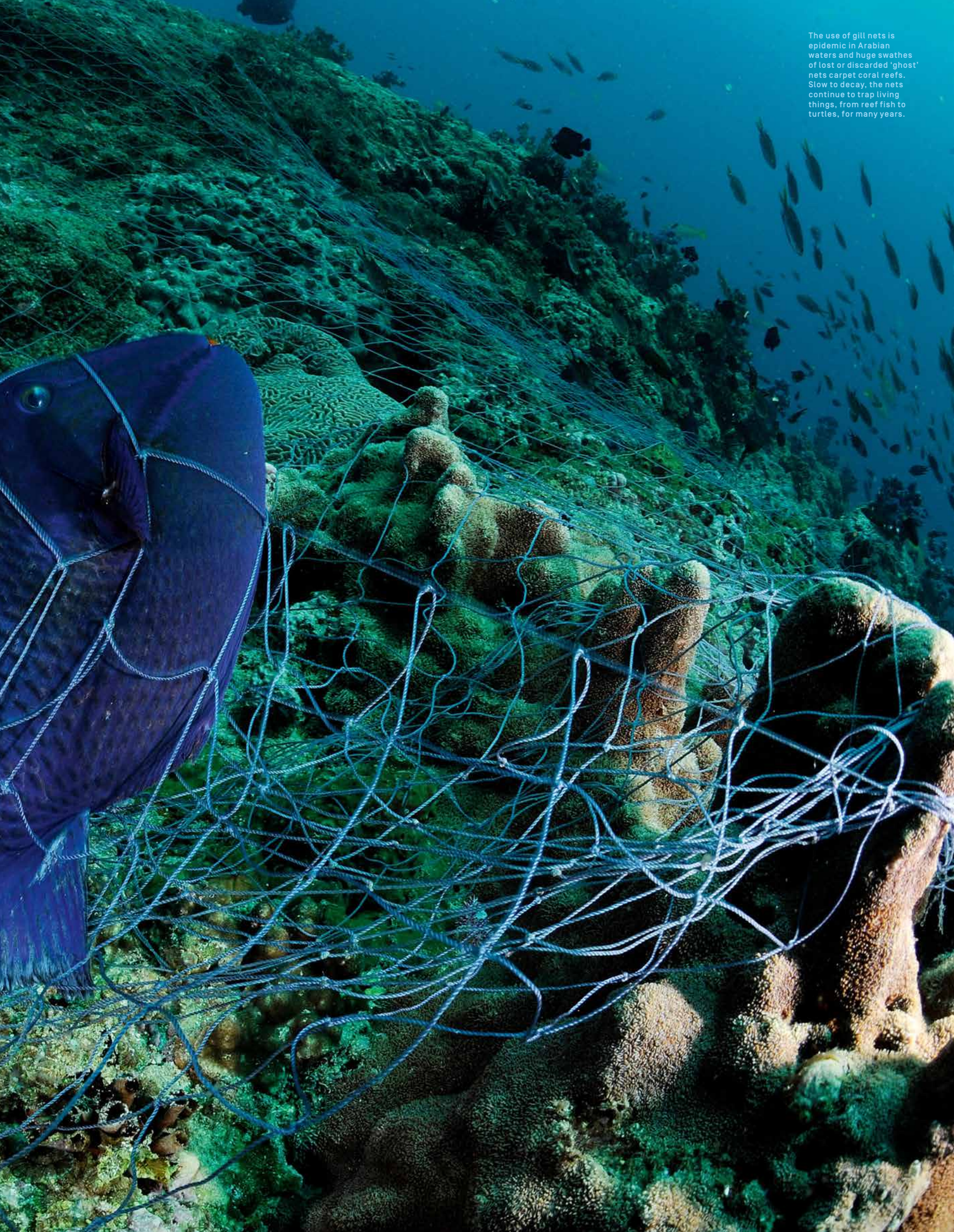
To combat such threats, marine conservationists are fighting an uphill battle. Yet they are putting protective measures in place, and artificial coral reefs, the replanting of mangroves, the rehabilitation of sea turtles and awareness activities about dugongs and marine reserves are now becoming reality. This photo-essay is a showcase of Arabia's rarely glimpsed marine biodiversity, the arc of industrial development casting its long shadow on the sea, and the effort of some to preserve what is left of this ancient and vital pocket of the world.

Forests of kelp and seaweed engulf the rocky reefs of Oman's southern coast during the south-easterly monsoon. A flamboyant red seaweed, as yet undescribed, has been torn free by wave action and drifts across the seasonal seaweed canopy.

On Kuwait's unique mudflats male mudskippers launch themselves into the air to attract females during the breeding season. The densest colonies occur on the shores of Sulaibikhat Bay and on Boubyan Island. These fish are naturally nervous and any sudden movement will send them back into their burrows, where they will stay for up to an hour.

Indigenous male ghost crabs build formidable pyramids at the water's edge on Oman's remote southern beaches. The structures are designed to signal to passing female crabs the males' strength and vigour. The sand used to construct the pyramid is taken from the burrow excavated next to it.

In the northernmost corner of the Arabian Gulf, where the waters of Iraq, Iran and Kuwait meet, shipwrecks are recurring reminders of decades of conflict. This oil tanker was allegedly scuttled on Saddam Hussein's orders to block access to southern Iraq from the sea.

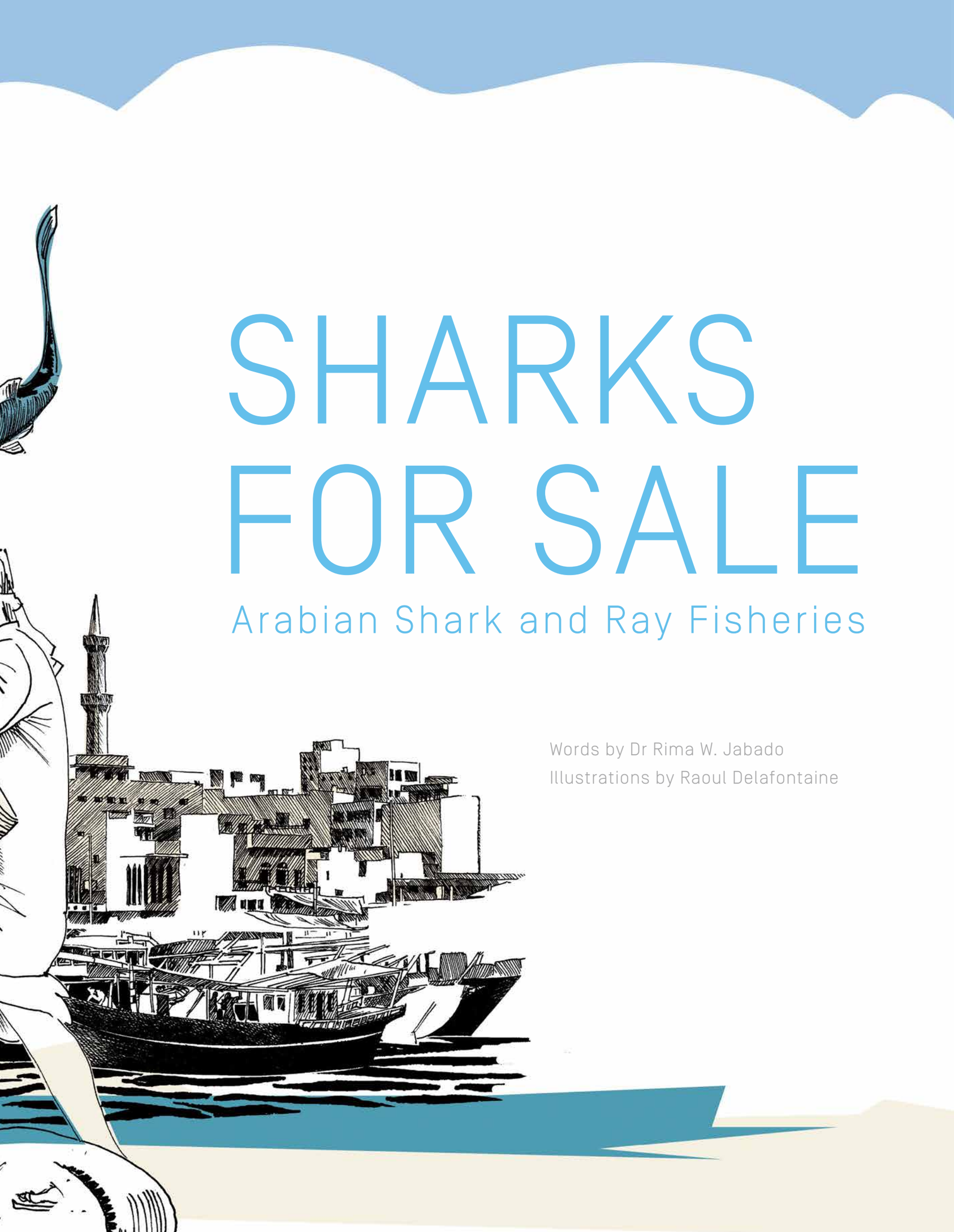


The use of gill nets is epidemic in Arabian waters and huge swathes of lost or discarded 'ghost' nets carpet coral reefs. Slow to decay, the nets continue to trap living things, from reef fish to turtles, for many years.

A sea mount studded with hard corals rises from a great depth, dwarfing the research diver nearby.

The beaches of Dubai were once a prime nesting ground for turtles, but today coastal development prevents them from hauling out here in large numbers. To lend a helping hand, the Dubai Turtle Rehabilitation Project nurses back to health injured turtles that have been found by the public. A few times a year the rehabilitated reptiles are released back into the wild en masse.

A sea turtle nesting on Masirah Island, off the southern coast of Oman, has left this track. The full moon sheds its glow on the beach and clouds, while a small flashlight lights up the turtle track.



SHARKS FOR SALE

Arabian Shark and Ray Fisheries

Words by Dr Rima W. Jabado
Illustrations by Raoul Delafontaine

Protecting and managing shark and ray populations in the Arabian Sea is a huge challenge, explains Dr Rima Jabado, primarily because so little is known about them.

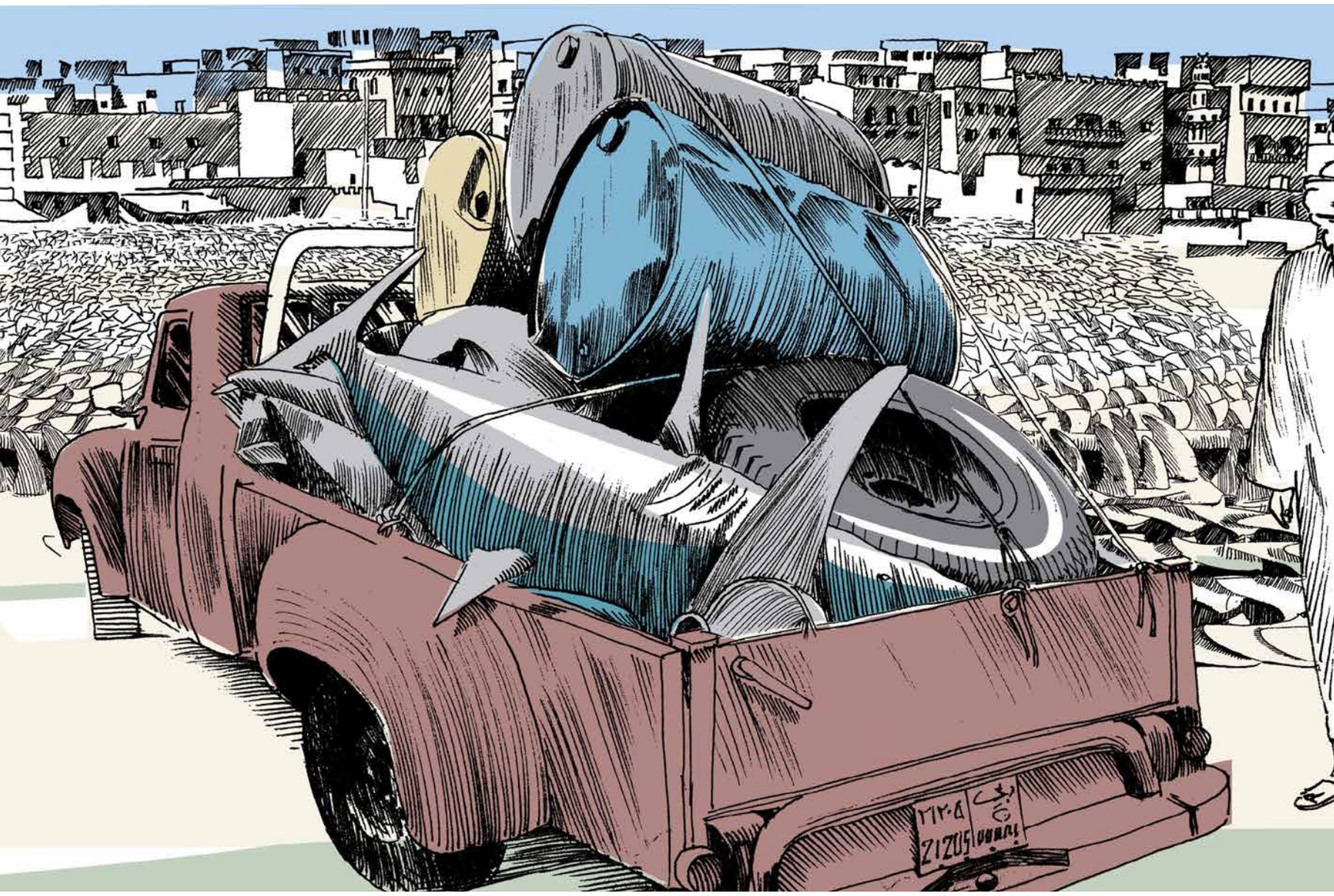
Reports of declining shark populations from around the world have proliferated in recent years, along with concerns that existing management measures are not going to be able to halt the sharp drop in shark numbers. But how do you manage shark populations in the face of uncertainty and how can you protect what you don't know? These are the main questions that conservationists face when dealing with shark and ray fisheries in the Arabian Seas region.

This part of the world is well known for the unique biodiversity of much of its coastline and many of its islands, as well as for its tradition of pearl diving and its oil resources. More recently, it has been in the news for the contribution the United Arab Emirates (UAE) and the Republic of Yemen make to the shark-fin market in Hong Kong. In fact, for more than a decade these two countries have ranked in the top 10 – and sometimes even the top five – of the nations that export dried shark fins to Hong Kong, with yearly quantities reaching up to 400 metric tons.

In addition, five of the planet's top shark-fishing countries – Iran, Pakistan, India, Sri Lanka and Yemen – border the Arabian Seas and together they contribute approximately 20% of the reported shark landings around the world. These numbers alone should sound an alarm about what could be happening to shark and ray stocks in the area. Yet this important region was, until recently, overlooked and to this day it is still understudied.

What most people don't realise, however, is that the story of the Arabian Sea's sharks and rays is much more complicated than it appears. Having always been utilised in the area, these animals feature in local traditions and contribute to the cultural heritage of many countries. Archaeological evidence from the UAE and dating back thousands of years shows the strong connection that the local communities had with the seas. Shark meat was an important component of the diet of many coastal inhabitants, oil from shark liver was used to waterproof dhows, the rostrum of sawfishes served as barbed wire around houses and even discarded fish parts were dug into date plantations as fertiliser.

More recently, as the demand for shark fins rose in Asian countries, fishermen around the Arabian Seas quickly realised that targeting sharks could be very lucrative. In fact, according to fishermen and traders from the UAE, Yemen, Oman and Saudi Arabia, demand from the Asian market has been the main driver for unsustainable shark fishing over the past 15 to 20 years. Fishermen in the UAE have confirmed that the abundance of sharks, the numbers caught and their sizes have all been greatly reduced – a sure sign of overfishing.



Local people depend heavily on multi-species fishing for their livelihoods and for food security and the coast is dotted with hundreds of sites where tons of fish are landed each day. Although the fishermen in the region are mainly artisanal and few industrial boats are registered, their impact on shark and ray populations is likely to be heavy due to the sheer number of boats operating. Local governments have failed to set up efficient systems to monitor the fishing and much of the information about quantities and species caught is inaccurate. Species-specific data on sharks and rays are not available and much of the historical information on the diversity of species comes from stand-alone, short-term projects or from surveys dating back to the mid-20th century.

More recent studies have shown that there are at least 69 shark and 35 ray species in these waters. New species are being added rapidly despite the minimal survey efforts; the latest species, Human's whaler shark *Carcharhinus humani*, was described as recently as a few months ago. This highlights how much we still have to learn about shark and ray diversity in this part of the world. Even more interesting is that genetic studies show that stocks of several commercially important shark species are shared across water basins. With little information on fishing effort and catches, it is difficult to evaluate the real pressure on these stocks. What is clear is that the full impact of fishing and other human disturbances is underestimated.

Although the large majority of the species found in the Arabian Seas region are listed in the Threatened categories of the IUCN Red List of Threatened Species™ (that is, Critically Endangered, Endangered and Vulnerable), the assessments relating to these species do not take the current situation in the region into account. Nor have the species been assessed in the light of new research that has emerged in recent years. Nevertheless, legislation promoting the conservation of sharks does exist in various forms, ranging from a complete fishing ban in Saudi Arabia and a finning ban in Oman to the protection of certain species, such as sawfishes, whale sharks, hammerheads, oceanic whitetips and mantas, in the UAE. Implementation mechanisms still lag behind, though, and few of the laws are enforced, especially in rural areas.

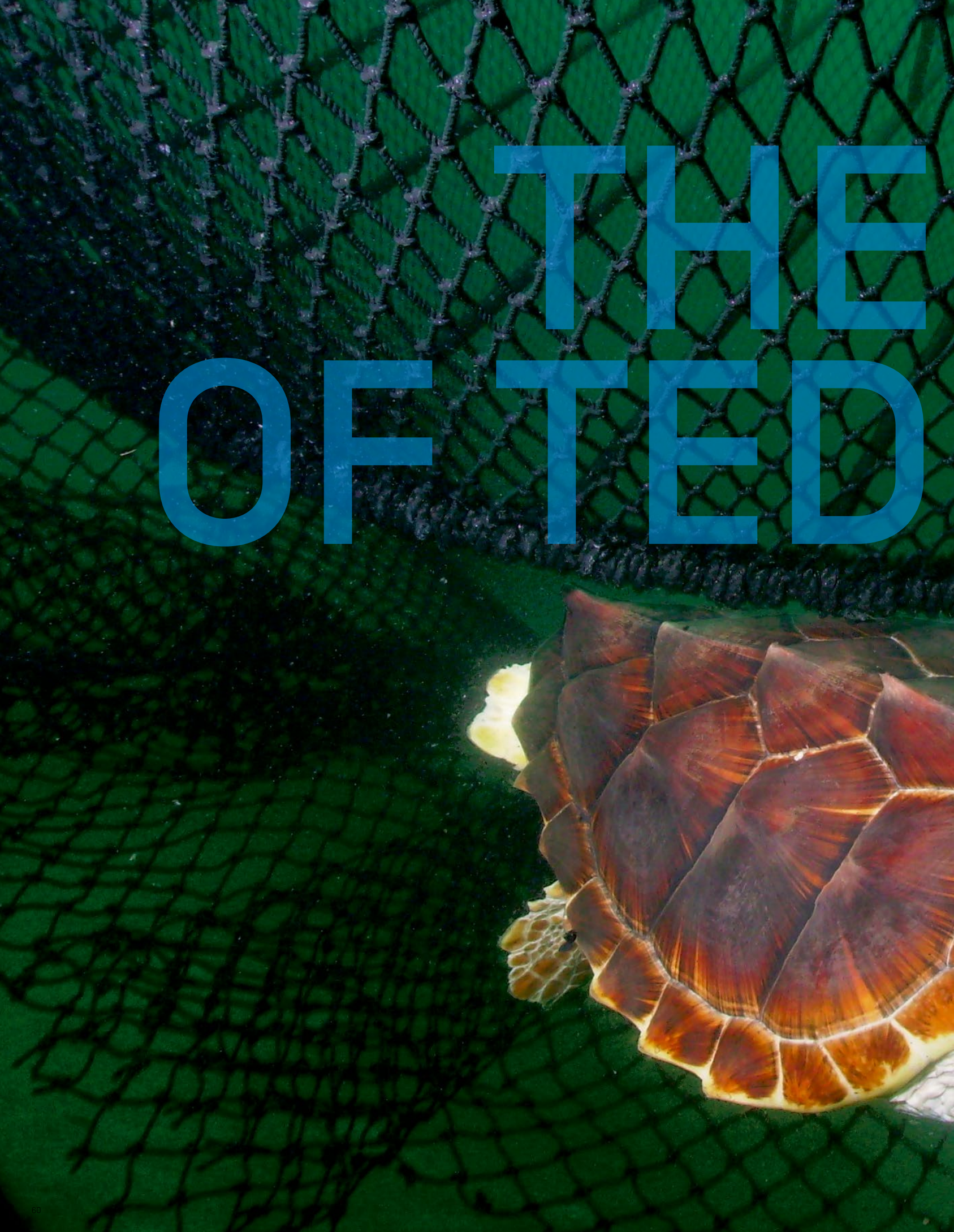
To top it all, the impact of the international shark-fin trade is huge and many countries use the Arabian Seas region as a hub for the export of whole sharks, fins or shark meat. Monitoring the trade is extremely difficult because the routes used are remote and arduous to follow. Truckers and middlemen play a key role in this trade and their routes are largely undocumented. Research undertaken under the

umbrella of the Gulf Elasmo Project has revealed, however, that shark and ray products may be either traded directly with Asian countries or transported overland to the UAE from neighbouring countries for processing and packaging before being re-exported.

Information gleaned from this research also indicates that more than 40 shark species are regularly traded through the UAE alone. Some of these species (including oceanic whitetips and several of the hammerheads) as well as two manta ray species have now been listed on the Convention for the International Trade in Endangered Species of Flora and Fauna (CITES). The listings aim to regulate the international trade in these species and came into effect in September 2014.

Several countries have stepped up and are working hard to increase their capacity for identifying the listed species and their body parts. As the UAE and Yemen are hubs for the trade in sharks and rays, their officials will need to be rigorous in monitoring and controlling it. This will no doubt be a challenge, since many of the countries in the region have removed trade barriers. Nevertheless some, such as the UAE, are pushing forward to ensure that strict measures are put in place to regulate the shark trade by banning the export of all shark products and the re-export of shark fins.

There are still many gaps in our knowledge of sharks and rays in the Arabian Seas region and it is clear that science-based conservation and management there is in urgent need of improvement. The fact that some species are migratory and some stocks are shared across international borders highlights the requirement for regional attention. Management measures will have to include protection at both a national and a regional level if further population declines are to be prevented. Since fishing is critical for the livelihoods of many people living along the coast, the potential for environmentally sustainable shark and ray fisheries will have to be considered. Even more important than that, though, is the need for research, since without adequate information on species diversity in the region it will not be possible to develop sound management initiatives – and, even less, to enforce them.



THE OF TED

STORY

Photo by NOAA

It's been a long battle, but gradually Dr Nicolas Pilcher is persuading the shrimp fishers, and government, of Malaysia that a simple device can protect turtles without detriment to their catch.

Words by Nicolas Pilcher

Sea turtles are iconic. They have the power to melt young hearts, to intrigue scientists and to mesmerise and impress the public. In Malaysia, where I am based and where I have devoted the past 20 years to finding solutions to sea turtle conservation challenges, the story is no different: sea turtles adorn tour buses, they are in just about every tourism brochure, they are on television adverts and in prime-time documentaries. They are featured in comic strips and on postage stamps. They are protected by more laws than in any other country in the world, as each state affords them protection over and above that provided by national legislation.

But they can hardly be considered 'safe', as a suite of pressures, both foreign and domestic, threaten their very existence. The leatherback turtle, once abundant, is now functionally extinct. The olive ridley is down to just tens of nests per year. The hawksbill is hanging on precariously. Only green turtle

Photo by Thomas P. Peschak

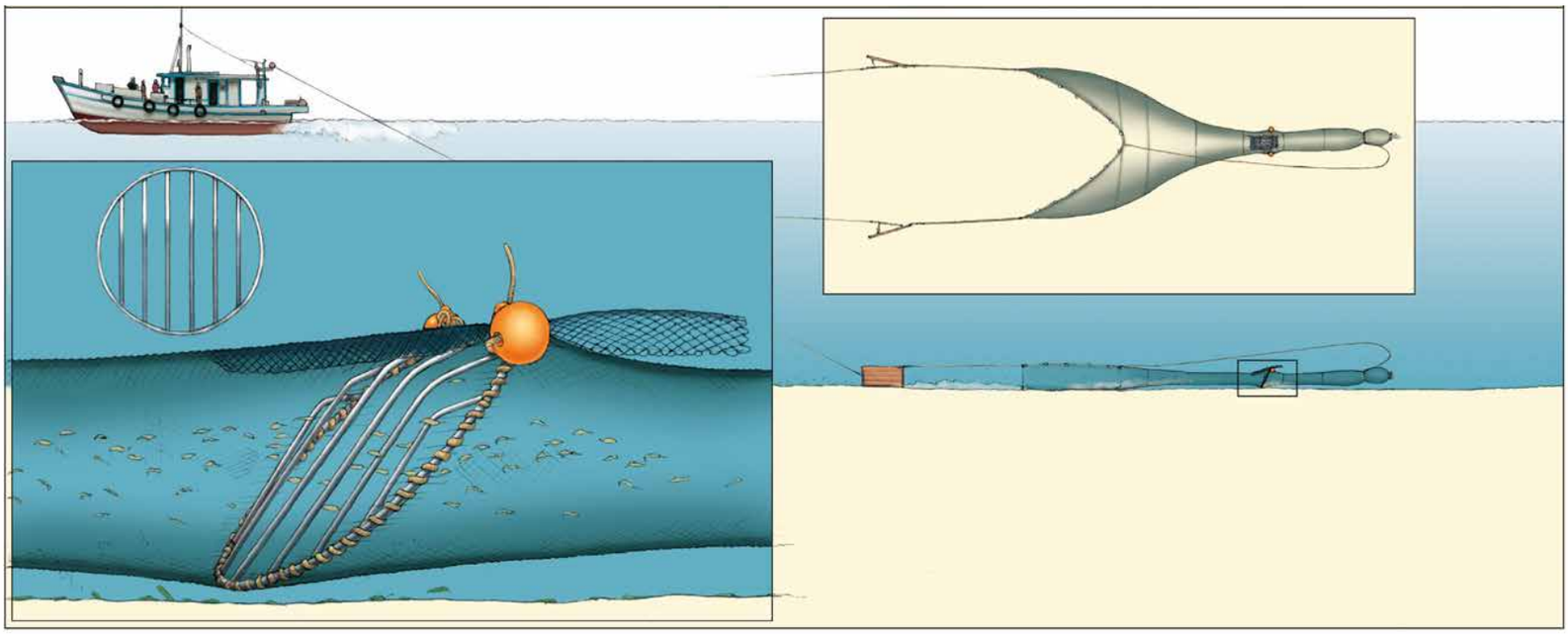
numbers remain stable, with several hundred turtles nesting regularly at a few rookeries and an impressive 5,000 nests annually at South-East Asia's largest nesting site off Sandakan, in Sabah (Borneo).

Yet while Sabah's turtles are currently abundant, they face some exceptional challenges. Turtle eggs are poached on all remote islands. Large adult turtles are caught by Chinese and Vietnamese fishing boats. Nesting sites are slowly being lost to coastal development. And by far the greatest threat to sea turtles in Malaysia is accidental capture in commercial and artisanal fisheries. Sea turtles have the unfortunate legacy of sharing habitats with some of our favourite foods, and of all the threats to their existence, the shrimp industry is perhaps the biggest. As shrimp trawl nets roll along the seabed they indiscriminately catch and drown numerous sea turtles – I estimate as many as 3,000 to 4,000 each year in Sabah alone.

Putting an end to this unwanted by-catch has been my passion and inner driving force for the past decade. I started out as a research scientist studying the reproductive biology and early life-stage behaviour of sea turtles. Working with these fascinating creatures was almost addictive, with one exciting discovery leading to numerous new puzzles to be solved. But as the years went by I evolved – luckily faster than the turtles I studied – and devoted more and more time to finding ways to save my subjects from extinction. The situation for turtles slowly improved thanks to small management changes at national parks, but the threat posed by thousands of shrimp trawlers remained daunting. And yet a very practical and inexpensive solution existed in the form of Turtle Excluder Devices (or TEDs), which are fixed within a trawl net and allow a fisherman's catch to be retained while turtles are excluded.

A TED is usually an oval frame with vertical bars set at precise spacing that allows shrimp and fish to pass through to the cod end, at the back of the net, while turtles and other large objects are forced out through an opening covered by a net flap. TEDs improve the quality of the catch, as large objects such as logs do not crush it, and the reduction of debris in the back of the net saves fuel, which is a benefit to fishers.

Although TEDs have many advantages, fishers are often wary of using them because of the large exit 'trapdoor' in the net that allows turtles and debris to escape. They are concerned that their target catch will be lost through this opening, even though self-closing netting flaps cover it. In numerous trials across the world, however – and more recently through my work in Malaysia – we have found that the TEDs rarely cause a decline in catches. Even if they do, such a decline is normally offset by fuel savings and higher-quality product. For me the greatest problem was not that practical solutions did not exist, but rather that TEDs were 'blacklisted'.

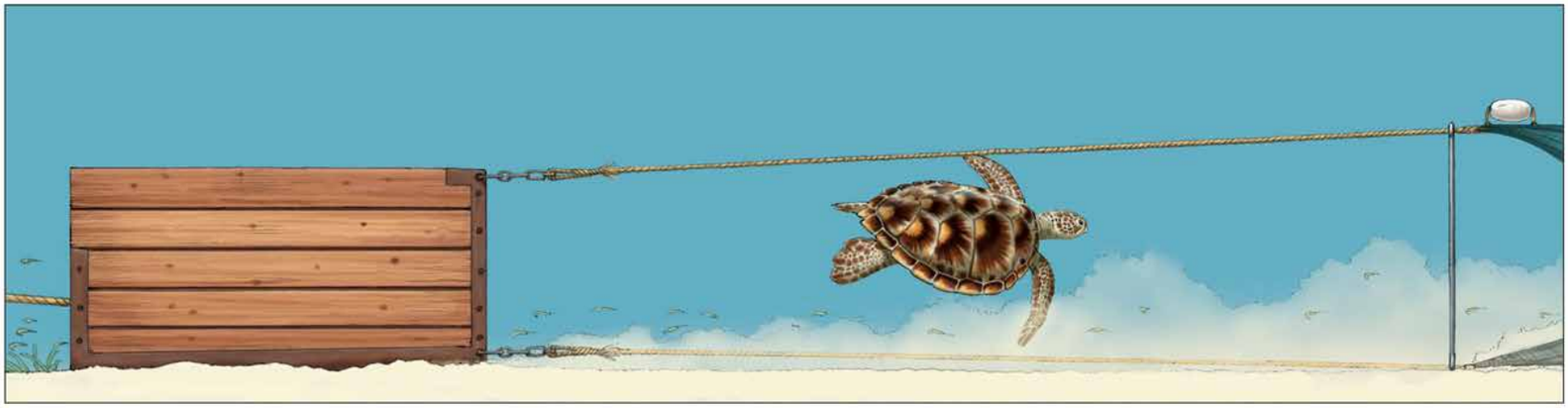


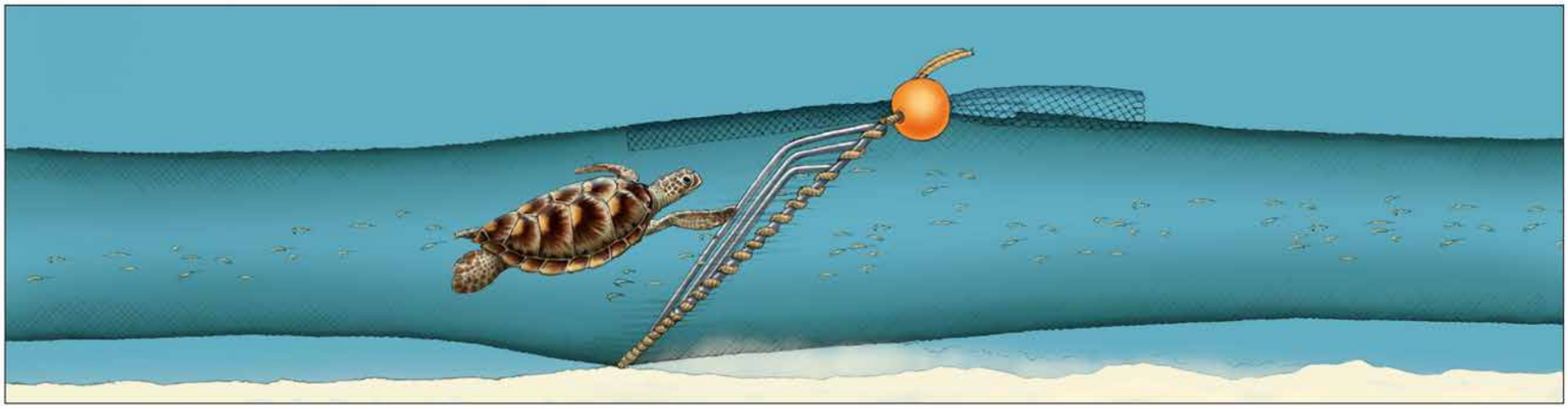
A Turtle Excluder Device (TED) is simply a metal grid with bars spaced about 10 centimetres apart. Set at an angle, it is typically installed in the neck of a shrimp trawling net. Shrimp and fish pass through the grid and are retained in the net, but the grid deflects large objects, such as turtles, upwards and out through a net flap.

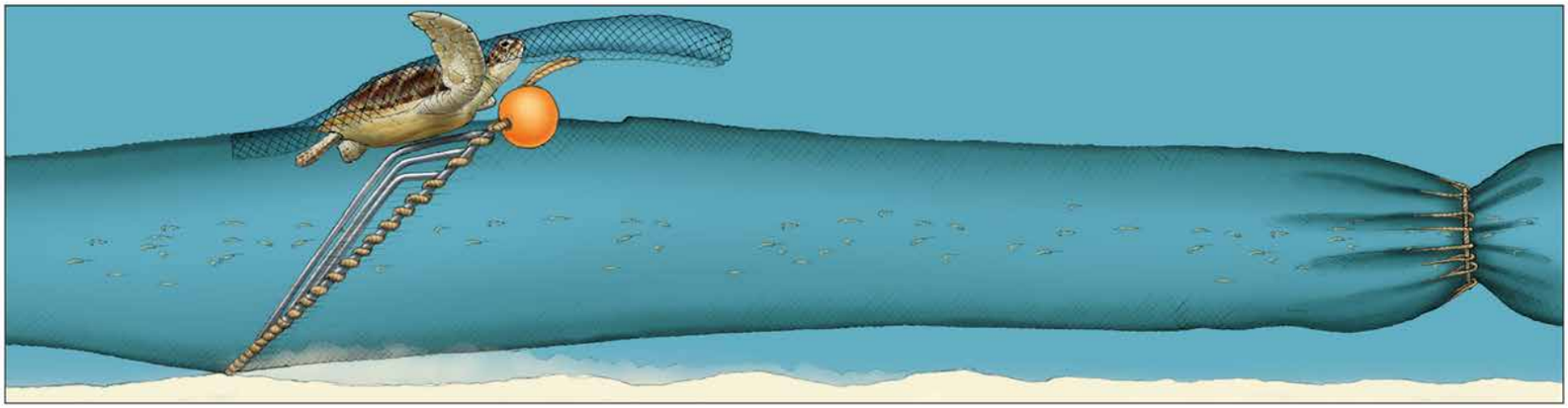
In the late 1990s the United States adopted legislation requiring countries that exported shrimp to the US to use bycatch-reduction devices such as TEDs. Malaysia and several other countries took the case to the World Trade Organisation (WTO), arguing that this imposed the laws of one country upon another. The WTO agreed and the US had to re-open the trade. For several years this went back and forth, until the WTO finally recognised the US's position and what it was trying to do – save turtles. The dispute left many leaders, attorney generals and ministers of trade and industry across South and South-East Asia feeling sour. Malaysia no longer had a trading partner in the US and was forced to sell at other markets at lower prices. So TEDs were not popular. Indeed, they weren't welcome. Talk of TEDs was infrequent and then only in whispers.

Against this backdrop and fearing that time was running out for Sabah's turtles, in 2007 I sought permission from the director-general of fisheries to initiate a small pilot project using TEDs. Permission was granted, but I was asked to keep things small and quiet to start with.

My plan was to tackle the problem by working with fishermen first, long before taking it up with the government. But fishing communities across the world are the least willing to change. They show incredible inertia when it comes to adopting new practices, even if such practices will be beneficial to them. And fishermen, worried that they will lose catch and income, have a particular aversion to TEDs. They are adamant that the devices don't work as advertised. As I pointed out in a grant application once, 'When fishers have a good day, it's a good day. But when they have a bad day, it's the TED's fault!'







Illustrations by Mark Dando

Undeterred and armed with funds from Malaysia's Global Environment Facility Small Grants Programme (GEF/SGP), I set about contacting fishermen. In Sandakan, a coastal city that is near the Turtle Islands Park (where thousands of turtles nest each year) and hosts more than 1,500 trawlers, I tried selling the idea of trialling TEDs for a short period, 'just to see how they would work on Malaysian boats'. At the outset I met Chua Yau Tsen, the owner of 13 trawlers and a shrimp processing plant who would soon become my ally and the greatest supporter of the TED programme. Chua let us install TEDs on his boats and chided other owners who remained on the sidelines.

In those early days I used to spend more nights on the back of fishing boats than I did at home, much to the chagrin of my wife and three daughters. I learned how to sew fishing nets and fix problems with the TEDs, welding them myself when they broke or needed modifying. I had sewing needles, knives and twine in my car, on my boat, in my office and in my pockets. I had TEDs in my garage, in my office and in my car. Speaking the local language helped immensely and I became an adopted crew member on the boats, hauling nets and taking my turn at the helm. TEDs slowly gained acceptance among a small group of fishers; the programme was under way.

When some of my guys complained they didn't quite understand how TEDs worked, I raised funds from Conservation International (Philippines) to create a short documentary video using one of Chua's boats and crew together with some turtles from another research project of mine. Another grant by Conservation International enabled me to take six fishermen on a study tour in the US, hosted by the National Marine Fisheries Service (NMFS). Although the team I took didn't speak much English, they all spoke 'fishing' and were happiest when out on the boats. These guys came back as ambassadors to the programme.

A year later, another round of GEF/SGP funding allowed me to expand the project to a second port in Sabah, where another project stalwart, Johnny Wong, came to my aid. During that phase I also put GoPro cameras on the nets to prove to fishermen that the flap was indeed closed and that turtles were being saved nearly every day. The camera footage was a real eye-opener and more fishing crews bought into the idea. I also convened a state-level workshop to spread the word far and wide, and both Chua and Johnny backed my claims. 'TEDs work,' they explained, 'and not at any loss to the boats or our operations.' Several grants from the Save Our Seas

Photo by Thomas P. Peschak

Foundation (SOSF) allowed me to continue to trial TEDs at an experimental level.

But the truth was that the voluntary adoption process was not working as well as I would have liked. It was time-consuming and I could reach only a handful of fishers willing to try TEDs, which they quickly removed when the trials were over. I needed the Malaysian government to come on board and drive the programme, because without legal backing TEDs were not going to make it to the big league. And a small NGO like mine was never going to implement a nationwide programme.

And so another year later and with a grant from the US National Oceanic and Atmospheric Administration's (NOAA) Pacific Islands Regional Office, I reprised my 'TED Tour Guide' role and took four government officials to visit the NMFS while TEDs were being tested with live turtles off the coast of Florida. The officials came back changed people. The experience had been a real eye-opener for them and probably the first time any of them had handled live turtles.

A month after the trip I was summoned to the director-general's office in Malaysia's new administrative capital city, Putrajaya. I was somewhat anxious about what might ensue, given the history of TEDs at higher political levels, but I was greeted warmly and thanked for all I had done to date to get TEDs on Malaysia's trawlers. The director-general even inquired whether he might be able to go on a similar site visit and see TEDs in operation for himself. The timing was just right: I had a grant application pending with the SOSF and asked whether I could include the overseas trip. It turned out to be the best thing I had done in years. The SOSF came through and six months later the director-general and I were on our way to Florida, accompanied by one of the government officers who had attended the previous year.

In those intervening months the Department of Fisheries had started to push TEDs on its own at another port in Peninsular Malaysia, mirroring the work I was doing in Sabah. The fishers were extremely receptive and even came up with a modification that improved their catches and still kept turtles safe. They also used GoPro cameras and documented the safe exclusion of several turtles, which raised further interest back at headquarters.

In Florida, the director-general and I submitted the Malaysia-designed TED to the NMFS for rigorous testing. It worked like magic: every turtle escaped in less than one minute. The NMFS certified the new TED for use in fishing fleets worldwide, while back home the director-general's pride after witnessing the performance of the Malaysia TED drove the acceptance process further. He instructed his staff to establish a

Photo by Gilbert Woolley

national steering committee and tasked it with developing a long-term implementation strategy. The committee has already met twice and a draft plan is on the drawing board. As the government embarks on the nationwide programme, I have been asked to be the technical advisor to the committee and the Department of Fisheries.

This was a magical time for me, seeing the government take ownership of the TEDs programme and include TEDs in fisheries legislation. It really is momentous. Not all Malaysia's fleets are equipped with TEDs yet, but this is just a matter of time. State by state and port by port, TEDs will be introduced one boat at a time – and as this happens, the future of Malaysia's turtle populations will be secured. I'm just glad I got to play a role and help get the process under way.

← Green turtles mate over a shallow reef flat.

↑ For the past two decades, Nick Pilcher has been working with turtles in Malaysia, encouraging fishers to equip their nets with Turtle Excluder Devices that will help them to avoid catching these gentle marine reptiles.

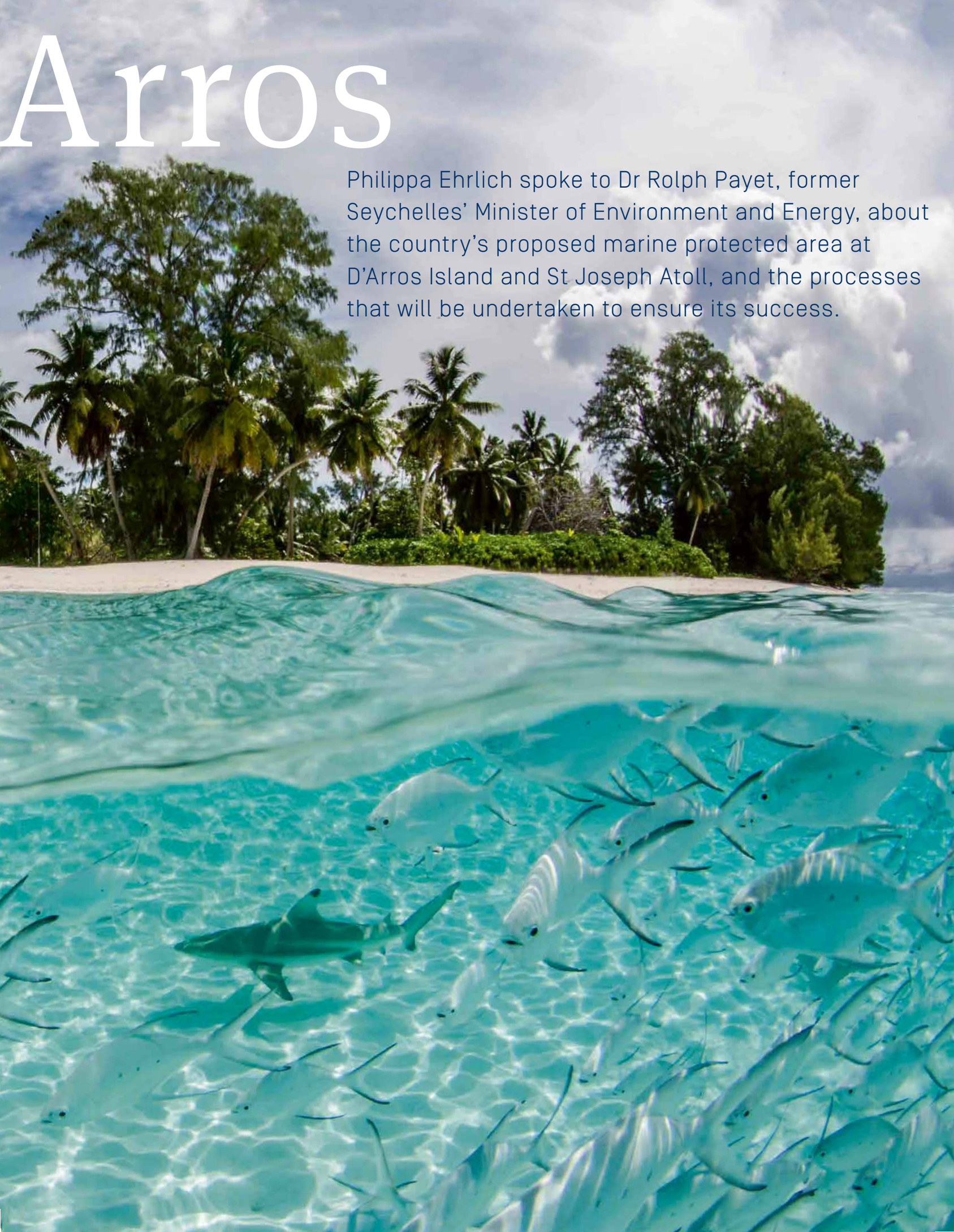
Protecting D'
and St Joseph

Small spotted darts shoal in the foreground while blacktip reef sharks patrol the sand flats in front of the SOSF D'Arros Research Centre. These waters and creatures will be protected by the D'Arros Island and St Joseph Atoll Special Reserve.

Photo by Byron Dilkes

Arros

Philippa Ehrlich spoke to Dr Rolph Payet, former Seychelles' Minister of Environment and Energy, about the country's proposed marine protected area at D'Arros Island and St Joseph Atoll, and the processes that will be undertaken to ensure its success.



Dr Rolph Payet,
Seychelles' Minister
of Environment
and Energy

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While growing up in the Seychelles, Dr Payet developed a deep connection with the natural world around him and it was this that motivated him to pursue a career dedicated to the environment. He was educated at various international institutions and received his PhD in environmental science from the Linnaeus University in Sweden. While his multidisciplinary research focused on sustainable tourism, his more recent work has concentrated on island issues, climate change and biodiversity, and has been widely recognised. In November 2007 he became the joint winner of a Nobel Peace Prize, in conjunction with Al Gore, for his work with the Intergovernmental Panel on Climate Change. Dr Payet was the Seychelles' Minister of Environment and Energy from 2012 to September 2014, and he is the pro-chancellor of the University of Seychelles. In October 2014 he took up the position of the United Nations' executive secretary of the Basel, Rotterdam and Stockholm Conventions.

When did you first visit D'Arros Island?

I think it must have been in early 2005. I remember walking off the plane and getting the sense that I was in a truly wonderful and unique place. What you see on D'Arros is nature at its best – in balance and intact. I would love to undertake research there for a while, maybe when I retire from office. There is so much to study at D'Arros that could help me understand our islands better.

What makes D'Arros Island and St Joseph Atoll an appropriate site for a protected area?

Even during that first visit, I thought the D'Arros and St Joseph system would be an ideal site for a protected area. St Joseph Atoll especially has a significant population of seabirds and has been well documented as a very important seabird area. The lagoon is home to an abundance of shark, turtle and fish species and is vital for marine biodiversity as a nursery area and foraging ground. Even in the channel between D'Arros and St Joseph, it is amazing how much wildlife you can find. A lot of research still needs to be done, but the main thing is to be aware of this very critical habitat in the Outer Islands and the need for its protection.

What would the benefits of protecting D'Arros and St Joseph be?

I think the benefits would be enormous, for now and in the future. At the moment we are going through the process of identifying strategic biodiversity centres in the Outer Islands. As you can imagine, managing an area in the remote Outer Islands is very expensive – logistically, financially and in terms of human resources. Having D'Arros Island as one of those centres of biodiversity, with adequate financing and resources, would be of great comfort to me, as well as to others in conservation and in government. The only actively managed protected area in the Outer Islands of the Seychelles is Aldabra. Adding D'Arros would contribute to our ambition to develop a network of managed protected areas.

Furthermore, D'Arros, which is about midway between Mahé and Aldabra, would be ideal for strategic conservation purposes, as it would form an important biodiversity corridor. The Outer Islands are very important habitats for seabirds, so creating a corridor of protected areas in which the birds can nest and feed is essential.

Another benefit would be for fisheries. The Seychellois people are already catching fewer fish than they used to, so creating marine protected areas where fish can breed and grow helps the fishing industry by supporting the sustainable use of our resources.

It is also essential to recognise the terrestrial environment. By protecting and restoring it here we can ensure that, in addition to Mahé but relatively far away, we have a location where we can conserve important species. Just imagine, if all our endemics were in only one place they could very easily be wiped out, for example by disease.

How has the Seychellois government managed to achieve such incredible conservation success at Aldabra, and how would the situation compare with D'Arros and St Joseph?

Aldabra has been very successfully managed. I think it boils down to its incredibly remote location, combined with good science and good management. D'Arros is a bit more challenging. We established Aldabra 25 years ago but, if declared, D'Arros would be a new protected area in changed global circumstances. People have bigger boats now, fishing is more intensive and the needs of fishermen have changed, so gaining their acceptance is going to be more of a challenge.

The other issue, of course, is that D'Arros is privately owned. The owner has made it very clear that he wants the island to be set aside for conservation, but until this happens people will have their doubts about the motives behind the proclamation. In time, though, they will see that protecting the area is genuinely good for the Seychelles.

D'Arros has some advantages too. Aldabra is a massive atoll – the largest raised atoll in the world – and because it has such dense and rough terrain it has been difficult even to map it completely. In comparison, access to D'Arros and St Joseph is relatively easy, which means that scientific research becomes a lot more manageable.

Was the Save Our Seas Foundation D'Arros Research Centre a critical factor in the decision to propose the reserve?

The SOSF D'Arros Research Centre has helped to create science in a very important location and I'm happy it is focused not only on marine science. I think it has helped us understand a lot more about island ecosystems, on the other coral islands as well as on D'Arros itself. We have to see the research centre for its benefits not only to D'Arros, but to the Amirantes Bank as a whole. It is important for every one of the Outer Islands, from African Banks all the way down to Alfonse and St Pierre.

What are the plans for managing the proposed protected area?

We intend to designate the marine area within one kilometre of the D'Arros Island Group and include the terrestrial habitat of St Joseph Atoll as part of the protected area. After designation, we will need to appoint the wardens, and I think after that we will work with the D'Arros team to prepare a management plan for the protected area. When that's been done, we'll be in a position to meet the stakeholders and discuss with them exactly what we are going to do on D'Arros. Once the plan is finalised, it will be up to the ministry to measure and assess the performance of the protected area based on the research, conservation and management targets that we have set jointly.

Do you think that local fishers are receptive to the proposed protected area?

Setting up a marine protected area is a very delicate issue. It's always a challenge with fishermen because they assume that we are trying to lock them out of areas they are used to having access to and that their livelihood will therefore be negatively affected. I think, though, we are winning the game by showing them that protected areas actually help fisheries. We've had good results here on Mahé, where we have demonstrated that protected areas are helping to build fish stocks. We will have to do the research so that we can provide them with similar information about D'Arros. I think that, in the long term, fishermen will start to see the benefits. Seeing fishing boats just outside the boundary of a protected area is proof enough that they can work.

What tools or plans do you have to foster stakeholder buy-in?

I think the first important tool is scientific research. It is very important to show that adequate research has been done, illustrating how crucial the region is in relation to other areas. We also need to be transparent. This is the only way stakeholders will take us seriously and trust our plans. Most importantly, we need to talk to people and listen carefully to their concerns. The process is about determining whether stakeholders' concerns are justified or not, and if they are justified, how best we can address them. We need to look at how to balance their needs with our conservation objectives.

What do you regard as the responsibilities of the Save Our Seas Foundation when it comes to the area?

I think the Save Our Seas Foundation is already doing a fantastic job on D'Arros to foster scientific research, and I think its role would extend to the management and enforcement of the proposed protected area. I also see the Save Our Seas Foundation as an important platform for engaging in local education, which I think is the other component. We need to get our kids and the local people involved with what's happening on D'Arros. The Island School Seychelles is an important part of this. Outreach would help to elevate the status of the D'Arros and St Joseph Special Reserve because people would see that we are doing something really positive and important on D'Arros.

Do you have any other sites planned for protection?

We are currently doing a marine spatial analysis where we try to identify sites for marine protected areas. We are a whale sanctuary, but we have not yet done anything for sharks. And although the turtle species themselves are protected, their foraging grounds are not.

My idea is to have satellite centres around the Outer Islands where we can visibly, economically and also financially develop and protect species of national and global importance, and at the same time create centres for biodiversity and resilience. Resilience is an important issue that will become more and more relevant as we tackle the challenges that come with climate change.

How will you ensure the long-term sustainability of these marine protected areas?

We are developing different financing models to ensure the sustainability of conservation in the Seychelles. In the case of D'Arros, for example, we plan to have private and non-governmental financing. In the case of North Island, we have financing from tourism. In other places, we have combined financing from government and tourism sources. Conservation can be very expensive and if it's not developed with innovative financial mechanisms, it will be very difficult for us to achieve the objectives that we have set.

The giant trevally *Caranx ignobilis* is a large apex predator that schools in large numbers to spawn over deep reefs.

Photo by Thomas P. Peschak

How are you aiming to address the conflict between growing material aspirations and long-term environmental sustainability in the Seychelles?

I think the first place to start is in homes and schools, and also with our visitors – tourists. When we talk about energy and water conservation, people might not think they relate to the oceans, but we need to help them see the interconnectedness of our planet's systems. By targeting actions in the home and in hotels, we can help people to understand their environmental footprint.

We also need to integrate marine and environmental education into schools, homes and tourist accommodation. We need our young people to grow up with the knowledge that their activities will have an impact on the planet so that they become wise consumers and wise users.

Why is a productive and healthy marine ecosystem so important for the Seychellois people?

The Seychellois are completely dependent on the ocean. We have survived for the past 200 years or so only by relying on the marine environment. It's a bit of an irony that sometimes you forget that you can negatively affect the same ocean you depend on. And today we, as a small country, are not the only source of impact on the ocean. You might say, 'Look, there are only a hundred thousand of us. We eat only a limited amount of fish. We don't have to export live fish. We don't dynamite coral. We don't trawl. We are doing things right.' But with globalisation, things are no longer only about 'us' in the Seychelles. In 1998, the Seychelles had – for the first time in recorded history – a coral bleaching event; it was clearly linked to global warming. Our islands are not immune to the threats of climate change; reducing greenhouse gas emissions is critical for saving coral reefs, even in remote locations, and this must be done by all the people on our planet.

We also have an increasing number of global companies wishing to exploit our seabed resources. We have new opportunities coming through for oil exploration. We have the shark-fin trade. There was no shark-fin fishing industry in the Seychelles until people discovered that there was good money to be made from shark fins. Demand for shark-fin soup continues to grow, despite all the conservation messages we keep sending out. We have to realise we are not only a hundred thousand people; we are part of a global community and that changes the whole dynamic of conservation management.

10 YEARS OF SP

Photo by Jon-Erik Munro

Shark Spotters working at Muizenberg beach in Cape Town, South Africa, hoist a black shark flag to indicate that spotting conditions are poor. This system helps to warn beach-goers about recent shark sightings and the prevailing conditions for spotting sharks.

OTTING FOR SHARKS

It seemed like a good idea at the time – and 10 years on, it's proven its value. From mountain vantage points, Shark Spotters watch the waters around Cape Town and warn surfers when sharks are present.

Words by Sarah Waries and Alison Kock

Believe it or not, polarised sunglasses, binoculars and a siren can help to keep you safe from sharks. This was discovered 10 years ago following a spate of shark bites in the waters off Cape Town, South Africa. Local surf shop owners Greg Bertish and Fiona Chudleigh from Muizenberg together with businessman Clive Wakeford and fishermen from Fish Hoek decided that the mountains above the city's beaches provide ideal vantage points from which to spot sharks.

Dedicated spotters were tasked with looking for sharks using polarised sunglasses to cut out the glare on the water and binoculars to scan the ocean below. If the spotter saw a shark, they would alert surfers and swimmers to its presence by means of a flag and a siren. Getting people out of the water as a shark swims past reduces the chance of a potentially dangerous situation.

Now Cape Town's primary strategy to increase the safety of humans in the presence of sharks, the Shark Spotters programme operates at eight of the city's popular beaches and employs 26 spotters, all of whom have been trained in first aid and are able to respond to emergencies. In 2011 a spotter who applied immediate medical care to a shark bite victim saved the man's life. But there is more to this grassroots project than just protecting people; conserving sharks and their environment is high on the agenda too. Shark Spotters incorporates cutting-edge research on white sharks into its safety and awareness campaigns and actively advocates non-lethal solutions to mitigate shark incidents. With the City of Cape Town, it has recently conducted trials of an environmentally friendly shark exclusion barrier at Fish Hoek beach (see page 82).

A registered non-profit organisation, Shark Spotters is funded primarily by the City of Cape Town and the Save Our Seas Foundation (SOSF), with additional support from the local community and business owners who benefit from its activities. SOSF backing has enabled the programme not only to expand its service to the community by monitoring

more beaches, but also to conduct the research necessary to better understand the presence and behaviour of the white shark, a threatened apex predator, in the coastal waters around Cape Town.

This applied research is undertaken by staff, students and collaborators and its objectives are to describe the demographics, size and trends of the local white shark population and to determine its environmental drivers (such as water temperature) as well as its biological drivers (such as prey abundance). The research also aims to understand the sharks' behaviour and movements, to define their role in the local ecosystem and to actively engage with – and test, where possible – shark safety technology and developments. Shark Spotters responding to a shark incident collect all the relevant information, which is compiled into a report that is distributed to the media and is also sent to the South African and International Shark Attack files.

Each year the Shark Spotters programme grows from strength to strength. To mark its 10-year anniversary in 2014, it is opening on Muizenberg beachfront an information centre that will operate alongside the SOSF Shark Education Centre in neighbouring Kalk Bay. Serving as a public interactive space where people can learn more about sharks and the unique and diverse ocean ecosystem around Cape Town, the Muizenberg information centre will also be a base for spotters, where they can develop their operations and continue to benefit the beach-going community and its ocean neighbours. In just 10 years, the Shark Spotters programme has come to be regarded as a major success story and a pioneering example of how people and sharks can co-exist.

Since June 2012, Shark Spotters have been stationed at Kogelbaai at the eastern end of False Bay. Currently spotters watch four Cape Town beaches year-round and four additional beaches in summer.

Photo by Sean Geer

A day in the life of a Shark Spotter

07:30 am
Arrive at the beach office to collect equipment – radios, binoculars, data-sheets and polarised sunglasses are essential for my job. Then I walk 700 metres up the nearby mountain to the lookout point.

08:00 am
Arrive at the lookout and immediately assess the spotting conditions. Because there are clouds overhead and the water is murky after a south-east wind, I radio the beach spotter to tell him to raise the black flag.

08:05 am
Despite the poor spotting conditions, there is plenty to see. A handful of surfers are already in the water, so I start scanning the ocean looking for signs of anything out of the ordinary.

09:30 am
I notice that the treknet [beach seine] fishermen have arrived at the beach, about a kilometre away from the main surfing area. I inform the beach spotter of their activities, which we need to be aware of in case a shark that is interested in the fish shows up.

10:10 am
I see and make a note of a southern right whale about 600 metres offshore, breaching and tail-slapping. This is a common sight in winter and spring. Sometimes whales strand on the local beach and die, attracting large numbers of sharks, so I keep an eye out for any strange behaviour.

10:25 am
A bus full of tourists from Brazil arrives at the lookout and they are eager to learn about the programme and hopefully see a shark. I describe what we do and answer their questions, while making sure my focus stays on the water.

11:45 am
Shark! Just as a cloud moves overhead, I spot it about 400 metres offshore heading south towards St James. I estimate it to be about 3.5 metres long. It is high tide, so the surfers are close to shore and the shark is moving away from them. I decide it does not pose an immediate threat and it's not

Photo by Thomas P. Peschak

Surfers try to break the world record for the largest number of them on a single wave at Muizenberg in South Africa.

September 2014

necessary to close the beach. I report the sighting to the beach spotter and he raises the red flag as a warning. I also radio the spotters and our manager at the adjacent beaches to let them know that a shark is swimming towards them.

11:50 am
I can still see the shark; it has turned around and is heading back towards Muizenberg in the direction of the surfers. It now poses a potential risk and I decide to close the beach and get the surfers out of the water as a precaution. The beach spotter sounds the shark siren and raises the white flag to alert the surfers. The surfers leave the water quickly and gather on the beach to listen to the beach spotter tell them the shark's size and location, and the direction it is travelling in.

12:00 pm
The shark swims slowly just behind the backline, oblivious to the commotion it has caused on land. It changes direction again and starts swimming out into deeper water. I keep track of it for as long as I can. When I lose sight of it, I scan the water below for five minutes to check it does not come back and that no other sharks have entered the area.

12:05 pm
All clear! I radio the beach spotter to re-open the beach and the surfers go back into the water. The white flag comes down and is replaced by the red flag again to let surfers and swimmers know that a shark has been seen within the past hour.

12:45 pm
It's almost the end of my shift. Shark Spotters are on duty for five- to six-hour shifts to avoid fatigue. My replacement arrives to start the afternoon spotting shift. I hand over my equipment and give him an update on the morning's activity. I make sure I have filled in the datasheets, including a map of the pathway the shark swam.

01:00 pm
That's the end of my shift and I walk back down the mountain to the train station to collect my daughter from school. Tomorrow I am on lookout duty again. It's Saturday and the beach is going to be packed with surfers. The water is also warming up, so I expect I will see a few more sharks.

Shark Spotters' milestones

November–December 2004
Shark Spotters programme starts at Muizenberg and Fish Hoek beaches following a spate of shark incidents.

2006
Shark Spotters expands to two more beaches, St James and Glencairn.

July 2006
City of Cape Town municipality adopts it as the primary shark safety strategy for Cape Town and commits to long-term funding.

2007
Shark Spotters expands to another two beaches, Noordhoek and Clovelly.

2008
Shark Spotters gains formal Non-Profit Organisation status.

April 2009
Save Our Seas Foundation comes on board as a primary sponsor.

2004 2005 2006 2007 2008 2009

Photo by Thomas P. Peschak

es

2010
SOSF-funded white shark research programme formally merges with Shark Spotters.

1 June 2012
Shark Spotters starts at a popular Kogel Bay surf spot, Caves, in response to a community request following a fatal shark incident.

15 December 2012
Shark Spotters expands to Monwabisi beach after a spike in shark activity in the area.

24 March 2013
Trial of a new shark exclusion barrier at Fish Hoek begins.

13 June 2014
Shark Spotters receives a silver award in the Cape Town mayor's Portfolio of Urban Sustainability.

September 2014
For their Shark exclusion barrier in Fish Hoek, the Shark Spotters were awarded the best eco-innovation at the prestigious 2014 eco-logic awards.

October 2014
Shark Spotters beach information centre opens at Muizenberg.

November 2014
Shark Spotters celebrates its 10-year anniversary.

2010 2011 2012 2013 2014 2015

Shark barrier with a difference

A complete barrier from the sea floor to the surface, the new shark exclusion net prevents sharks and other marine animals from entering a designated 'exclusion zone'.

In March 2013, following a serious shark bite incident, Shark Spotters and the City of Cape Town began trials of a new design of shark exclusion barrier at Fish Hoek. Unlike traditional shark barriers, which are permanently fixed in position, this environmentally friendly unit was deployed and retrieved each day – the only such system in the world. The aim was to develop a means of keeping sharks out that has minimal impact on the environment, because marine creatures such as whales are more likely to become entangled in barriers that are left in place overnight.

The new shark barrier was deployed 130 times between March 2013 and May 2014, mainly during peak periods such as the summer school holidays in December. It proved not only to have minimal impact on marine life, but also to be both cost-effective and non-lethal – and it drew strong support from the public. The conclusion is that for pocket beaches in white shark habitat – and possibly that of other species, such as bull and tiger sharks – it could be an appropriate non-lethal management tool.

Photo by Jean Tresfon

Photo by Shark Spotters

Shark Spotters as information collectors

In addition to providing safety for surfers and swimmers, Shark Spotters go the extra mile in handling cases of lost children and surfers' car keys, stranded whales and other beach-related emergencies. Spotters are also in a unique position to collect valuable information every day about the presence of sharks and their behaviour, the occurrence of other marine animals and the activities of water-users. The data are analysed by the research team and the results are used to inform safety and education campaigns. From more than 1,600 shark sightings since 2004, some analysis highlights are:

- More than 70% of shark sightings are in relatively deep water, behind the surf zone, which is why swimming in shallower water can reduce the chance of encountering a white shark.
- At Fish Hoek and Muizenberg, shark sightings last for about 20 minutes on average.
- The behaviour of each shark spotted is categorised as either swimming past the beach from one end to the other or patrolling the area, where it makes repeated turns. Most sharks are moving through the area on their way somewhere else.
- In spring and summer, the likelihood of spotting a shark is about 4% at Fish Hoek and 10% at Muizenberg.
- By correlating shark sightings at Muizenberg and Fish Hoek with environmental conditions, we have discovered that shark sightings are more likely when the water temperature is warm (18 °C or above) and during the phase of the new moon.
- Water-users tend to respond to siren warnings rather than flag warnings. This indicates that we need more education and awareness about the meaning of the flags.
- Fewer people use the water in years that have had fatal shark incidents and for up to three months following an incident. This emphasises the need for a shark management strategy, such as Shark Spotters, in Cape Town.

Blue water

, white tips

Demian Chapman, assistant professor at Stony Brook University's School of Marine and Atmospheric Sciences, paints an emerging portrait of the oceanic whitetip shark *Carcharhinus longimanus.*

Words by Demian Chapman | Illustration by Marc Dando

The oceanic whitetip shark *Carcharhinus longimanus* is an enigmatic animal. One of only a handful of sharks that has evolved to live in pelagic waters off the continental shelf, it thrives in a hostile environment alongside some of the ocean's fastest hunters, like tuna and billfish. It probably even preys on these swift giants, though we have no idea how the bulky and seemingly languid oceanic whitetip could manage this feat.

I have been fascinated by this species since I first saw it in Peter Gimbel's 1969 film *Blue Water, White Death: the Hunt for the Great White Shark.* The film culminated in some of the first footage ever seen of white shark cage-diving, yet it was the images of Gimbel's crew diving among scores of large oceanic whitetips off South Africa that seemed more impressive to me. So when my friends and colleagues Lucy Howey and Dr Lance Jordan from Microwave Telemetry asked me if I wanted to help them study this little-known species I was immediately hooked. Microwave Telemetry manufactures pop-off satellite archival tags (PSATs) that enable researchers to track marine animals remotely. Lucy and Lance felt that they could use this technology to shed new light on the lives of these blue-water apex predators.

There are two major obstacles that stand in the way of getting to know the oceanic whitetip. The first is obvious and common to all pelagic sharks and rays: the species lives far from land, at least for most of the time. The cost and logistical difficulties involved in observing it are orders of magnitude greater than those involved in observing, say, a shark associated with coral reefs. In most parts of the world the only people who regularly interact with oceanic whitetips are open-ocean commercial fishermen such as long-liners and purse-seiners. Scientists rarely have the opportunity to study them.

The second barrier to researching the oceanic whitetip, at least in contemporary times, is that it has become quite rare – a situation that would probably have been unthinkable in Jacques Cousteau's era. In those days, anyone who regularly boated, fished or swam in warm, deep blue water had a story or two to tell about whitetips. In the space of a few decades, however, industrial pelagic fishing fleets have had a massive impact on the species.

Whitetips readily took bait intended for the more valuable tuna and billfish and were well known – and hated – for attacking hooked fish. Hemingway immortalised this habit in *The Old Man and the Sea* when the great catch of Santiago, the principal character, was ultimately annihilated by a pack of sharks. If the story were true, the sharks would almost certainly have been whitetips. So when a whitetip was hooked in the early days of pelagic fishing, it's a safe bet that it was not released gently back into the water.

The problem for whitetips ratcheted up a notch when the Chinese economy boomed in the closing decades of the 20th century and, as a consequence, a market for shark fins developed. The popularity of shark-fin soup as a delicacy surged when the newly wealthy middle class in China began consuming all manner of luxury dishes in hitherto unheard-of quantities. Although the large, rounded fins of the whitetip (called 'rolling ball' by fin traders) are not especially coveted as fins go, they were good enough. More importantly, large quantities of them could be readily obtained by fleets on the high seas. And so the great liquidation of *Carcharhinus longimanus* began.

Marine scientist Dr Shelley Clarke estimated that the fins of between 400,000 and 1.5 million oceanic whitetips were traded globally in 2000 alone. Her team later showed that between 1996 and 2009 the catch rate for this species plummeted by about 90% in the South Pacific, providing compelling evidence that fishing pressure had surpassed sustainable limits. This certainly rang true for me. In 2010 I visited a shark fin exporter's warehouse in Suva, Fiji, the global hub to which shark fins from all over the South Pacific are transported before onward shipment to Hong Kong. Dried shark fins were stacked in piles that I could have climbed – and more than a quarter of them were from oceanic whitetips.

We have less data on this species in other parts of the world, where in many cases the largest declines probably occurred earlier than in the South Pacific. But the result appears to be the same: there are many old-timers' stories about encounters with oceanic whitetips, but very few or none from recent years. Lucy and Lance were keen to use their PSATs to learn how we can better protect oceanic whitetips and restore their populations.

When we began to think about studying oceanic whitetips in the Atlantic our initial question was, 'Where?' My wife, Debra Abercrombie, gave us the answer. Then working for the National Marine Fisheries Service Pelagic Observer Program, Debbie knew who to talk to in the fishing community. Their recommendations were unanimous: Cat Island in The Bahamas. Anglers spoke of recent encounters with whitetips close to the island in spring, when the sharks often trailed the boats and attacked hooked gamefish before they could be boated.

Friends and colleagues Sean Williams, Annabelle Brooks and Dr Edward (Edd) Brooks from the nearby Cape Eleuthera Institute rounded out the team to scout the site and see what we could do there. Low on funds but high on hope, the first expedition took place in spring 2011. Subsequently funded by the Save Our Seas Foundation, the Moore Bahamas Foundation and the Pew Charitable Trusts, we have been there every spring since to find out more about the region's whitetips, where they go and what they do. What we experienced on our initial visit was nothing short of a lost world in which the whitetip still rules the blue.

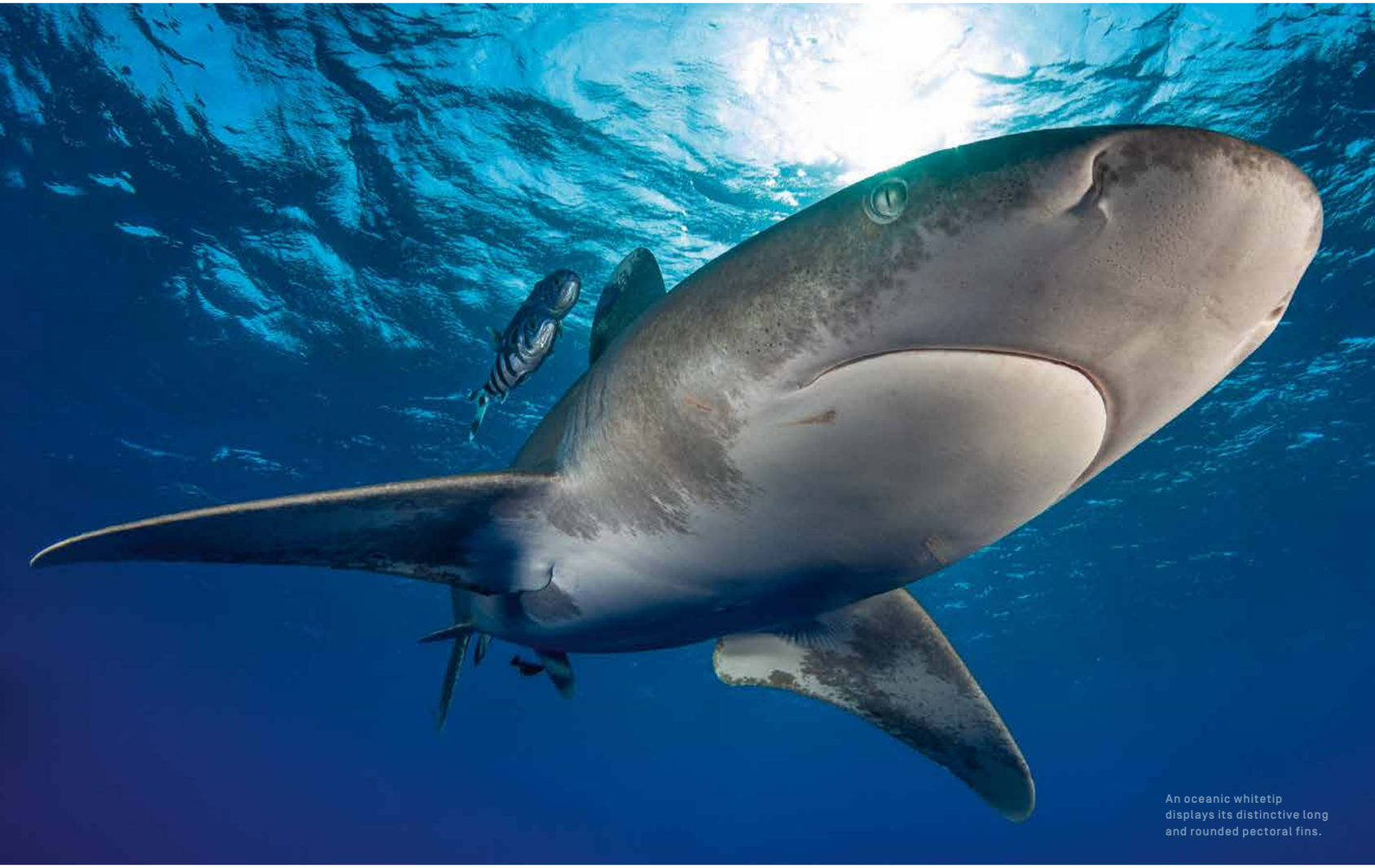
My first meeting with Cat Island's whitetips took place about a mile offshore on a calm, clear spring morning. Edd and Sean had taken one of the institute's boats, the *Cobia,* out at dawn and had started chumming. As the rest of us packed up a smaller skiff, the vessel we planned to tag sharks from, they called us over the radio to let us know that five big oceanic whitetips had already found them. I was pretty anxious to get out there; having worked with a wide variety of shark species, I know that sometimes you have only a few minutes to see them before they move on. Now that I have worked with a large number of the Cat Island whitetips, I know that we could have stopped for a cooked breakfast without losing them. These sharks shadow boats for hours on end.

After a half-hour ride, I stood on the bow as we approached the *Cobia.* The ocean's surface was glassy and almost immediately I could see the large brown shapes cruising behind the bigger boat. Two sharks broke off and swam directly to our skiff, their round fins breaking the surface as they slowly approached. They were both mature females, the most common life-stage we see at Cat Island, where all the sharks are adults and males are outnumbered by about 5 to 1. In later years, Brenda Anderson and Dr Jim Gelsleichter from the University of North Florida would ultrasound many of the females and show that more than two-thirds of them are carrying young in spring. I had been warned that these sharks were bold and the pair that followed us more than lived up to this reputation, closely circling the skiff and giving us a good look. By the time we docked with the *Cobia* I was thinking to myself, 'Who's studying whom?'

First impressions are usually good impressions. After hundreds of encounters I can unequivocally say that the oceanic whitetip is the boldest of all the shark species I have worked with, which include many other apex predators like white, tiger and bull sharks. Unlike these species, the whitetip spends nearly all its life in open blue water, where prey is patchy and very hard to find. Even in the vicinity of Cat Island and its fringing reef, the local whitetips do not feed on reef fish, as Dr Dan Madison of Stony Brook University has shown by using chemical tracers. The research is ongoing, but it is likely to indicate that the whitetips' diet consists mainly of other pelagic fish. This could explain the species' boldness, which may ensure that it takes advantage of a potential feeding opportunity whenever one occurs. Or it could be that whitetips at Cat Island have a higher probability of being hungry than related coastal sharks, which live in a more productive habitat.

That is not to say that whitetips immediately attack potential prey. Far from it; they often circle for hours before feeding. When they arrive, however, they are dogged in their approach and closely circle anything they think might be food. When they ultimately decide to feed, often prompted by a critical mass of several sharks accumulating in the area, they are aggressive and efficient. We have seen sharks 2.5 metres or more in length eating individual pieces of fish smaller than a scrap of sashimi that you might find on your plate.

From the beginning, our primary research question has been: where do these sharks go when (and if) they leave Cat Island? This is interesting from a conservation perspective because they



An oceanic whitetip displays its distinctive long and rounded pectoral fins.

Photo by Todd Winner

are 'safe' while they are in Bahamian waters (commercial shark fishing is not permitted), but if they leave they may encounter commercial fishing gear such as long-lines. We are also interested in the purpose of their migrations: do they move away from Cat Island to mate and give birth, since we never see young sharks or evidence of mating at Cat Island?

The answers to these questions have started to materialise. Having fitted 11 females with PSATs in the first year of the study, we were able to reconstruct their movements and decipher some patterns.

First, about one-third of the tagged sharks stayed in The Bahamas for the whole year. This was a surprise, given the fact that oceanic whitetips are characterised as a highly migratory species. Two-thirds of the tagged sharks, however, lived up to this characterisation by travelling thousands of kilometres from The Bahamas for the summer, when the sea surface temperature through most of the western Atlantic warms to above 26°C. Some of these sharks went north, to an area between North Carolina and Bermuda. The rest headed east to a section north of Puerto Rico, and some of these later continued to the northern area.

All these migratory sharks returned to The Bahamas in the autumn months. We even saw some of them in subsequent years back at Cat Island, a stone's throw from where they had been tagged. In later years we increased our sample to nearly 90 sharks and, with a few exceptions, found the same three migration patterns. We now suspect that some of these large movements may relate to reproduction.

Regardless of their underlying motivation, whitetips are mobile but clearly spend much of the year in The Bahamas where they are relatively safe. Perhaps this is why we can still find them there, in contrast to so many other regions where the species has been depleted. In any event, this finding helped inspire The Bahamas to argue for stricter international controls on the trade in oceanic whitetips, which were ultimately adopted under the Convention on International Trade in Endangered Species (CITES).

We still have a lot of work to do because oceanic whitetips are full of surprises. Although these sharks normally spend almost 100% of their time in the upper 200 metres of the water column, the PSATs have logged them occasionally diving to below 1,000 metres. The deep dives almost always occur at night and fit a profile whereby the shark descends quickly, spends a few minutes at depth and then ascends slowly.

Why would whitetips venture into cold, dark water and spend hardly any time there? Prey would be rare at those depths. Researchers studying other large marine vertebrates, including other shark species and tuna, have recorded similar deep diving, so it is possible that such dives incur a universal benefit. If we can work out why the whitetips dive like this, perhaps this universal benefit will be revealed.

Remaining mysteries aside, we are in an exciting phase of our research: a portrait of Cat Island's oceanic whitetips is starting to materialise. These blue-water apex predators can be highly migratory, but their voyages seem to have purpose, with clear way stations that the sharks are able to relocate year after year. This trait may help humankind save this species by enabling countries like The Bahamas to successfully enact protective legislation for them. If other countries follow suit and cooperate on conservation, perhaps the oceanic whitetip will once again exert its rule over the world's blue waters.

LEARNING FROM EXPERIENCE

Eleanor Yeld Hutchings, poised on a sheer cliff above the Umzimvubu River on the Wild Coast, relates stories of the South African shoreline.

Photo by Claudio Velasquez Rojas/Homebrew Films

Manager of the SOSF Shark Education Centre Eleanor Yeld Hutchings tells us about her colourful South African upbringing and why she chose to pursue a career dedicated to communicating marine science to the public.

Words by Eleanor Yeld Hutchings

I was born in Cape Town, into a family with ties to the sea on both sides. My father grew up in Fish Hoek on the False Bay coast near Cape Town, surfing, snorkelling and playing on the beaches. My mother hailed from KwaZulu-Natal on South Africa's east coast, with a family history of fishing and boating on the shores and estuaries of the Eastern Cape. For me this meant a childhood of holidays spent at various points along the coastline, from Fish Hoek beach in the west through Sandbaai (near Hermanus) and the Tsitsikamma National Park to Kenton-on-Sea in the east. I remember my first snorkelling experiences from the catwalk in Fish Hoek and learning early on how to catch small klipfish in rock pools, which creatures to avoid (spiny chitons and sea urchins) and how to bodysurf the waves. But it wasn't just about the sea; we were also very lucky to be taken around southern Africa by our parents, exploring nature reserves and game parks and being exposed to the terrestrial splendour of our country.

Despite this exposure to all things wild and wonderful, I did the usual flip-flops of children and adolescents as they contemplate what they want to be when they grow up. My choices were to be a figure-skater, a mathematician (that didn't last long!) or a paediatric psychologist. Then I wanted to be a writer, or maybe an illustrator. Eventually the lure of biology grew stronger and stronger and after finishing school and wandering around the world for a time, I ended up at the University of Cape Town enrolled for a degree in the life sciences. In my very first year, an inspirational lecturer stood up and started talking about parasitology. Bam! I was hooked – and on parasites, of all things.

My reaction stirred a memory of spending a holiday in Namibia when I was in my teens and meeting researchers there who were working on anthrax in wildebeest populations. This was the first inkling I had that a single incident of exposure to the natural world, be it formal or informal, can play a pivotal role in how you are inspired and where your life leads you. Although it may be difficult to look back and say that one specific event led to a career path in natural science, I am coming more and more to believe in the power of experiential learning, whether it is articulated as such or is no more than informal happenstance.

With my newfound focus I continued my studies, which included, almost incidentally, some marine ecology courses. For my BSc Honours degree I had my first opportunity to choose a real research project so, of course, parasites were at the top of my list. Any research on parasites would have done; I certainly didn't go looking for a marine focus, although I had both enjoyed and been interested in the marine courses offered at undergraduate level. But coincidences do happen and mine came in the guise of a postdoctoral research fellow who was working in the laboratory of one of the senior marine biology staff members. This researcher had just arrived and it turned out that his subject of study was nothing other than marine fish parasites! Even better, when I hopefully mentioned sharks (because, let's face it, there's no sexier marine subject matter!) he perked up and looked very interested.

Together we worked out a project that became my Honours thesis and formed the basis of what I went on to do for my doctoral research: the parasites of four endemic South African catshark species. It was a topic we were both passionately interested in and, at the same time, one that no-one else could

understand the appeal of – at all! When asked, I tried to explain that most people are interested in sharks biting us; I, however, wanted to find out what bites sharks.

One of the results of my research was that over the next four years I spent a large amount of time diving, boating and fishing in and around False Bay. Through this I got to know a whole lot better an area that I had always taken for granted. I realised what an amazing and special place False Bay is and what a privilege it had been to grow up alongside it and now to be able to do my research there.

Like many other long-term graduate students, I needed to earn a living while completing my degree and this led me to what I think was the next pivotal point in how I got to where I am now. The job that I found was as the manager of a marine biology tour company. In addition to some staff, finances and marketing management, it involved a lot of tour-guiding along the Western Cape coast and most of the False Bay coastline (and for this I needed tour guide certification). Through the experience I gained taking group after group of tourists along the shore, out onto the rocks, into harbours and occasionally out to sea, I learned how to communicate marine science to the public. I also discovered that this is something I am really, really interested in!

This led to my next step: I was invited to screen test for the role of marine biology presenter for the documentary series *Shoreline,* a journey of discovery around the South African coast from the border with Namibia in the west to the border with Mozambique in the east. Who could say no to such an invitation? Certainly not me! And, to my delight, I was offered the role. We have made two series so far, travelling the entire coastline twice and visiting incredible, beautiful, remote, scary and fascinating places. We've also publicised ground-breaking scientific research, and even won awards. My work with the series and my other science communication efforts were recognised earlier this year when I was presented with the 2014 Marine and Coastal Communicator Award by the South African Network for Coastal and Oceanic Research. My experience on the show taught me more than I ever thought I would know about our coastal ecology – and that this is the most important work we can do to further marine conservation in South Africa. Even this isn't enough, though; we need to direct our efforts at younger audiences and focus on education and spreading awareness of the value of the coastal environment.

Somewhere among all of this, I managed to finish my thesis, graduate and make my first move into the realm of formal marine conservation by taking a position with the South African branch of the Worldwide Fund for Nature (WWF-SA). The real appeal of this was that the project I had been appointed to run was an ecosystems-based management plan for a very special part of South Africa: False Bay, a place I know intimately and care about very much.

The process involved was an adaptation of something known as the Ecological Risk Assessment Framework, which takes people into account as part of the ecosystem, identifies the 'end goal' or vision, and then quantifies the risks that could prevent us from attaining that vision. It was a very interesting project and it brought me into contact with all kinds of stakeholders in False Bay and its surrounds. It also served to emphasise that if people have no awareness of our oceans and no basic understanding of marine conservation, the achievements of ambitious projects like this will be limited. This once again indicated to me the importance of education and how much we need it. It was at this point that I made the move to the Save Our Seas Shark Education Centre in Kalk Bay.

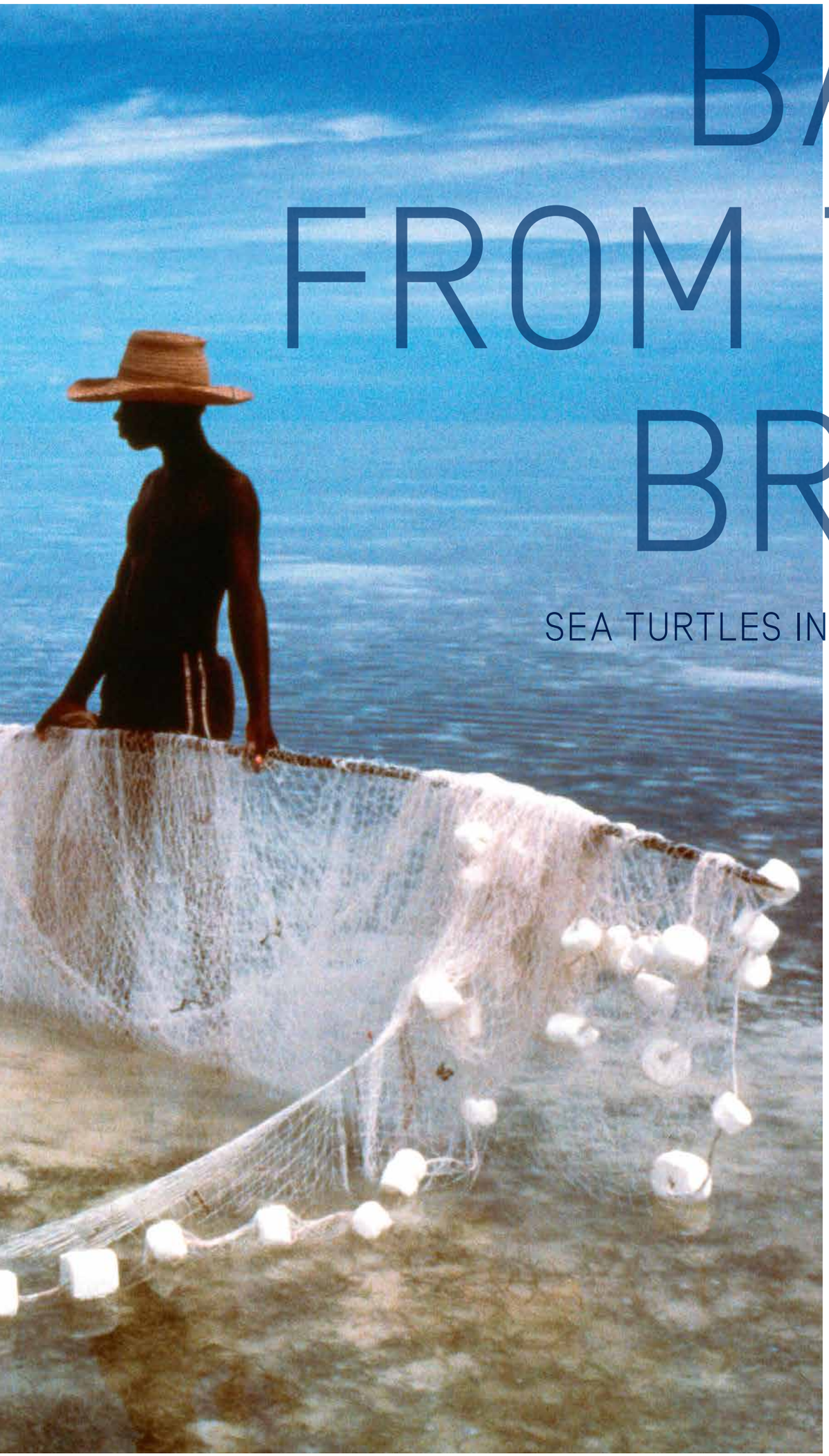
The opportunity provided by a place like this, with its unique location, dedicated staff and generous funding from the Save Our Seas Foundation, was one that I could not let pass, especially as it meant that I would be part of exactly what I see as the most important building block in saving the world's ocean ecosystems. So here I am, in the most beautiful location in the world.

I'm still finding my feet, but already I have seen the joy on a girl's face as she holds a sea urchin for the first time – and realises that not only does it not hurt her, but it moves and tickles, and becomes a character she can relate to. I have seen the excitement of a boy as he learns to snorkel for the first time, donning a wetsuit, weight-belt, mask and fins and beating me to the bottom of the pool to retrieve a weighted rubber goldfish. I have heard the gasp of a class of children as they watch a shark launch itself out of the water in pursuit of a seal. And I know that to be part of a team that is re-evaluating and revamping our role in environmental education, and giving children the opportunity to be educated about the sea through experiential learning, is the best place for me. After all, this is the embodiment of one of my favourite quotes of all time: Baba Dioum's 'In the end we will conserve only what we love; we will love only what we understand; and we will understand only what we have been taught.'

Photo by Claudio Velasquez Rojas/Homebrew Films

On the set of the South African television series *Shoreline*, Eleanor Yeld Hutchings shares her knowledge of Cape gannets.

Fishermen getting ready to net for small bait fish in the shallow waters inside the lagoon at Cosmoledo Atoll in 1982. They will use the small fish to help them catch the much larger snappers and groupers that are their target species.



BACK FROM THE BRINK

SEA TURTLES IN THE SEYCHELLES

Called to the Seychelles more than three decades ago to help ‘fix’ the problem of declining sea turtle populations, Dr Jeanne A. Mortimer is still there – and well satisfied with the nation’s proud conservation record.

Words and photos by Jeanne Mortimer

I had never been to the Seychelles. All I knew about the country was what I'd been told by the very few of my acquaintances who had been there and what I could glean from sparsely available books and scientific publications. I knew the primary language was a local French-based Creole and that English and French were also spoken. I was also aware that large numbers of sea turtles, both green *Chelonia mydas* and hawksbill *Eretmochelys imbricata,* were killed each year and that people were concerned that the resource was in decline. And by all accounts the country – comprising more than 125 islands strewn across an expanse of more than a million square kilometres of ocean – was very beautiful. My study area was to include as many of these islands as possible, and I was expected to offer advice on how to fix the 'turtle problem'.

I arrived on the main island, Mahé, in late January 1981, having flown from Miami via London. My job was to assess the status of the Seychelles' national sea turtle populations and make recommendations for the management of the turtle resources. Just days before leaving Florida I had obtained my doctoral degree as a student of Dr Archie Carr, a man now considered the 'father of sea turtle biology'. As an MSc and PhD student, I'd worked with nesting turtles on Ascension Island (in the mid-South Atlantic Ocean) and in Central America, and with turtle-hunting communities along the Miskito Coast of Nicaragua. So I had a lot of experience working to conserve turtles at remote sites and in developing nations.

Once in the Seychelles, I saw the need to approach the problem from several angles. I had to learn about the turtles. How many were there? What was their nesting cycle? Where were their most important habitats? Equally importantly, I had to understand how the local people related to the turtles. What value did they put on turtles, both living and dead? How many turtles were being killed? How and where were they hunted? To answer these questions I needed to go to the places where turtles were facing the greatest threats – and these places included the Outer Islands,

← ← A turtle hunter aiming a harpoon at an adult green turtle at Cosmoledo Atoll in 1982. The harpoon head, which is attached to a cord held by the hunter, will enter the turtle's carapace and dislodge from the 'baton'. The hunter will then reel in the turtle by the cord.

← Adult male green turtles being transferred from the landing craft to the cargo ship *Cinq Juin* in 1982 for the 10-day journey back to Mahé, where they will provide fresh meat for the market in Victoria. The turtles in the photo are suspended from the crane by a noose tied around a front flipper. They will be placed on their backs on coconut leaves on the ship's deck, covered with another layer of coconut leaves to protect them from the sun and sprinkled with water each day of the journey.

← ← Adult male green turtles being butchered at Farquhar Atoll in 1983. Their meat will be either salted and dried to produce the traditional delicacy called *kitouz* or consumed fresh by the workers on the atoll.

← Sooty tern eggs collected from Île aux Goëlettes at Farquhar Atoll being transported back to the workers' settlement for local consumption in 1983.

Jeanne Mortimer with giant tortoises on Aldabra Atoll in the Seychelles in 1982, soon after she arrived in the country to help assess the status of its sea turtle populations.

where few people lived and much of the important turtle nesting and foraging habitat lay.

It was at these remote islands that I spent about half my time during the course of my three-year contract. In those days, the parastatal Islands Development Company (IDC) promoted traditional economic activities, including the harvesting of copra and turtle products – the latter being of particular interest to me. The IDC used to send its cargo ship the *Cinq Juin* on three circuits of the Outer Islands at approximately two-month intervals. On each route, the vessel left Mahé loaded with supplies and sailed down the island chain, stopping at each island to unload its cargo. When it came to the end of the line it retraced its route, collecting the produce of the previous two months.

By travelling these circuits as a passenger on the *Cinq Juin*, I was able to get a good sense of the amount and nature of turtle activity at each island. The southern route was particularly important for me because the ship collected from these islands considerable amounts of salted green turtle meat (known locally as *kitouz*), tortoiseshell from hawksbill turtles and live green turtles for the Mahé market.

Each time the *Cinq Juin* stopped at an island, I was among the first to disembark. I'd walk the island's perimeter and record all signs of turtle nesting activity as well as carcasses in the bushes. By also interviewing the island manager and as many residents as possible, I was able to determine which islands hosted the highest intensity of turtle nesting. I would then arrange to return to those islands for extended visits.

The most memorable and perhaps my favourite of all these longer visits was the five months I spent on the remote Cosmoledo Atoll, a fishing-and-turtling station inhabited by about a dozen Seychellois fishermen and a handful of women. We had neither running water nor electricity, and during most of those five months an unusual lack of communication with the outside world, due to the malfunction of our radio and a disruption in the *Cinq Juin's* schedule. Our diet on Cosmoledo comprised largely fish and rice – and turtle.

In addition to the small permanent human settlement on Menai Island at the western end of the atoll, three corrugated-iron fishing huts were located 12 to 18 kilometres away on islands on the southern and eastern sides of the lagoon. This was where the men camped when they were fishing and where most of the turtle nesting took place. I spent about a quarter of my time at the far end of the lagoon, conducting daily surveys of the nesting beaches. Having my own boat and engine made me self-sufficient, but the fishermen and I often shared the same camp and I frequently went out fishing and turtle hunting with them.

After a few weeks the men confided to me that when I first arrived they were concerned that I might interfere with their turtle-hunting activities. That was not my goal, however; I was there to gather baseline data that would enable me to develop a sustainable management plan for the turtle resources of the Seychelles.

As far as I could, I tried to set aside my own preconceptions in order to learn objectively about the relationship between the turtles and the people of the islands. I was not opposed to hunting turtles for meat in principle, but I was concerned about unsustainable over-exploitation and also disturbed by any unnecessary cruelty to the animals. With regard to the latter, I was always impressed by the men who had both the skill and the sensitivity to kill a turtle quickly by cutting off its head before butchering it.

The most successful turtle hunters had been studying the natural history and behaviour of their quarry for many years – in some cases even for decades. How else would they know where to find the turtles and how to catch them? I found it easy to develop friendships with such men, given our shared interest in turtle biology.

Clearly there was much the men and women of the Outer Islands could teach me, both about the turtles of the Seychelles and about how to survive on a remote atoll. With time, as they came to know and trust me, they began to realise that I also had knowledge that was of value to them.

During many months of field work I gathered information about, among other things, the sizes of the turtle populations and the numbers of turtles being killed each year. Based on this as well as on the data I had access to in the form of decades' worth of government statistics about the history of turtle exploitation, in 1984 I was able to make certain recommendations to the Seychelles government. Primary among these were:

- to completely protect all adult female green and hawksbill turtles everywhere in the Seychelles;
- to immediately stop exporting raw hawksbill shell from the Seychelles (in accordance with the CITES agreement), with a view to eventually banning all trade in hawksbill products within the country;
- and to reduce the number of green turtles being killed on the Outer Islands by restricting (and eventually stopping) the importation of green turtle meat to Mahé.

Between 1984 and 1992 the government experimented with various approaches to sea turtle conservation, including seasonal restrictions and quotas, but found them inadequate. During the same period, the Seychelles' tourism industry was expanding. Understanding that it was in the country's economic interests to preserve the natural assets that attract tourists, the government took serious action.

In 1993, in order to end both the domestic and the export trade in hawksbill shell, a programme was initiated to compensate and retrain artisans who had made their living by crafting items from the shell. The artisans also agreed to sell their remaining stocks of raw shell to the Seychelles government, which placed the stockpile in a locked container. The government subsequently demonstrated just how serious it was about ending the trade in hawksbill shell when James Michel – then the country's vice-president and now its president – set fire to the stockpile at the Miss World event held in the Seychelles in 1998. This sent a clear message that the shell trade in the Seychelles was dead and would not be revived.

← The current president of the Seychelles, James Michel, setting fire to a stockpile of hawksbill shells in 1998 to make a serious conservation statement in full view of international media.

↓← Fishermen cleaning and salting their catch at Grand Ile, Cosmoledo, at the end of the day in 1982. Salt and fish were stored in the empty turtle carapaces on the ground.

Having considered the needs of the artisans, in 1994 the government brought in national legislation that completely banned the killing of sea turtles. The next step was to ensure that the people of the Seychelles would respect the law. To this end, I was hired to implement two new turtle conservation projects that were to operate from 1995 until 2004. The projects included public awareness campaigns that ran in schools and the national media, covering television, radio and newspapers. Field studies to monitor turtle nesting beaches, some already underway for more than two decades, were expanded to include more sites.

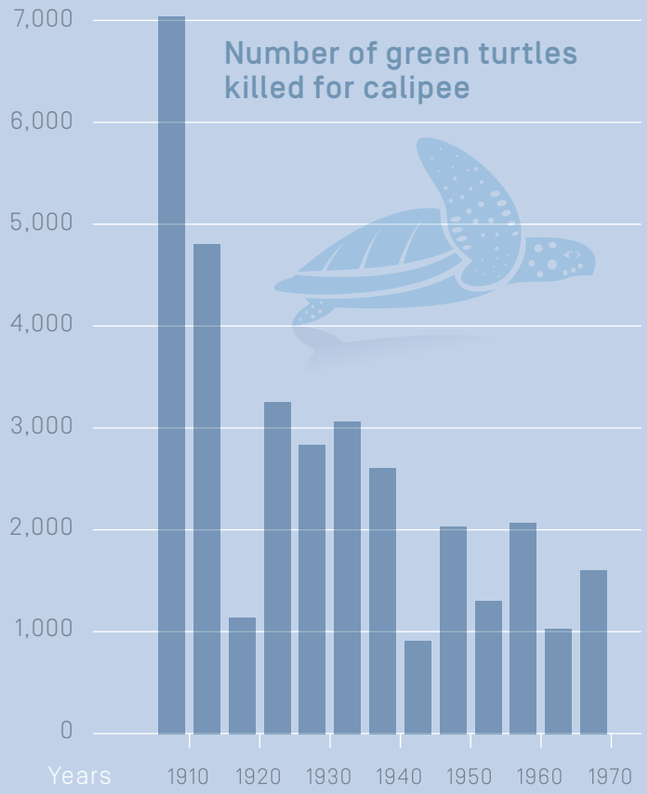
Turtle-monitoring programmes are among our most effective conservation tools as they produce multiple benefits. They gather data on turtle populations, encourage interest and awareness by involving local community members, and maintain a presence on the beach that deters poaching. Today there are almost 20 such programmes operating in the Seychelles. The oldest in the Amirantes Island Group is the community-based programme operated at D'Arros Island and St Joseph Atoll by the Save Our Seas Foundation.

Currently, turtle protection is being promoted by a combination of legislation, public awareness campaigns that involve schools and the media, and the turtle-monitoring programmes' on-site surveillance. All these measures discourage the killing of turtles, but this is only part of the problem. Equally important is the potential loss of turtle habitat, especially nesting areas. Given the rapid pace of coastal development in the Seychelles, this needs to be addressed – and the government is doing so by establishing nature reserves and actively ensuring that they function as such. The most important and effective of these sanctuaries to date are the special reserves – Aldabra Atoll, Cousin Island and Aride Island – whose ecosystem integrity is legally guaranteed in perpetuity. A number of other sites are currently being managed as nature reserves, but there is no guarantee that the integrity of their critical habitats will be maintained in the long term.

Remarkably, the Seychelles government has already declared its intention to set aside 50% of the nation's land area and up to 30% of its marine habitat for conservation, a significant portion of which would include nesting and foraging sites that are critical for turtles.

It is now more than three decades since I first set foot in the Seychelles and during that time I have seen the country become a global leader in environmental conservation. I am proud of the Seychelles and of my own small contribution to helping it achieve this success. Now is an exciting time to be a conservationist working in this pioneering country, and I am delighted to be part of this remarkable ongoing process.

The numbers of green turtles killed for calipee between 1907 and 1968. Each bar indicates the average number killed during a five-year period, except the first and last bars which depict four- and three-year periods, respectively.



The exploitation of turtles in the Seychelles

During much of its colonial history the Seychelles kept records of turtle products exported to other countries, notably calipee from green turtles and tortoiseshell from hawksbill turtles. Calipee is the dried cartilage found just inside green turtles' shells, which was exported primarily to Europe as the main ingredient in turtle soup. An adult green turtle weighing 200 kilograms would yield a mere 1.5 kilograms of calipee. The delicacy had probably been exported from the Seychelles since 1770, when French colonists first settled on the islands. So many green turtles had been killed for calipee by the early 20th century that in 1968 the government banned the export of green turtle products [see graph above]. Controversially, it also began restricting the exploitation of green turtles for local consumption, most importantly by legally protecting adult females and allowing only adult males to be harvested.

Throughout much of its colonial history, the Seychelles also exported hawksbill shell to Europe. Demand rose sharply in the 1960s when Japan began to aggressively import the shell from tropical countries around the world, including the Seychelles, and purchased as much as hunters could provide at prices significantly higher than previously paid. This trade caused the decline of hawksbill populations worldwide. It is to the credit of the Seychelles that when it became an independent nation in 1976, it not only continued to record export data for hawksbill shell, but in 1979 initiated a system whereby hunters had to report to their local police details about the hawksbills they had killed before they could obtain an export permit for the shell. Called the Declaration of Caret, this system produced good records of the numbers and sex of adult turtles killed between 1979 and 1986, especially in the Inner Islands.

SPREADING THE SHARK LOVE

A cowtail stingray in the Seychelles. Stingray coloration often reflects that of the sea floor, helping to camouflage the rays from predators.

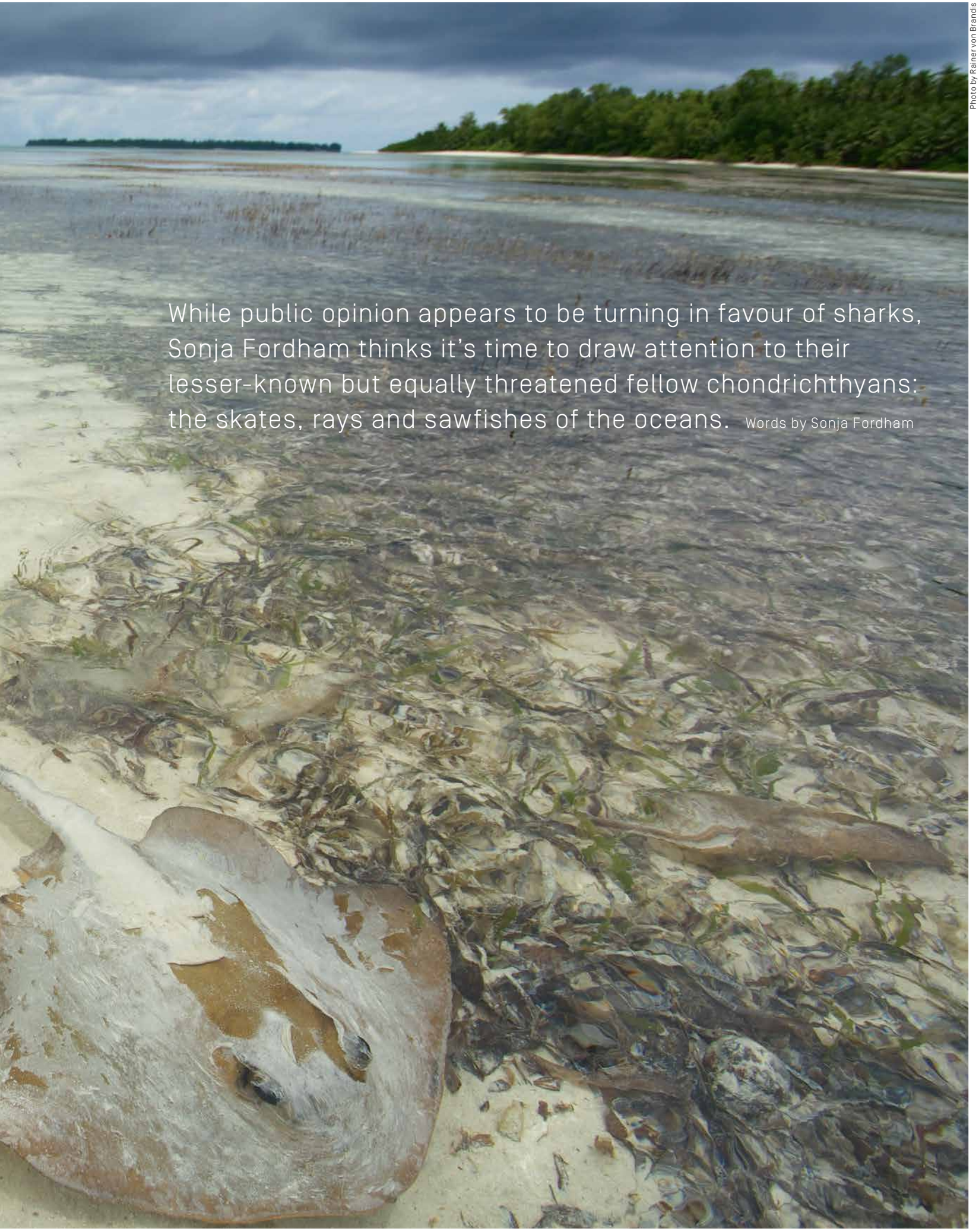
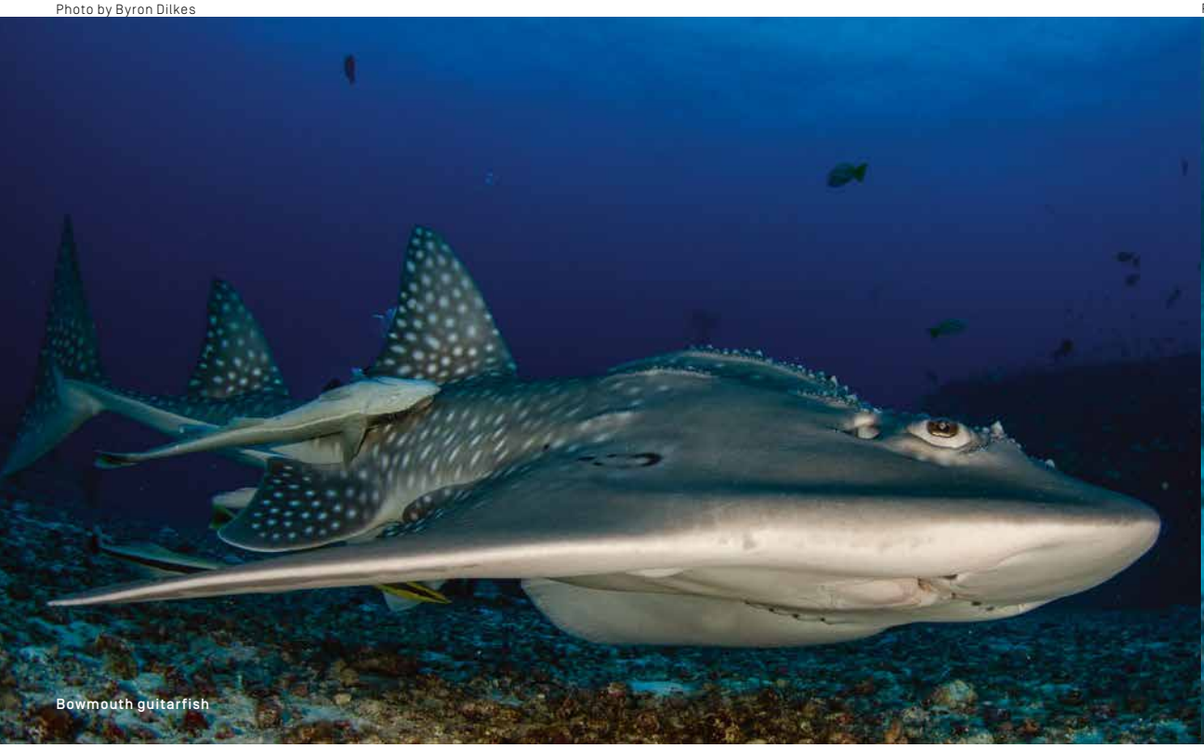


Photo by Rainer von Brandis

While public opinion appears to be turning in favour of sharks, Sonja Fordham thinks it's time to draw attention to their lesser-known but equally threatened fellow chondrichthyans: the skates, rays and sawfishes of the oceans. Words by Sonja Fordham

Photo by Byron Dilkes



Bowmouth guitarfish

Photo by Michael C. Scholl

Marbled stingray

When was the last time you saw a protest outside a French restaurant serving *raie* (ray), a letter demanding the release of a captive stingray or a petition calling for an end to the cruel practice of 'winging' skates alive?

These days, thanks largely to the advent of social media, it seems the Internet is ablaze with concern about the mistreatment and mismanagement of sharks. This enthusiasm and public support is encouraging and vital, especially considering all the damage done in the 'only good shark is a dead shark' era, but it is becoming increasingly apparent that a broader view of these exceptionally vulnerable animals is appropriate – and, in fact, urgently needed.

Lately more than ever, I find myself reminding people that – in the contexts of biology and of international policy – the term 'shark' usually encompasses all the chondrichthyan fishes (that is, fishes with skeletons made of cartilage rather than bone), which include dogfishes, chimaeras and a wide variety of rays. Within this group, the chimaeras probably get the least love and dogfishes are subject to the most negative characterisations, but let us focus for the moment on the 'flat sharks', a wonderful array of cartilaginous species that encompasses skates, devil rays, mantas, sawfishes, guitarfishes and stingrays. These species share the inherent vulnerability of 'proper' sharks but perhaps not their charisma – and the consequences of this are deeply troubling.

From a conservation perspective, it is important to stress that rays are generally more threatened and less protected than sharks. In fact, five of the seven most threatened families of cartilaginous fish are made up of rays (and that's not even including the somewhat flattened angel sharks). These findings were presented earlier this year in the global Red List of Threatened Species™ paper presented by the International Union for Conservation of Nature (IUCN) Shark Specialist Group (SSG).

Of those threatened 'flat shark' families, the sawfishes are the most imperilled: all five species are classified as Endangered or Critically Endangered by the IUCN Red List. These exceptionally vulnerable shark-like rays have disappeared, practically unnoticed, from much of their former range and are assumed extinct in 21 countries where they used to be found. Indeed, the IUCN SSG has concluded that sawfishes are the world's most endangered marine fish. As a result, they are the subject of a new, first-ever IUCN SSG Global Conservation Strategy, made possible through the generous support of entities like the Save Our Seas Foundation.

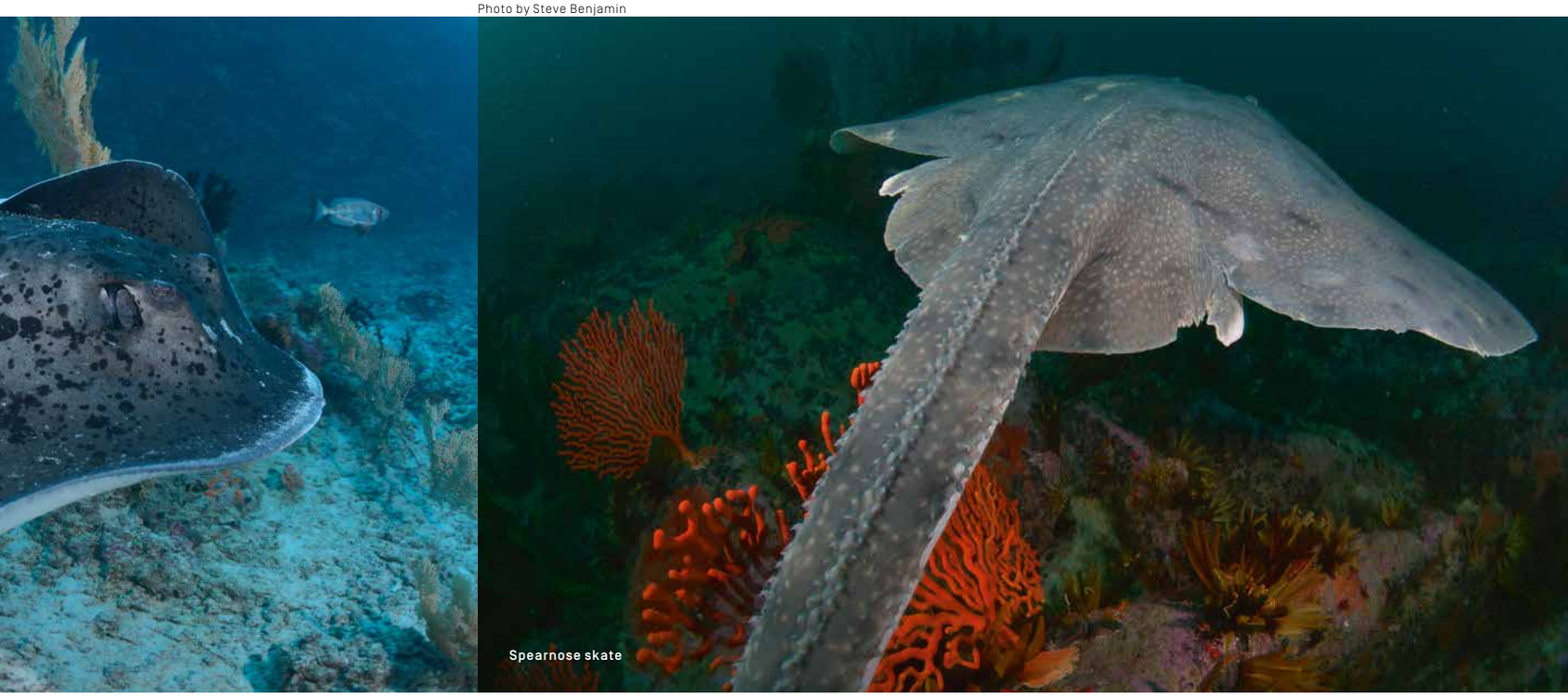
Ten years after the initial proposal, the sawfishes were eventually listed under the Convention on International Trade in Endangered Species (CITES) in 2007; it took another six years to apply the global ban on international commercial trade to all sawfish species. While these were big and essential steps, trade is not the only threat to sawfishes. There is local demand for them and they are killed incidentally in fisheries targeting other species. They are also dependent on the health of their near-shore habitats. Yet only 16 of the roughly 90 countries where sawfishes occur have enacted national protective measures for them.

The good news is that there's a new proposal to list all sawfishes under Appendices I and II of the Convention on the Conservation of Migratory Species (CMS), an intergovernmental treaty. If agreed by the participating countries in November 2014, this initiative could prompt strict protection in key range states and provide a framework for implementing the IUCN's Global Conservation Strategy on a regional basis.

Also of great concern but lacking any global strategy or international treaty recognition are the guitarfishes. Killed incidentally by fisheries, landed for meat and prized for use in shark-fin soup, more than half of the guitarfish species are categorised by the IUCN as Threatened. Nevertheless, specific national protective measures are exceptionally scarce – and most of those that do exist appear to be poorly enforced.

Even more important commercially are the skates, whose conservation status is the focus of a relatively small group of dedicated interest groups, including the UK-based Shark Trust. In both the United States and the European Union, smaller skate species tend to be faring better under heavy fishing pressure than the larger-bodied ones. At least for now, the largest and most depleted species are mostly off limits, while other skates are managed rather loosely. This is due to a lack of fine-scale information about the fisheries catches of individual species, since catches are usually aggregated across multiple species.

Photo by Steve Benjamin



Spearnose skate

In the US, landings of skates dwarf those of large sharks, yet testimony from conservation advocates about the management of the nation's biggest skate fisheries (those of New England) has been rare. This is even as managers are lifting protection for the huge, famed barndoor skate, once thought to be heading towards extinction. Imagine the public outrage if a large portion of the US fishing quota for hammerhead or tiger sharks were allocated for bait in lobster fisheries. Yet this is the fate of most of the little skates caught in the US.

Of the skates landed in the US for human consumption, most are exported to Europe and Asia. Efforts are, however, being made to promote local demand for these and other 'trash fish', at the same time that opposition to the consumption of large sharks (fins and meat) appears to be gaining ground. The number of skates fished in the waters between Europe and North America is subject to a rare international fishing quota system that is administered by the Northwest Atlantic Fisheries Organization. Yet since its inception a decade ago, the overall catch limit has been set far in excess of scientific advice. During that time, similar regional bodies governing international tuna fisheries in other parts of the world have granted a number of large sharks fully prohibited status.

US fishing interests, particularly in the mid-Atlantic region, have made quite an effort to develop markets, both domestic and foreign, for cownose rays, which are taken mostly as by-catch in coastal fisheries. Not many elasmobranchs produce fewer young than this species; a female usually gives birth to just one pup per year. Yet, around 2007, various conservation-minded publications promoted cownose rays as seafood after a well-publicised (yet disputed) scientific paper claimed that cownose ray numbers had increased dramatically due to the depletion of large sharks and that the rays in turn were reducing the numbers of popular shellfish.

The fishing industry capitalised on the media attention, changed the cownose ray's name to the more palatable 'Chesapeake ray' and worked to convince people that eating the species would be good for them and the environment. Fishery managers in Virginia – the core of cownose ray promotion – have yet to seriously entertain requests from noted scientists for precautionary catch limits or to request technical advice for management. There are also no cownose ray limits in nearby Maryland, a state that has banned all possession and sale of the fins of large sharks.

On a brighter note, in the past few years the Save Our Seas Foundation has been instrumental in elevating public concern for the plight of manta rays (see page 116). Arguably the most elegant and captivating of the rays, mantas have acquired relatively quickly a status comparable to that of many large, charismatic sharks, as well as a recent CITES listing. Just as importantly, mantas make excellent ambassadors for their kind and may open the door to a deeper appreciation of and better protection for other rays, from wedgefishes to pelagic stingrays.

The first case in point is devil rays. Although they have so far failed to attract the support needed for a CITES proposal, devil rays are slowly making their way to centre stage in the international policy arena, primarily because they face risks similar to those highlighted for closely related mantas: strong Chinese demand for gill plates, unregulated by-catch mortality and low reproductive rates. A proposal to list mantas and devil rays under CMS is being considered and, thanks to the Save Our Seas Foundation's support, the IUCN SSG has recently embarked on the development of a global conservation strategy for these species. Even fisheries managers are starting to take notice, at least in the eastern Pacific, where scientists have recommended specific techniques for maximising the survival of manta and devil rays taken as by-catch in the region's tuna purse-seine fisheries.

The adoption, refinement, expansion and proper implementation of the above-mentioned remedies would amount to significant steps in 'flat shark' conservation. But there is, of course, much more work to be done. As with sharks, there are hundreds of species of rays with varying life-history characteristics, habitats and threats. And also as with sharks, some faster-growing ray species should be able to support sustainable fisheries if strict, science-based limits are imposed. Other rays, however, simply can't handle much fishing pressure at all. As we've seen with sharks, public concern and support can accelerate policy progress. Indeed, such backing is essential if the strong safeguards that are warranted for these inherently vulnerable yet underappreciated species are to be secured.

Most threatened families

1. Sawfishes (Pristidae)

2. Angel sharks (Squatinidae)

3. Wedgefishes (Rhynchobatidae)

4. Sleeper Rays (Narkidae)

5. Whiptail stingrays (Dasyatidae)

6. Guitarfish (Rhinobatidae)

7. Thresher sharks (Alopidae)

Photo by Byron Dilkes

How you can help to spread the love

Although rays clearly do not enjoy the level of public fascination and concern afforded increasingly to big sharks, there has been progress on this front. Here are a few suggestions for how you can help the 'flat sharks':

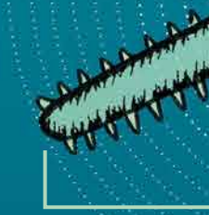
- If you live in a country that is a member of the Convention on Migratory Species (CMS), urge officials of your environment ministry to support proposals to list sawfishes and manta and devil rays under the CMS appendices.
- Report any sighting of a sawfish – alive in the water or dead at a market – to the online International Sawfish Encounter Database.
- If you live in a warm-water coastal country, ask officials of your fishery ministry to establish measures for collecting data and safely releasing manta and devil rays caught in tuna fisheries.
- If you live in a cool-water coastal country, ask officials of your fishery ministry to work for science-based, international fishing limits for shared populations of skates.
- Spread the word and follow the conversation on social media via *#RaysNeedLove2*.
- Contact your government representatives as regularly as possible to express your support for precautionary local catch limits for skates and rays, protection for endangered species, conservation of critical habitats and research into population status.

Five of the seven most threatened families of cartilaginous fish are made up of rays. This cowtail stingray is a member of the whiptail stingray family.

SAWFISHES

The world's most endangered marine fish

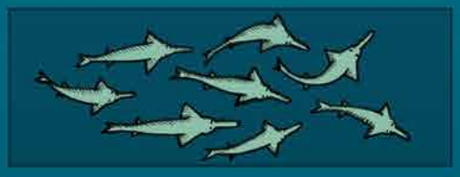
Sawfishes are a small group of shark-like rays that were once common in shallow coastal warm-water areas. Named for their long, toothed snouts, called rostra, sawfishes use their saws to detect the small electrical signals of their prey and to swipe at their target before eating it – so they can knock down fish from the water column! Unfortunately for sawfish, their most remarkable adaptation has also been their downfall, and they are now the world's most endangered marine fish.



What makes them vulnerable?

Easily entangled
The toothed snouts of sawfishes get caught easily in fishing gear.

Slow reproduction
Sawfishes mature late in life and have relatively small numbers of young.

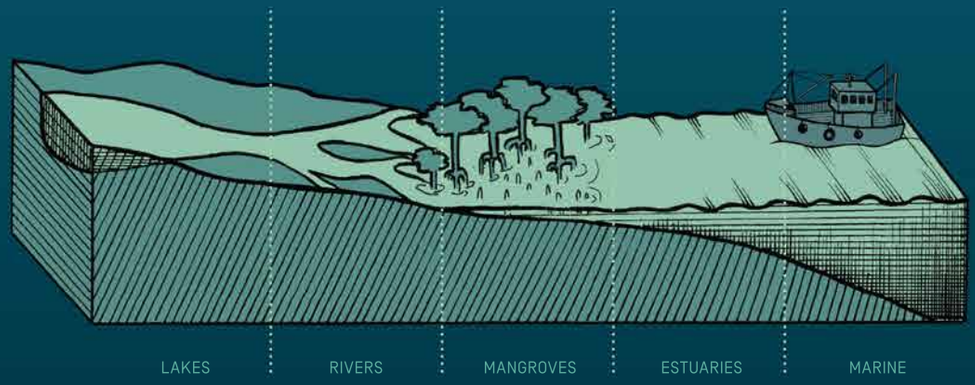


Valuable
When they are caught, sawfishes are kept for their rostrum as well as for their meat, skin and eggs.

Habitat loss
Sawfishes live in coastal and riverine habitats, which are disappearing due to growing human populations and development.

Where do they live?

Sawfishes live in rivers, lakes, estuaries and shallow marine areas, including mangroves. They are able to tolerate a wide range of salinities.



the total number of sawfish species **5**

- Narrow sawfish
- Dwarf sawfish
- Smalltooth sawfish
- Largetooth sawfish
- Green sawfish

20-28%

of the body consists of the rostrum

7

metres tip to tail

is their maximum length

Where are they found?

HISTORICAL

CURRENT

90 the number of countries where sawfishes were **present in the past**

43 the number of countries that have **lost at least one species** of sawfish

20 the number of countries where sawfishes are **now entirely absent**

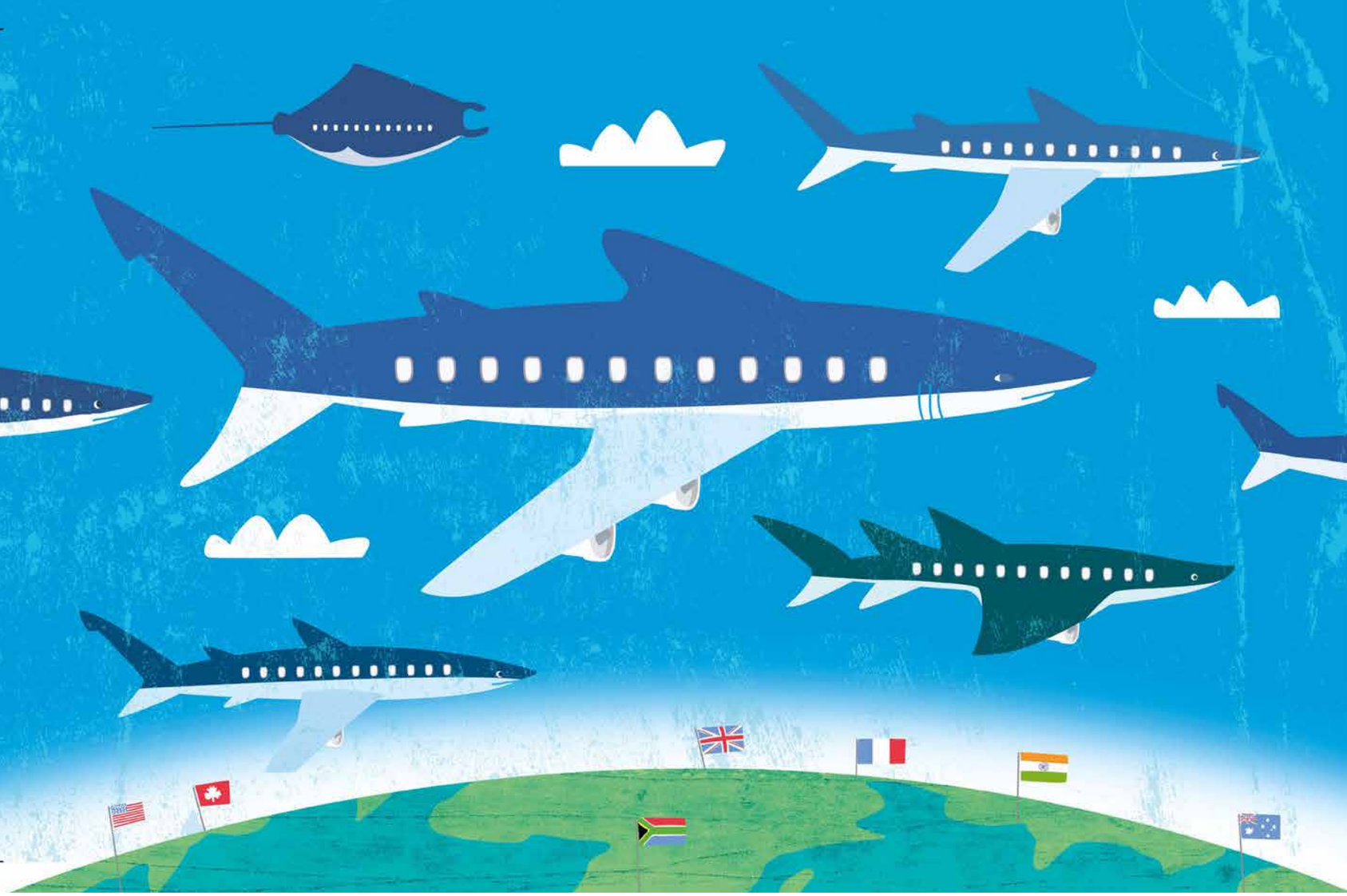
81 the percentage of their current distribution that has **sawfish-specific protection measures**

What can be done to save them

1. International conservation agreements
2. Legal protection in key range states
3. Community engagement and outreach
4. Enforcement, enforcement, enforcement
5. Fundraising

This information is taken from the IUCN Shark Specialist Group (SSG) Sawfish Conservation Strategy developed as the result of a 2012 SSG workshop funded by the SOSF; Dulvy et al. in press. Ghosts of the coast: Global extinction risk and conservation of sawfishes. Aquatic Conservation: Marine and Freshwater Ecosystems.

Illustration by Jessica Warner



Walking along the corridors during coffee breaks at Sharks International in Durban, June 2014, took me back in time. I don't mean just a few years to the first Sharks International conference in Cairns, Australia, in 2010, but all the way back to 1992 and 'Sharks Down Under' in Sydney. That was my first international shark conference. It was a huge eye-opener to a marine ecologist from the United Kingdom, where the subject of shark conservation was rarely mentioned and very few people even knew that there were sharks in British waters.

Although 22 years have passed since then, there were some striking similarities between the two meetings. In Sydney there was a whole symposium on shark-control programmes for bathing beaches (it reached the conclusion that once such programmes are introduced, local politics make it impossible to halt them – so don't start!). Early results of shark-tagging programmes were presented (using conventional visual tags, naturally) and there were talks warning of the vulnerability of shark species to overfishing, persecution and the threat posed by the steeply rising demand for fins in East Asia during the late 1980s. Most importantly, the delegates of almost a generation ago shared with those of today a contagious fascination and enthusiasm for, and dedication to, these animals.

In other respects, however, a great deal has changed in two decades (and I am not just referring to the grey hairs of the 'Sharks Down Under' delegates who attended the Durban and many other intervening meetings). Our knowledge of the biology, ecology, species and populations of sharks has undergone a step change during the intervening decades. So too has our awareness that their flatter cousins (skates, rays, guitarfishes and sawfishes) are just as important and many of them are even more seriously threatened.

Technology, too, has advanced at an astonishing rate. Some of the presentations during Sharks International left me open-mouthed in amazement at the huge strides in knowledge made possible by new technology, from acoustic and satellite tags to genetic analyses and novel methods for studying age and growth. No less remarkable is the ease with which such data can now be accessed. Are the stinky undergraduate dogfish dissections that I remember so well obsolete, now that the anatomical imagery presented by Gavin Naylor from the Chondrichthyes Tree of Life is available to all?

I suspect that the audience in Sydney more than two decades ago would have considered some of this year's papers to be highly elaborate practical jokes; science fiction carried to new heights of imagination. How could such tiny tags possibly record, archive and transmit such a huge range of movement and environmental data for such a long time? The first satellite tag used on basking sharks looked like a small lifeboat compared with today's salt cellar-sized instruments! Even these techniques pale in comparison with the power of stable isotope analysis of tiny tissue samples to tell us so much about a shark's lifetime of diet, habitat use and migrations.

And yet, there we were this year, absorbing new techniques, new ideas, new results – but still only scratching the surface of the scientific knowledge necessary if we are to rise to the challenge of securing the future conservation and management of shark and ray populations.

Words by Sarah Fowler | Illustrations by Patrick Latimer

A REFLECTION ON SHARKS INTERNATIONAL

In this age of digital communication, do conferences still play an important role in research and conservation? SOSF principal scientist Sarah Fowler thinks so, and she explains why.

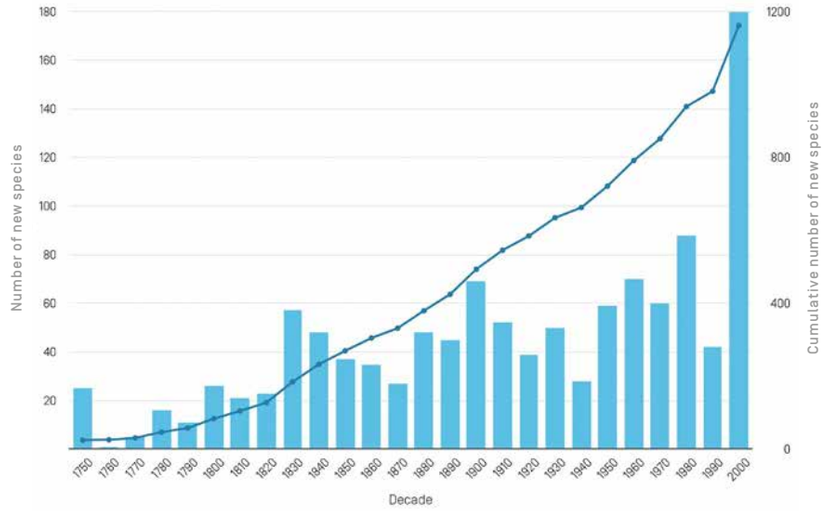
As a marine conservationist, I am sometimes challenged to explain how I can justify the air miles and fossil fuels consumed to bring scientists together at these conferences, when new technologies mean that face-to-face meetings are no longer necessary. Surely we could as easily gain this new knowledge by logging on to watch presentations online from our homes or workplaces at an hour convenient to our time zone? Or we could 'meet' just as effectively, and perhaps even more efficiently, in virtual chat rooms or video conferences?

Looking back over the past 20 years, can we estimate the extent to which advances in shark research and conservation have, at least in part, been generated by the collaboration and direct exchange of ideas between delegates at these meetings? That's a tough question to answer. After all, conferences only take place because many scientists have already generated interesting new research results for presentation, the essential prerequisite for such meetings. Furthermore, other scientific meetings dedicated to chondrichthyan research take place more frequently, including those of the American, Japanese, European, Brazilian and Oceania societies or associations, and they too stimulate the development and publication of research within those regions. Nevertheless, I am convinced that the exponential rise in the number of scientific papers published annually since the early 1990s is due at least in part not only to the opportunities for collaboration that these major international meetings provide, but also to the contribution they make to building research capacity and encouraging engagement in conservation activity.

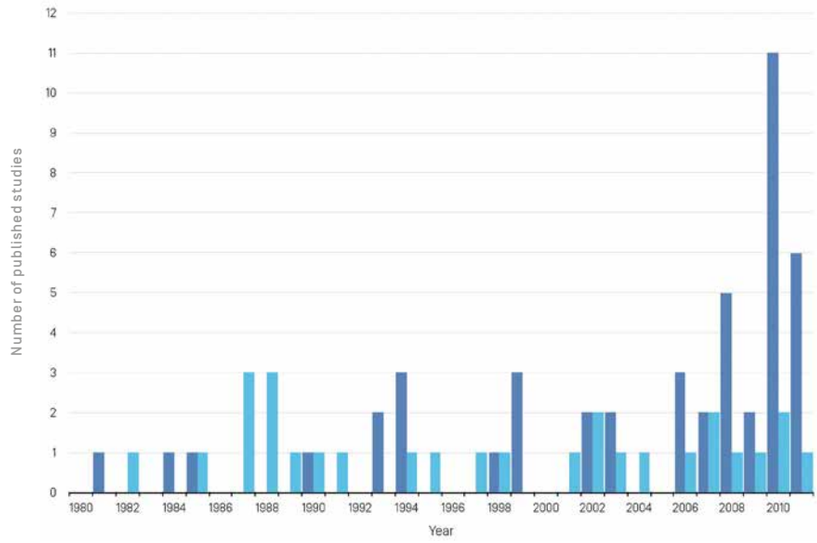
The rise in numbers of 'new' shark and ray species described by scientists since that first major meeting back in 1992 is also interesting. A quick look at the first graph overleaf shows how the relatively constant rate of species discoveries from 1758 makes a noticeable jump in the 2000s. This is primarily the result of major research efforts by Australian shark taxonomists describing a large number of recently discovered Australian endemics and subsequently other new species from the Indo-Pacific region. Some of these species descriptions are wholly 'home-grown' within the Australian research community and owe very little to international collaboration. Others, however, can be attributed to the joint initiatives of shark biologists from several countries, possibly inspired by the seeds of ideas planted during international meetings when scientists first met, face to face.

Another way to assess the direct contribution of such meetings to shark conservation and research is to consider particular taxonomic groups, such as those that have been the focus of research funded by the Save Our Seas Foundation (SOSF). In 2012, the SOSF funded an IUCN Shark Specialist Group project to develop a conservation plan for the largely forgotten and Critically Endangered sawfishes. It kicked off with a planning workshop at the Zoological Society of London that was attended by scientists from all over the world, many of whom had never met before. The same impact and degree of collaboration could never have been obtained without a face-to-face meeting. In a few years from now, when we review scientific papers about the sawfishes, I am sure that we will clearly see the results of this first sawfish meeting. They will be measurable not only in the form of increased research attention and output, but also in the methods employed

The number of currently recognised shark and ray species described in each decade since 1785 [■] and the cumulative number of species [—●—].
Source: White W.T. and Last P.R. 2012. A review of the taxonomy of chondrichthyan fishes: a modern perspective. *Journal of Fish Biology* 80: 901–917.



Recent publications on manta [■] and mobula [■] rays.
Source: Couturier et al. 2012. Biology, ecology and conservation of the *Mobulidae*. *Journal of Fish Biology* 80: 1075–1119.



to protect important species, such as including them in regional and international agreements and adding them to national protected species lists.

As another example, since its inception the SOSF has supported several long-term studies on manta rays and recently broadened its scope to include their smaller and poorly known relatives, the devil rays. Also known as mobulid rays, they are probably just as threatened as mantas – and just as interesting. A comparison of the numbers of papers published on manta rays and devil rays (see the second graph above) shows a large increase in manta ray publications in recent years, whereas the more numerous species of devil rays have so far received scant attention. An SOSF call for proposals for devil ray projects has now stimulated new research into these animals in a number of regions, ranging from the eastern Mediterranean to Pakistan, the Philippines and Peru, and at the same time has provided, at a global level, the identification tools needed for these studies.

Most recently, immediately after the Sharks International conference, the SOSF funded an IUCN Shark Specialist Group conservation planning workshop for manta and devil rays, similar to that convened a few years ago for sawfishes. Devil ray researchers who had never met before spent several days discussing and agreeing on conservation and management objectives, goals and actions for their species. I confidently predict that in a few years from now a review of the publications for manta and devil rays will show a significant increase in the number of research papers. And, as happened with sawfishes, there will be an increase in conservation and management initiatives aimed at improving the status of these poorly known animals.

Of course, virtual meetings can be very useful in many circumstances (particularly for those of us who already travel far too much and have grown to dread the journey to the airport), but they are not the same. I very much doubt whether the above success stories would have been possible if many key individuals had not been able to meet face to face.

Nothing is as effective and productive as getting away from our offices and laboratories every few years to meet old and new colleagues and exchange scientific findings and novel ideas, not just in presentation and poster sessions, but informally in coffee breaks, dining rooms, restaurants and bars. It is, literally, in the corridors and over coffee cups that researchers have the invaluable opportunity to swap, compare and generate new theories and ideas, discuss potential future collaborations and make or renew personal and professional friendships that will yield scientific dividends for years to come. It's also where students discover new mentors and realise that it's possible to meet and talk to their role models (and discover that they are ordinary people, just like them), thus setting them off on careers that will change their lives.

We are social animals and we need to meet socially every now and then if we are to create and reinforce the scientific communities that produce the amazing new results presented at Sharks International and other such gatherings. I believe that advances in research, conservation and management depend ultimately on individuals: getting to know one another and discovering common goals, then working together to achieve them. It is hugely gratifying to know that the SOSF, through its sponsorship of conferences and workshops, provides so many shark scientists with the opportunities to do just this.


CONFERENCE
CONFERENCE

Photos by Matthew Pottenski

INSIDE STORIES

In for the long

The longest tagging study of a single species – conducted by the Bimini Biological Field Station team and led by Dr Samuel Gruber – has produced invaluable information about the biology of the lemon shark.

In January 2014, a team of scientists working with lemon sharks at the Bimini Biological Field Station published a pioneering paper that represents the culmination of my research on the lemon shark extending back half a century to 1961. As a young graduate at the University of Miami, I was trained in the discipline of animal behaviour, known technically as ethology. My speciality was learning, psychophysics and sensory biology, with an emphasis on the vision of sharks. As such, the first 15 years of my research were spent primarily in the laboratory. Then in 1976 came an epiphany: I hadn't signed on to spend 12 hours a day in a dark laboratory looking at the golden eye of a lemon shark. I was hankering for the reefs and sea-grass flats where these amazing creatures live.

Miraculously, I snagged a career-development grant from the US National Science Foundation and for the next decade I was privileged to combine laboratory and field research, looking at the behaviour and ecology of my favourite subject, the lemon shark. Between 1979 and 1989, we went to sea on oceanographic research vessels four times a year. The maiden cruise took us around the Bahamas in search of an appropriate site, one that teemed with lemon sharks.

My first trip to Bimini had been in 1959, when the Bahamas was still a British Crown Colony (independence was granted in 1972), and by the 1980s I knew the islands quite well. We surveyed them for lemon sharks and, much to my elation, Bimini turned out to be the best place to set up our research site. There were many reasons for its suitability, including its pristine waters, proximity to Florida and the excellent, untouched colony of lemon sharks inhabiting the lagoon.

But my elation was short-lived. In 1988 the cancer I had been fighting for a decade became critical and the doctors told me my time was over. Not being one to accept authority, I set to work with a friend and we searched the literature for experimental cancer trials. To cut a long story short, we found a promising phase-1 research project and I was able to receive the drug Fludarabine on a compassionate-treatment basis. Clearly it worked well, and here I am writing this article a full 26 years later.

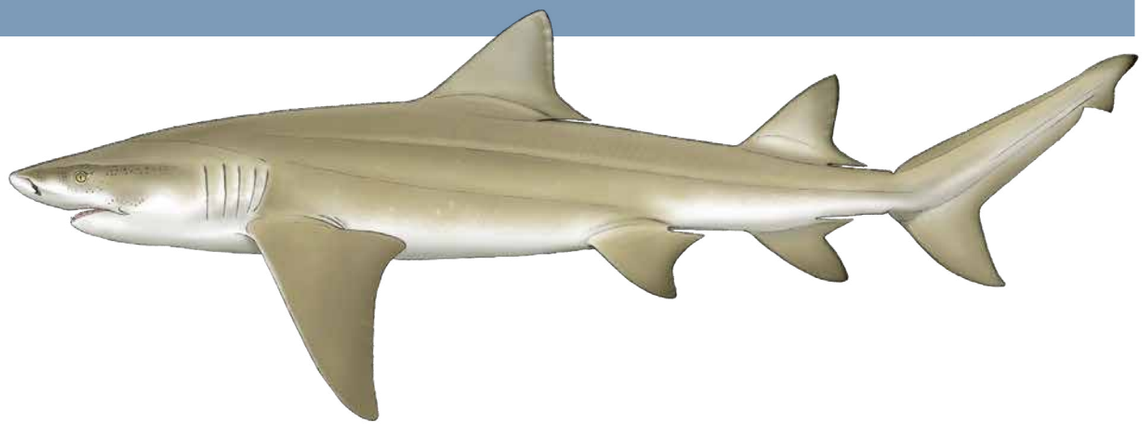
I mention all this because when I recovered with a new lease on life I realised that I now had a future with options, as well as the time and experience to pursue them. Notwithstanding the university politics that had to be overcome, I was determined to establish a research station on Bimini to study my beloved lemon sharks. I was also firmly committed to creating a place where students with a passion for sharks could come and study these creatures, learning the field techniques that we had developed over the past decade. So my wife Mari and I mortgaged our house, brought a bunch of beds, pots, pans and appliances to Bimini and opened the doors of the Bimini Biological Field Station in March 1990. The saying 'Fools rush in where angels fear to tread' applies 150% in this case. But I digress.

As soon as the research station was up and running, I decided to launch a twice-yearly shark census at Bimini in an effort to tag every lemon shark in the lagoon. It's a challenge to determine population dynamics and abundance, and one that I had been wrestling with for 17 years. First there was the tricky choice of which tag-and-release model to employ: the classical Peterson method, the Jolly-Seber method, the triple-catch technique or what? Then we had to decide which tag to use and whether it might affect the sharks' growth or mortality. For instance, we found that the standard dart tag of the National Oceanic and Atmospheric Administration (NOAA) killed at least 10% of young sharks and seriously affected the growth of others. Using it means that a lot of the data it delivers is useless – as I found out to my frustration because I chose the wrong tag when we began our research in 1979. Back then, a control study by my student Alan Henningsen showed that most kinds of tags fell out at rates approaching 90%. The exception was the NOAA dart tag, so naturally that's the one we chose. However, if you expect almost all your marked sharks to survive but your tags injure them, you can guess what that means for your statistical analyses.

After years of searching, in 1988 we stumbled upon a tag with a very low shed rate and no deleterious effects on the little sharks. Called a passive integrated transponder (PIT) tag, this glass-encapsulated electronic tag is the size of a rice grain and needs no power source. When the body of a shark is scanned with a small hand-held reader, microwaves excite the previously implanted PIT tag and it spits out its number like a barcode scanner in a supermarket. We inject these tiny tags under the skin at the base of the shark's dorsal fin and it usually stays there for life.

So after years of study, we thought we were ready for our new research project at Bimini. Because of the species of choice (the lemon shark) and the unique ecological conditions (more like a lake than an open, infinite marine environment), we reckoned that we were ready to carry out a unique series of comprehensive and detailed studies on population dynamics. Our goal was to yield life-history parameters, such as growth, survival and habitat selection. But assumptions had to be made. For example, we assumed

haul



Words by Samuel 'Doc' Gruber

that Bimini's population of lemon sharks did not immigrate or emigrate out of the shark nursery for three years, and that there was no fishing mortality either – only natural mortality.

Against this background, we set up a big pen and fished large sections of the nursery at a time. We knew from John Morrissey's comprehensive tracking study of 1988 that young lemon sharks have a restricted activity space, so at sundown we set 180-metre-long gill nets at three places in the shallow nursery and walked their length every 15 minutes during the 12-hour summer night. When we came upon an entangled shark, we removed it and rushed it by boat to the big pen, where the tagging crew weighed, measured, sexed and tagged each shark as it came in. By this extraordinary effort we were able to tag about 90 juvenile lemon sharks that first season. The plan was to return six months later and do it all over again so that we could keep tabs on our little sharks. They say the best-laid plans often go astray and this is exactly what happened. The next November we were only able to catch two sharks, which of course put a stop to our project.

It took another five years to consider starting up again. By this time, our capabilities and goals were much better focused and we organised a campaign that is still going today, two decades later. This has become the longest-ever tagging study of a single species and the centrepiece of our research at Bimini. Based on the success of this campaign, we advanced our goals to follow all the lemon sharks born at Bimini from birth to adulthood and beyond. Only this time we applied the innovative techniques of genetics research to the sharks. Our interest was to understand many of the life-history traits of lemon sharks using breeding biology as the focus of the project.

Fast forward to 2014. After tagging more than 3,500 lemon sharks over the past 20-year period and producing a genetic catalogue for each and every one, we created a pedigree of all the families of lemon sharks using Bimini's lagoon. It is important to note that by using molecular techniques we were able to identify the parents of each baby shark by examining the maternal and paternal contributions to its genome. Thus, we never saw most of the parents nor did we need to. In addition, the method we used, called microsatellite analysis, meant that we were able to genetically fingerprint each shark so that if we ever caught that individual again, we could identify it definitively without any other tags or marks. So it was that we had Bimini's entire lemon shark population under scrutiny for two decades. I will not go into the myriad of new findings, publications, graduate dissertations and theses that we gleaned from this study. Suffice to say that the advances in our knowledge of lemon shark biology were significant and will be the subject of numerous future articles.

Finally, to return to our recent landmark paper, many shark biologists in the past believed that many shark species, like salmon, return to their birthplace to reproduce. These biologists used statistics and calculations to suggest that this reproductive behaviour, known as philopatry or natal homing, was a fact. However, no one had actually observed natal homing. Given that it takes 12 to 15 years for a lemon shark to reach reproductive maturity, who would wait that long to find out? The answer: the shark fanatics of Bimini Biological Field Station! After waiting the dozen years, with great anticipation, we genetically examined a cohort of sharks born in 2010 to see if any of their parents had been born in 1995 and had returned to Bimini to give birth. We were thrilled to find that several sharks had indeed remembered their birthplace and come back to give birth.

But that was not enough. The editors of the journal we submitted our paper to wanted proof and required that we actually catch a mother lemon shark and directly identify her as having been born in Bimini. To cut to the chase, we did it! We've developed techniques to find and catch by hand (no hooks or harpoons) adult lemon sharks entering the lagoon (that's another story for the future). These allowed us to successfully read a PIT tag that had been placed under the skin of one mother shark so many years ago.

We have learned many lessons from this long-term study. One of the most important is that it is very easy to drive a local population to extinction. This can be done either by destroying the population's nursery habitat or by killing off the breeding stock of mothers that return to the nursery where they are born to give birth. Understanding these local populations and where their most important habitats lie is imperative to conservation and management plans, particularly spatial protection measures such as marine protected areas, for these apex predators.

Feldheim K.A., Gruber S.H., DiBattista J.D., Babcock E.A., Kessel S.T., Hendry A.P., Pikitch E.K., Ashley M.V. and Chapman D.D. 2014. Two decades of genetic profiling yields first evidence of natal philopatry and long-term fidelity to parturition sites in sharks. *Molecular Ecology* 23: 110–117.

Conserving devils

Words by Isabel Ender

We had four days in Durban, South Africa. A room full of experts and one goal: to draft a global strategy for the conservation of manta and devil rays. What a challenge, yet what an amazing opportunity too!

In June 2014, the IUCN Shark Specialist Group and the Manta Trust, supported by the Save Our Seas Foundation, brought together 20 experts on devil and manta rays to create the basis for a global conservation plan of action. Their workshop followed the Sharks International Conference held in Durban the week before, which made it easier to call in the experts from the field and assemble them at one venue. Insights from projects around the world, ranging from community work in Peru to tagging research in New Zealand, were used to define a vision and three strategic goals. These goals are to ensure

- Sustainability. Devil and manta ray populations are to be maintained at, or recovered to, ecologically sound levels by managing fisheries, trade and demand.
- Knowledge. The knowledge required to appreciate devil and manta rays and sustain their populations is to be created, communicated and applied.
- Appreciation. Educated and engaged communities support, and benefit from, the conservation and management of devil and manta rays.

At the Manta Trust we have made it our mission to strongly support this strategy, making use of our network of projects to achieve the required results. Our work in more than 16 different countries across the globe focuses on advancing the worldwide conservation of manta and devil rays and their habitat by means of robust science and research, raising awareness and providing education, influence and action. As the head of conservation strategy, I have the responsibility to coordinate these activities as well as oversee the Manta Trust's own strategic plan for the coming years – a very exciting job indeed!

1 **So what's been happening in the field already? The Global Mobulid ID Project** – now well under way – directly supports the first goal of the strategy: to address the challenge of managing fisheries, trade and the demand for devil and manta rays. This project, led by the Manta Trust's associate director Daniel Fernando and funded by the Save Our Seas Foundation, aims to create a comprehensive taxonomic, morphological and genetic identification guide for all manta and devil ray species (which together are known as mobulids).

Information about the biology and ecology of mobulids is limited, but the rapid increase in fishing pressure due to the global trade for their dried gill plates – which manta and devil rays use for feeding – makes it imperative that we learn more about them if we are to protect them. A first crucial step to gaining knowledge about mobulids is to identify individual species – and this is remarkably difficult. That's where the ID guide will come in. During 2013, all manta ray species were listed on Appendix II of the Convention on International Trade in Endangered Species (CITES). In the approach to the deadline for implementing this CITES listing, and during the months following, the ID guide will be particularly important for managing and monitoring trade in manta products. In future years the guide will also be useful in supporting the listing of additional devil ray species on international treaties, such as CITES and the Convention on the Conservation of Migratory Species of Wild Animals.

2 **A closer look at our operations in India shows project leader Mohanraj working hard to address the second goal:** to generate the knowledge required to sustain and appreciate devil and manta rays. India, the world's seventh-largest country by geographical area and the second-most populous country, has a coastline that measures more than 7,500 kilometres and includes the island chains of Andaman, Nicobar and Lakshadweep, where both manta and devil rays occur.

The mantas of India are severely threatened by local fisheries and receive no local or national protection as yet, so every day for the past two years Mohanraj has been collecting information about the landings of manta and devil rays. Representing one of the most detailed databases on the local fishery of manta and devil rays, his work not only demonstrates the severity of the threat, but also provides insight on trends and seasonal peaks in landings, which is important information for ensuring that conservation management measures in this region are effective.

3 **The Indonesian Manta Project, which is led by Sarah Lewis and focuses on collaborating with local people, supports the third strategic goal:** to see that communities educated about mantas and engaged in protecting them also benefit from their conservation. The project aims to merge the biological and social sciences, contributing not only to the ecological aspects of manta conservation, but also to the understanding of the social factors that drive manta fisheries.

In partnership with a number of NGOs and the Indonesian government, Sarah has begun working in Lamakera, one of

Photos by Shawn Heinrichs

Photos by Daniel Fernando

Photos by Guy Stevens

Indonesia's largest manta fishing communities. In addition to arranging meetings and discussions with local people, she set up a film-screening event that has been created, organised and executed by world-renowned conservation filmmakers Shawn Heinrichs and John Weller. The aim was to use art and storytelling to inspire local communities to be proud of their natural resources and conserve them. A huge outdoor cinema and a seven-metre inflatable manta, together with a small media team, were brought to Lamakera for the occasion, making it an exciting spectacle for the community.

The overall response was very positive, but there are still many concerns as manta fishing is one of the community's primary sources of income, as well as a large part of its culture. The project will continue to work very closely and respectfully with this and other communities over the coming months. Social science surveys will be used to carefully examine the communities' situation, their views will be taken into account and options for alternative livelihoods and the non-destructive use of mantas, such as well-managed ecotourism activities, will be explored.

Photos by Thomas P. Peschak (2)

Words by Christopher Boyes

↑ Giant tortoises are important agents of seed dispersal for many species of indigenous plants.

→ The canopy of indigenous broad-leaf trees is prime nesting habitat for fairy terns.

If you had arrived on the small island of D'Arros in the Seychelles two centuries ago, you would have landed on bright white beaches fringed with coconut palms and casuarina trees. In the interior you would have found patches of broad-leaf forest interspersed with scrub vegetation. Extensive deposits of ancient guano would have indicated that the island supported very large populations of nesting and roosting seabirds. It was also home to healthy numbers of giant tortoises, land crabs and indigenous birds.

Fast-forward 200 years and, in September 2004, the D'Arros Research Centre (DRC) was established on D'Arros Island and St Joseph Atoll. In August 2012, having come under the management of the Save Our Seas Foundation, the centre was renamed the Save Our Seas Foundation D'Arros Research Centre (SOSF–DRC).

All endeavours at the centre are in line with its mission statement, which is 'To preserve and showcase the ecological integrity of D'Arros Island and St Joseph Atoll through research, monitoring, restoration and education'.

In its time the DRC has implemented no fewer than 36 research projects, which have focused on endangered marine species such as sharks, manta rays and turtles, as well as their habitats. Long-term programmes have been put in place to monitor nesting turtle numbers, coral reef health and climate change. Recently, under the expert guidance of the SOSF, the DRC has conceived additional targeted research projects and initiated an exciting environmental education programme.

But it's not just about the ocean and its inhabitants. The marine and terrestrial environments are closely connected and the SOSF–DRC views them as equally important components of the D'Arros Island and St Joseph Atoll ecological unit. Native tree forests provide a home for abundant seabird populations, which contribute valuable nutrients to the terrestrial environment. These nutrients eventually run off into the ocean, where they stimulate plankton growth and provide food for animals higher up the marine food chain, such as manta rays.

During the past two centuries, however, all the natural vegetation on D'Arros Island and St Joseph Atoll was cleared so that coconuts could be grown, guano collected and mangroves harvested. But by the 1970s it was no longer economically viable to produce coconuts on the Seychelles' Outer Islands. The plantations were abandoned soon after D'Arros Island came under private ownership in 1975 and the coconut trees have subsequently taken over.

Native mixed broad-leaf forests can support a diverse community of species, including roosts and nesting areas for seabirds, habitat for indigenous forest bird species, and differing niches in which many insect, fungus and plant species are able to thrive. The alien coconut monoculture, on the other hand, cannot sustain as many species, and a less productive ecosystem is the result.

In 2003, a rat- and cat-eradication programme was completed successfully and the islands were once again able to provide safe nesting areas for many land and seabird species. The following year, the first attempts at stimulating native forest growth on the islands were begun. The original forest rehabilitation programme involved clearing coconut palms out of an area and planting indigenous tree species in the open space. The programme proved to be flawed, however, as the local forest trees did not grow well in full sunlight. Paradoxically, the conditions suited invasive pioneer shrubs and creepers, enabling them to thrive. It is only when the treetops meet and the forest canopy closes, forming a uniformly shaded environment, that the desired forest species will out-compete the invasive shrubs and creepers. It has been 10 years since the first forest space was cleared, but the indigenous trees are still far from closing the canopy because their growth was so severely stunted. This means that the cleared site requires prolonged and intensive maintenance to ensure that the forest can out-compete the pioneer species.

In 2010 Rainer von Brandis, the scientific director of the SOSF–DRC, realised that the forest rehabilitation programme wasn't working and redesigned it. The current programme uses the established coconut palm canopy to provide the correct environment for the native forest trees to flourish in. To do this, the understorey of young coconut palms is uprooted and cleared to create space for the new forest trees. This eliminates competition for resources between the young palms and the indigenous trees. Any coconut palms that will not form part of the main canopy, because they are either too tall and protrude above it or too short and do not reach it, are cut

Photo by Christopher Boyes

A lesson in forest restoration

down or poisoned. The rehabilitation will be regarded as a success only once no further maintenance is needed and the forest can be allowed to develop on its own into a healthy, stable ecosystem.

To keep the programme going, a selection of 10 broad-leaf tree species that grow naturally on the island have been propagated from seeds or seedlings in a small shade cloth-covered nursery, which has a capacity of about 1,400 trees and a turnaround time of 12 months. Fifteen of the 112 hectares of old coconut plantation on D'Arros Island are currently being planted with native trees. It has never been the long-term plan to rehabilitate the entire island, but rather to establish dominant forest patches that will, over time, out-compete the coconut plantation and spread across all viable land. In the coming years, the forest rehabilitation programme will be expanded across the channel to the islands of St Joseph Atoll.

Seeing a site change from a sterile monoculture to a diverse environment that has all the potential to develop into a healthy, self-sustaining ecosystem full of life is an extremely rewarding process. However, the true results of a forest rehabilitation programme such as this will only be seen after many years, in time for a new generation to appreciate its effects – both on land and in the surrounding ocean.

Photo by Rainer von Brandis

CONNECTING CHILDREN AND THE MARINE WORLD

Words by Philippa Ehrlich

↑ Seen from the air, St Joseph Atoll could be the lost world. Visiting this delicate place is humbling, regardless of one's age, but children in particular can benefit from learning through experience in these abundant waters.

→ D'Arros Eksploratorsfollow Christopher Boyes along the mangroves of St Joseph Atoll, treading carefully to avoid porcupine rays.

According to a very wise, and long-dead, Greek philosopher, 'Wisdom begins in wonder.' It's not easy to describe what it feels like to be on a tiny crumb of earth in the middle of the Western Indian Ocean, but wonder is a good place to start – especially when your head is jammed in among a tangle of mangrove roots and you are surrounded by a group of Seychellois teenagers who are just as in awe as you are.

Seychellois children are born into a community that is inherently connected to the marine world. The island nation of the Seychelles is the second smallest country in Africa and its land area – only 455 square kilometres – is less than 1% of its overall territory. About 90,000 people live on this land. Despite this, the economy has expanded roughly 700% since 1976, and this is almost entirely due to the country's marine resources. The Seychellois tourism industry employs about 30% of the labour force and provides more than 70% of hard currency earnings. The next most important contributor is the tuna fishery.

For children who are so directly dependent on the sea, understanding the difference between exploiting natural resources efficiently and exploiting them sustainably is invaluable. In late April 2014, the Save Our Seas Foundation (SOSF) brought 16 teenagers to a tiny island 222 kilometres south-west of Victoria, the capital of the Seychelles, to participate in the first D'Arros Experience. A major project run by the newly established SOSF

Photos by Michael Scholl (2)

Island School Seychelles – Lekol Zil Sesel, in collaboration with the SOSF D'Arros Research Centre (SOSF–DRC), these educational camps are based on the principles of project-based, location-based and experiential learning.

'The D'Arros Experience is an amazing opportunity for Seychellois students to come into contact with a unique habitat that has been subjected to very little human interference,' explains Abi March, project manager of the SOSF Island School. 'Here they can discover up close lots of different animals that they would rarely get a chance to see on Mahé and Praslin. Experiencing these creatures and habitats in real life has a much bigger impact on the students than reading about them in books or being told about them in the classroom.'

The intention behind the camps is to inspire children to become wise custodians of the marine world and ambassadors for the natural realm of the Seychelles. Michael Scholl, CEO of the Save Our Seas Foundation, elaborates: 'We are very lucky to have such a special place that we can bring kids to. They were selected for the camps based on merit and their natural enthusiasm for the oceans. But it isn't just about the wildlife; it's the fact that we have actual research projects happening here. The programme was made possible by a passionate team. This means that the kids were able to discover the natural world they live in under the guidance of professional researchers, conservationists, educators and journalists.'

Experiencing the intricacies of the marine environment first-hand enabled the students to gain important insights, such as that of 12-year-old Leanne Appoo. She explains how her opinion of sharks was transformed during the trip. 'Abi and I were snorkelling and a blacktip shark swam right past us. It didn't even notice us. My friends on Mahé are always talking about people going boogie boarding and having their legs bitten off by sharks, but now I think they were just trying to scare me. From what I've seen, if you don't bother sharks, they won't bother you. If I tell people at school they might not believe me, because they only know about sharks from movies. Most movies discriminate against sharks, but they are actually really calm animals.'

During their week on the island, each of the two groups of D'Arros Eksplorators spent time in different parts of the D'Arros and St Joseph Atoll system and were encouraged to write about their favourite experiences. 'Out of the shallow blue a juvenile green turtle jetted past, grabbing the eyes of everyone on the boat. Delight and excitement rippled through us as we clung to the sides, eagerly waiting for the appearance of another magnificent creature. In the distance, tiny black-tipped dorsal fins could be seen breaking the surface. They belonged to juvenile sharks. It is only at low tide that these small creatures can be seen, because the shallow water protects them from the larger predators,' wrote 16-year-old Sean Pillay after a visit to St Joseph's lagoon.

For 15-year-old Carol Hoareau, discovering a nesting turtle during a very early morning beach survey was an emotional and illuminating experience. The children had been woken before sunrise and had walked around most of the island before they came across the large female green turtle that had just finished laying her eggs. 'It felt amazing, standing so close to an animal that I had only learned about in the classroom. It was the first time I had witnessed such a special event. Every single thing that I had learned about turtles this week came to life right in front of me. Hearing it breathe and move through the sand brought this feeling of joy and admiration,' Carol remembers. 'I knew turtles were important, but seeing one up close on land created this sense of urgency. It is truly my duty as a member of the growing generation to do something for their well-being and to protect this species from the threats it faces,' she adds.

And that is a perfect example of what Socrates, the aforementioned Greek, was getting at. The concept of conservation may not have existed for him and his peers, but had they been given the chance to share these insights about the delicacy of our natural world, we would probably be in a far better position now. Socrates also said, 'Let him that would move the world move himself first'. By that logic, planting the seeds of environmental respect and responsibility in even a few young individuals is an invaluable contribution to the future of our oceans.

Past, Present, Future

Words by Eleanor Yeld Hutchings

Ideally situated at the edge of False Bay in Cape Town, South Africa, the Save Our Seas Foundation Shark Centre overlooks the ocean and the distant Hottentots Holland Mountains. It was established in 2008 in a beautiful heritage-status building in Kalk Bay, right on the doorstep of the incredible Dalebrook Marine Protected Area – an apt location for a marine-focused centre, as Dalebrook is a sanctuary zone within the greater Table Mountain National Park Marine Protected Area.

The centre had multiple objectives when it was first established. It was to be a research hub that housed resident scientists (even offering a laboratory) and would be available for visiting researchers to use as a home base in Cape Town. It was to provide accommodation and facilities for visiting Save Our Seas Foundation staff and associates, as well as an event, meeting and conference space for local science, research and conservation organisations. Not least of all, it was to be an education facility for both public walk-in and organised school visits and for outreach activities.

This was a lot of different roles for a single centre to play, but for several years it served these different communities and needs. It hosted a number of extremely successful and high-profile projects, such as Dr Alison Kock's research on the white sharks of False Bay. There were also exciting collaborations with international researchers like Adam Barnett and Christopher Neff.

At times the demands on the centre were so numerous that it was difficult to decide which would take priority. Although all the objectives were worthwhile and needed, it became clear that narrowing the focus of the centre and expanding into just one or two areas of priority was going to be more effective in achieving real gains in marine conservation.

A detailed investigation into the potential of the Shark Centre was undertaken to identify how best it could both deliver benefits to the Save Our Seas Foundation and achieve broad-scale conservation successes. This proved to be a great opportunity and it came at just the right time to harness the incredible potential of the centre's location and its dedicated staff and, with the support of the Save Our Seas Foundation, to turn it into something truly wonderful.

In South Africa there are huge inequalities in the school system. The Shark Centre is in a unique situation in that it can contribute both physically, by immersing children in experientially focused educational activities, and financially, by accommodating students and schools that are extremely disadvantaged. Thus the decision was made to re-invent the centre as the Save Our Seas Foundation's Shark Education Centre, which would focus specifically on school-level education – although adults would also be welcome! In order to do this, educational staff would have to be appointed and new and exciting programming would have to be implemented. And the interior of the centre needed a change to match. The Shark Centre already had a strong history of excellent education work and it wasn't hard to imagine the new Shark Education Centre taking it even further.

Now, as in the past, groups of schoolchildren come through the centre. And just as they have always done, the youngsters leave feeling excited about all they have learned and inspired to care about the oceans. In addition to the schools' visits, there are outreach events (where the educators go to the schools), holiday clubs, marine awareness camps, marine explorers' clubs and many other activities. But with education now being not only the primary focus but also the name of the game, the time has come to step it up a notch and strategically develop programming, exhibits, capacity and direction. The goal is to ensure that the SOSF Shark Education Centre becomes a Cape Town site not to be missed, and that our marine education and conservation messages are spread far and wide.

As part of the vision for the SOSF Shark Education Centre, the building now also houses the Save Our Seas Foundation's Conservation Media Unit (CMU), a small, dynamic team that comprises a designer, a journalist, an editor and a social media specialist and is dedicated to showcasing the foundation's marine conservation activities. Working in the same building gives the education staff and the CMU wonderful opportunities for collaboration, particularly by sharing knowledge and exchanging ideas. Moreover, the presence of people with these diverse backgrounds and interests, along with our researcher-in-residence (currently Lauren De Vos, who is doing PhD research funded by the Save Our Seas Foundation), enables visiting children to see examples of different career opportunities available in marine science and conservation, and the various avenues there are for getting involved in the field.

So as you read this, and even while current education activities continue and schoolchildren still visit the centre, the re-envision is under way. Ideas are bouncing back and forth, plans are being drawn up and the excitement is palpable. Will there be a whole room dedicated to 'Shark World'? Will we install simulated kelp forests? How about interactive shark sense games, immersive technology or sand-pit treasure hunts? Touch pools, tanks, microscopes, games and recycling stations are all being mentioned as possibilities. Watch this space. We can't wait to reveal what we come up with!

Photos by Peter Verhoog (2)

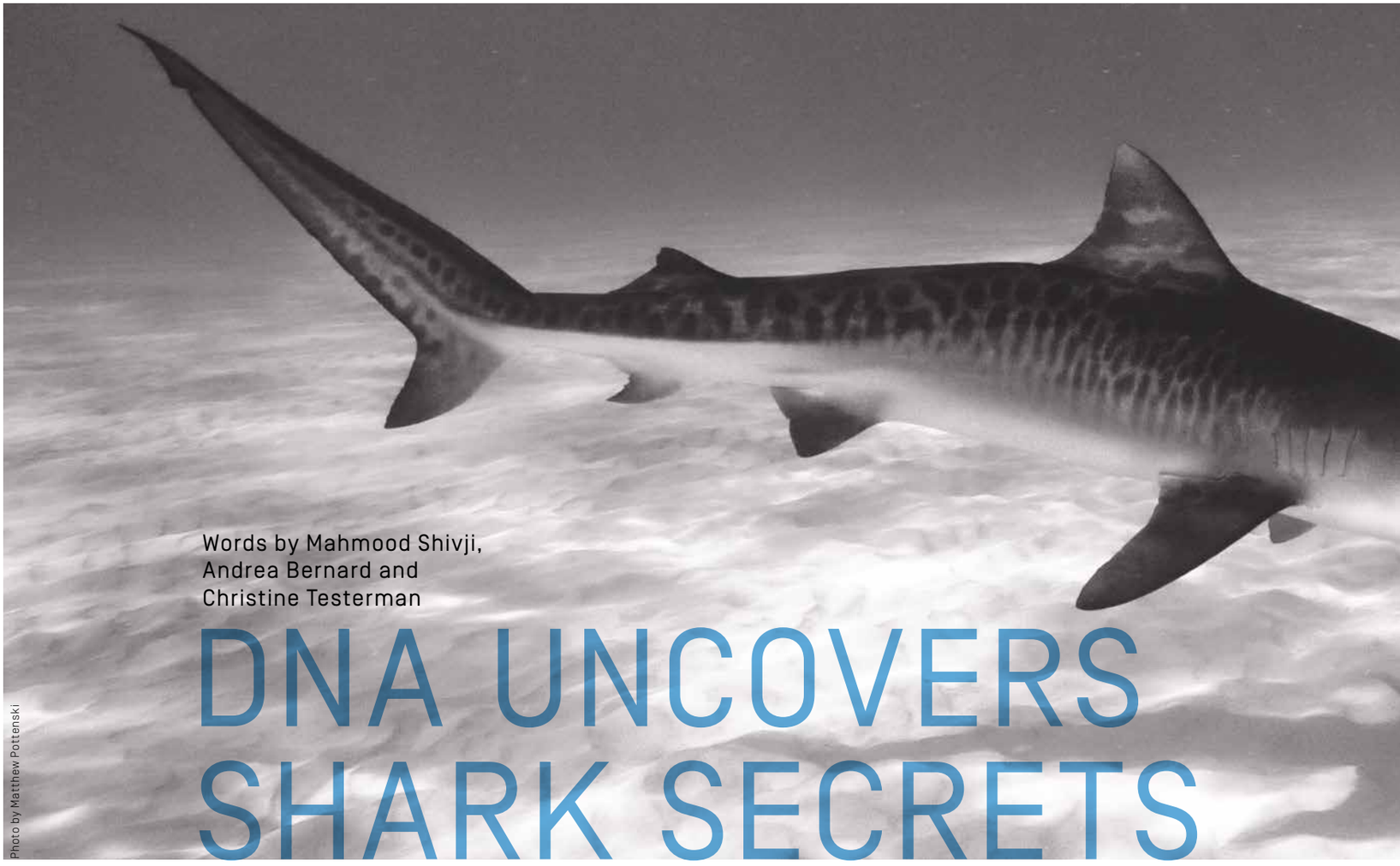


Photo by Matthew Pottenski

Words by Mahmood Shivji, Andrea Bernard and Christine Testerman

DNA UNCOVERS SHARK SECRETS

Studying the DNA of sharks and rays is a key aspect of the work undertaken at the Save Our Seas Foundation Shark Research Center (SOSSRC) in the United States. But why, you might ask, would one research DNA? How does that help us to understand and conserve sharks and rays? The broad answer is that the DNA of an organism, in its beautiful simplicity and yet intricate pathways inside cells, is fundamentally responsible for the form and function of all living things, from bacteria to sharks to humans. If we really want to understand how a species works and evolves at its most basic level, we'll find the answer mainly in its genes – and when and where those genes are switched on and off.

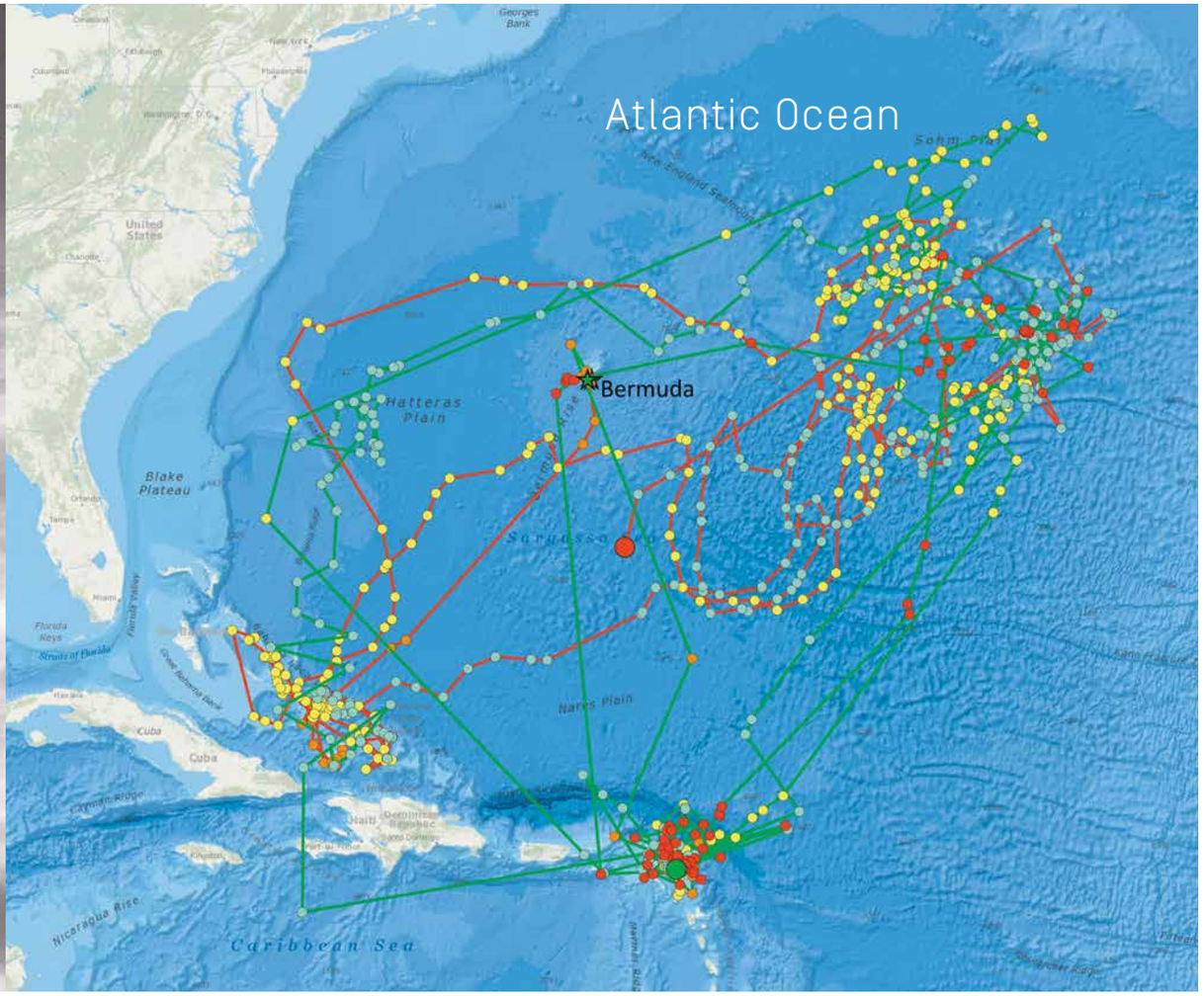
But that's not all. The DNA of an organism contains a lot of other secrets hidden in its sequences (of As, Ts, Cs and Gs), including signatures of its past: where it evolved, how and when it spread from one place to another, how it is related to other species and even its evolutionary potential to adapt to changing environments. At a finer scale, signatures in DNA can illuminate issues of immediate relevance to wildlife conservation and management. They can, for example, identify populations that are genetically distinct, gauge the genetic health and relative abundance of specific populations, and assist law enforcement by recognising wildlife body parts that are being traded. They can also help us to understand mating behaviour. In fact, there is an entire research discipline known as conservation genetics and it is dedicated to extracting this type of information from DNA to guide conservation efforts.

At the SOSSRC, students and research scientists are engaged in investigating all the above aspects with special reference to sharks and rays. In the following accounts, Dr Andrea Bernard and Dr Christine Testerman, research scientists at the SOSSRC and Guy Harvey Research Institute at Nova Southeastern University in Dania Beach, Florida, report on their worldwide genetics research on two fascinating animals, the tiger shark and the great hammerhead.

The tiger shark Like its striped land-mammal namesake, the tiger shark *Galeocerdo cuvier* is a majestic and awe-inspiring predator. Nothing else in the ocean looks quite like it. Indeed, its unique appearance has made it a favourite subject for skilled photographers. And yet it is a poorly understood species. Until recently, its body shape and what we know about where it is caught led to the conventional wisdom that the tiger shark is best adapted to living in waters near the shore, including temperate coastal regions and tropical coral reefs. Pelagic sharks such as the shortfin mako, blue and oceanic whitetip have streamlined, torpedo-shaped bodies and long fins that seem to be well suited to long-distance swimming and living in the open ocean. The tiger shark, however, has almost the opposite traits: a stocky build with a broad head and stubby pectoral fins. Based simply on appearance, it looks like it would have a hard time swimming at a fast clip over long distances. It turns out, though, that in the case of this enigmatic shark appearances are deceptive!

Recent tracking research undertaken by my colleagues at the Guy Harvey Research Institute and the SOSSRC has uncovered unexpectedly rapid, long-distance travels by many tiger sharks of western Atlantic and Western Australian waters, showing that the species is not constrained to staying close to shore. Although their bodies do not look like those of typical pelagic sharks (with the exception of a weak keel just before the tail), tiger sharks spend a surprisingly large amount of time in the deep oceanic waters of the mid-Atlantic. Electronic tags mounted on their dorsal fins have revealed

The tiger shark



The tracks of two tiger sharks, Correia and Harry Lindo, show the extent to which this species travels, traversing great ocean distances.

- Correia
- Harry Lindo
- Last known location
- Tagging location
- 2009
- 2010
- 2011
- 2012

these astonishing movements by communicating location information to satellites each time the shark's fin breaks the surface (see the tracks at *ghritracking.org*). But as is typical of many scientific discoveries, new information often raises just as many questions as it answers.

Tens of millions of sharks are killed each year worldwide, so the need to manage fisheries properly and protect shark species has become a global priority. As apex predators, sharks play a crucial role in the environment and their loss or widespread decline may have far-reaching implications for marine ecosystems. The tiger shark is no exception. As declines for the species have been reported in key areas of its global distribution, understanding tiger shark movements – how, when and why they move – is critical, and now more than ever.

Physically tracking sharks can be logistically difficult and rather expensive, however, and it often presents only part of the larger story about tiger shark ecology. Combining tagging data with other sources of information can provide additional insights into patterns of movement and connectivity, enabling researchers and managers to target conservation efforts effectively. At the SOSSRC, we utilise diverse scientific sources and approaches in our attempts to understand the biology of tiger sharks, one of which is to dig deeply into their DNA.

As part of my research, I have been studying the global connectivity of tiger sharks using the signatures in their DNA. Just as with human forensics, shark DNA can be used to track individual sharks, measure relatedness among individuals, discover parents and their offspring, and determine the level of interbreeding among geographically disparate groups. Armed with this information, we can address scientific questions that are fundamental to managing the species, such as whether the tiger sharks from one area are interacting with sharks from another area.

This type of information is especially important for large, highly mobile marine animals like tiger sharks because they frequently move across international boundaries, often making it necessary for different governments and their resource-management agencies to work together if the species is to be managed and protected. Conversely, when individuals of the same species from two different areas are not linked by movement or interbreeding, then each area represents a unique population that needs to be protected from overfishing if its genetic legacy is to survive. In such cases, the welfare of each population should be considered separately in local management policies.

Thanks to the generosity of our international friends, our research group at the SOSSRC has been fortunate to obtain hundreds of tiger shark tissue samples from around the world, including the waters of the western Atlantic, South Africa, the Middle East, Indonesia, Australia and Hawaii. These highly valuable resources arrive at our research centre typically as small fin clips, often not much larger than a fingernail. Small they may be, but these pieces of tissue are exceptionally important, each one housing millions of copies of the shark's entire genetic blueprint.

Using advanced DNA sequencing and fingerprinting technology with markers known as microsatellites, I have been working to isolate and characterise specific regions of the tiger shark's genome. By comparing the DNA of individuals captured across the globe, my research aims to help us understand tiger shark movement patterns and connectivity, both historical and contemporary. The SOSSRC hopes that by combining my genetics research with our recent tiger shark-tracking efforts we will not only be able to shed more light on this exceptional animal, but also provide managers

The great hammerhead shark

with crucial information about the connectivity of its populations, which is necessary to conserve the species. This contributes to the collective goal of unravelling the why, where and when of tiger shark movements, the uniqueness of its populations and which populations may be in most need of urgent protective measures.

A research scientist at the Save Our Seas Foundation Shark Research Center at Nova Southeastern University's Oceanographic Center in Dania Beach, Florida, Dr Andrea Bernard leads the SOSSRC Tiger Shark Global Conservation Genetics project. Her research focuses on conservation genetics and the molecular ecology of tiger, white and Caribbean reef sharks.

The great hammerhead shark Sharks are an ancient and extremely diverse lineage of animals comprising more than 500 species. One of the most novel body designs in this fascinating group is that of the hammerheads, which have curiously expanded and flattened heads and eyes that, cartoon-like, are spaced far apart. Indeed, the hammerhead's shape conjures up a caricature of a creature from outer space! But evolution works in unpredictable ways, and this peculiar head shape offers a clear benefit by improving the shark's field of vision. It is also thought to enhance its sense of smell and its electroreceptivity. Based on these features, one would think the hammerheads were well equipped to thrive, but they also have an Achilles heel – and one that is not driven by evolutionary selection. Unfortunately, their survival is threatened by the fact that their large fins are highly valued in the world's shark-fin markets.

Among the many shark populations, and sometimes even entire species, that have been fished unsustainably, the large-bodied hammerhead species are prime examples. To improve the management of shark fisheries, we need two crucial pieces of information: which species are involved in trade, and the geographic origin of shark products. But getting this information has been difficult. In the first place, shark products are typically traded as detached fins, or as carcasses without fins, heads or tails. Secondly, the fact that our knowledge about their global genetic structure, genetic connectivity and population dynamics is limited hampers our ability to understand local and international patterns of exploitation and to identify regional hotspots of overfishing for individual species and their populations.

The great hammerhead shark *Sphyrna mokarran* is the largest of the nine hammerhead species and is found around the world in tropical coastal seas. Although it is not typically targeted by commercial fisheries, there is cause for significant management and conservation concern. Great hammerheads are often caught incidentally as by-catch and, as they are extraordinarily sensitive to the trauma of being captured, the mortality rate is high. Additionally, the high market value of their large fins provides incentive for opportunistic fishing. In fact, our previous research on the shark-fin trade has shown that fins from more than two million hammerhead sharks, mainly the great, scalloped and smooth hammerheads, have been traded in the global fin market each year. And of these three species, the great hammerhead's fins appear to be preferred, fetching the highest prices.

Concern about the future of the large-bodied hammerheads is clearly warranted. Studies indicate that all hammerheads have declined by 89% in the north-western and west–central Atlantic and by 99% in the Mediterranean. The abundance of the great hammerhead specifically has declined by about

Photo by Matthew Pottenski

80% off the coast of South Africa and in the eastern Atlantic. The species is listed as Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species™ and in March 2013 it was listed on Appendix II of the Convention on International Trade in Endangered Species (CITES), with a deadline for implementing this listing by September 2014. Given its dire status worldwide and the limited scientific information that is available to guide its conservation and management, there is a pressing need to gather more information about the biology of the great hammerhead, as well as about its genetic structure and diversity, migration patterns, mating systems and breeding and pupping grounds.

At the SOSSRC, research on the genetics of the great hammerhead is a priority. We start with conservation-related questions that can be uniquely addressed by the in-depth analysis of DNA taken from individuals across the species' global distribution. Our results are revealing the genetic structure of great hammerhead populations and to what extent regional populations are connected. They have also enabled us to estimate current genetic diversity, which is being used to get an idea of trends in the genetic health of the population. In addition, we are gaining insight into the migratory behaviour of male and female great hammerheads, particularly whether females return repeatedly to specific places to breed or give birth, a behaviour known as philopatry.

With this basic information in hand, we plan to move into the realm of wildlife forensics by designing rapid molecular tests to identify the geographic origin of great hammerhead products in the marketplace. We will be able to use these forensic tools to evaluate fishing patterns, which may indicate disproportionate harvest levels in certain regions and tell us whether great hammerheads are being fished illegally in protected areas or are being transported globally in contravention of international laws or agreements. This information will indicate where additional national and international protection needs to be put in place.

Another area being actively investigated at the SOSSRC is the mating system of great hammerheads. Understanding the sex lives of endangered animals is important for effectively managing their populations. For example, a species' genetic diversity – and ultimately its ability to adapt to changing environmental conditions – can be directly influenced by whether females mate with multiple males (polyandry) or whether more than one male fathers the offspring in a single litter (multiple paternity). Although shark mating is rarely observed in the wild, DNA taken from mothers and their offspring can provide insight into the sharks' sex life. Earlier research conducted in our lab has shown that female bonnetheads (a small hammerhead species) have an unexpectedly low incidence of multiple paternity in their litters. Even more surprisingly, females of this species can reproduce by virgin birth, also known as parthenogenesis! One wonders what other surprises lie in wait as we continue to examine the mating behaviour of great hammerheads.

A research scientist at the Save Our Seas Foundation Shark Research Center at Nova Southeastern University's Oceanographic Center in Dania Beach, Florida, Dr Christine Testerman leads the SOSSRC Great Hammerhead project. Her research focuses on conservation genetics and the molecular ecology of several shark species, including smooth hammerhead, bull and porbeagle sharks.

Photo by Mac Stone

Marine Conservation Photography Grant **Winners**

Marine Conservation Photography Grant Winner Mac Stone

In June 2014 the Save Our Seas Foundation announced the winners of the inaugural Marine Conservation Photography Grant. The foundation received 90 entries from emerging photographers around the world and the judging panel met in the Seychelles to choose the winners. The panel comprised SOSF CEO Michael Scholl; Thomas P. Peschak, a *National Geographic* photographer and the SOSF's director of conservation; Kathy Moran, the senior editor of *National Geographic Magazine;* and David Griffin, the visuals editor for the *Washington Post.*

The judges were looking for photographs that they had never seen before and for photographers who could go beyond the single image to tell a story with a series of pictures. Both winners, Joris Alphen and Mac Stone, have proven their understanding of how to use their images to drive real-world conservation change. We asked them for some insight into their backgrounds and motivation as conservation photographers.

Can you describe a moment from behind the lens during which you realised that you wanted to become a wildlife photographer?

I was in high school, it was winter and I was photographing polar fog on Newnan's Lake in Gainesville, Florida. Class was about to start, but the light was good and I just couldn't leave. As the sun broke the horizon, I dialled in my exposure – back in the days of slide film – and waited. Like clockwork, the birds I had watched dozens of times came to roost on a cypress tree. As they arched up towards the tree through the

Mac Stone | United States of America

fog, I triggered the shutter. I remember looking at those slides and thinking it was the first time I felt I had total control of the camera, complete awareness of my surroundings. At that moment, I knew my life was going to be defined by photography.

What has been your most intense moment in the field?

During the dry season in remote areas of the Everglades, American alligators are known to congregate in the remaining waterholes. Wanting a unique image of this behaviour, I headed out and was amazed at what I found. More than 100 alligators were wallowing in a muddy mire, clinging to life in the hope that the rain would soon return. Out in the middle of the reptile pit, I could feel them wriggling beneath my feet. The stench of rotting fish and faeces burned in my nostrils. When I arrived at the largest 'gator of the group, I crouched low and fired off a few frames, nervously holding my breath. As I rose, the 'gator spun around in a whirl of mud and muscle and barrelled through the group in the opposite direction. My heart nearly exploded, but I left with an image that helps tell the story of Florida's hydrology and iconic reptile.

What would be your ultimate photographic destination and why?

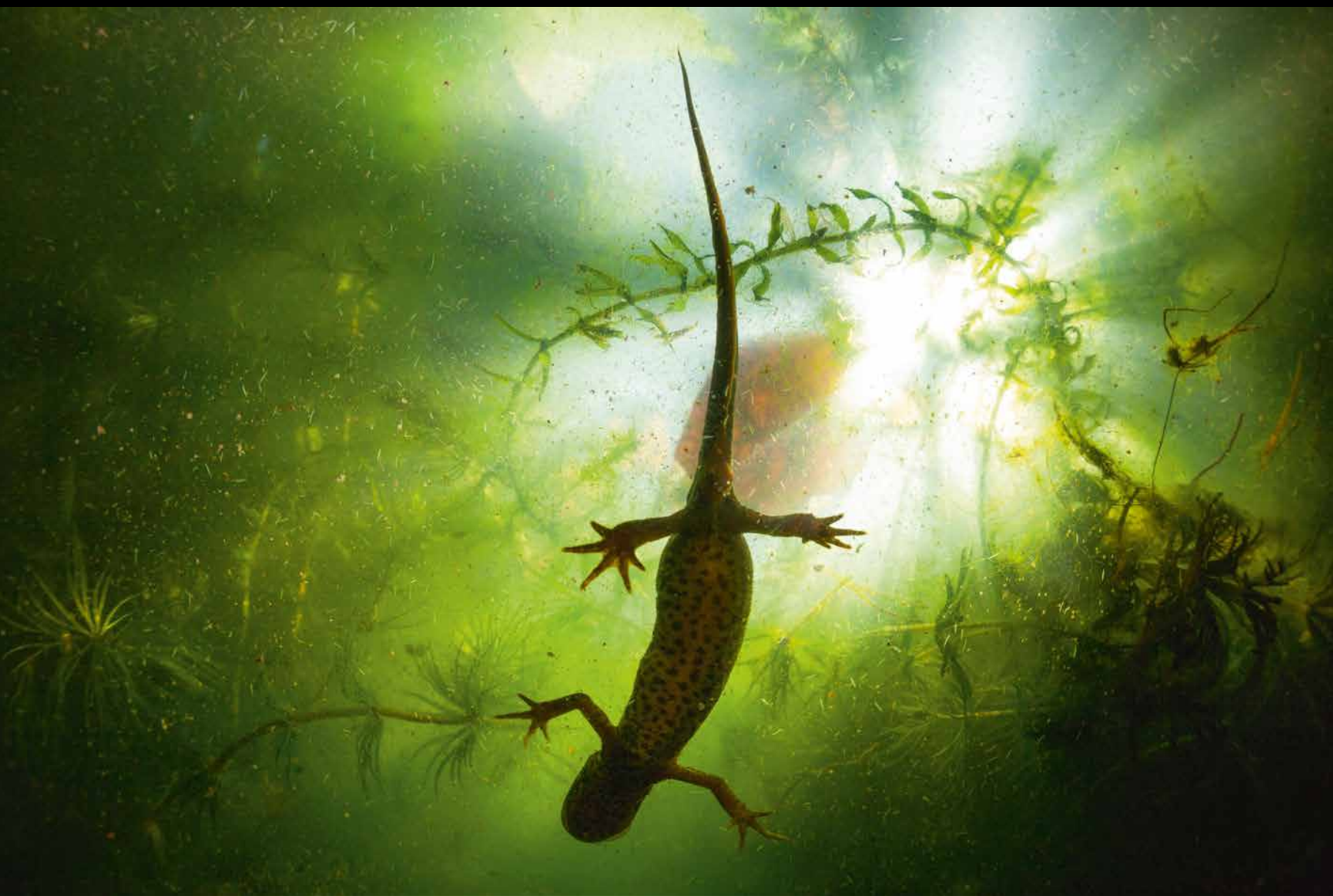
There are endless stories to tell and incredible things to see all around my home state, but if I had a golden ticket to shoot a story anywhere in the world, I think I would have to pick the Maldives. I've grown up seeing images from that archipelago, dreaming of one day swimming in a pod of feeding mantas.

Marine Conservation Photography Grant Winner Joris van Alphen

Can you describe a moment from behind the lens during which you realised that you wanted to become a wildlife photographer?
I think it was rather the moments that I wasn't behind the lens but wished I could have been that got me photographing wildlife. Initially I wasn't interested in wildlife photography at all. I did study biology, but when it came to photography my focus was completely on people. It was only when I took up diving that I started to miss being able to share my experiences. Photography seemed the obvious answer.

What has been your most intense moment in the field?
My first big assignment took me to the island of Chiloé in Chile in search of blue whales. It is one of the most beautiful places on earth, but also one of the most challenging to work in. On the second day out, I had the most intense moment of awe and the most intense scare. The awe came when I first saw a blue whale up close. Nothing could have prepared me for its staggering size. The first thing that appears is a blowhole large enough for you to jump into. Next, if you are lucky, you see a very, very large eye staring back at you. And then, for the longest time, all you see is metre after metre of back rolling by until finally it sinks into the blue. Shortly after the encounter, the weather suddenly turned and 10-metre waves were slamming into our little boat. One wave hit so violently that a pin connecting the rudder gave way and we lost control and very nearly capsized. If we had, we would probably not have survived.

What would be your ultimate photographic destination and why?
The biggest thrill for me is to visit a



Joris van Alphen | The Netherlands

place so remote that it is still undisturbed by humans. Sadly, that has become a very hard thing to do. The scale of our impact on the planet is overwhelming. Even the few inaccessible places left on earth bear the burdens of climate change. But as I'm writing this I'm very excited to be on my way to an almost untouched part of the Amazon basin. That's about as ultimate a photographic destination as I can think of.

Photo by Joris van Alphen

Photo by Thomas P. Peschak

Next issue

False Bay is South Africa's biggest true bay and it's home to a diversity of fish and sharks. Lauren de Vos, a PhD student funded by the Save Our Seas Foundation, is using underwater cameras to assess the diversity and abundance of the area's species, such as the red roman. Next issue, take a journey with us to South Africa to meet these colourful fish and the other inhabitants of False Bay.

The Save Our Seas magazine is available for free online on both issuu and Zinio. View it on your desktop, tablet or phone anywhere you like!

ABOUT THE FOUNDATION

In the effort to protect our oceans, the Save Our Seas Foundation funds and supports research, conservation and education projects worldwide, focusing primarily on charismatic threatened wildlife and their habitats. From a small not-for-profit organisation funding just five projects, in less than 10 years the Save Our Seas Foundation (SOSF) has grown to become a major player in the fight to save the world's oceans and the wealth of marine life they contain. While the SOSF itself is not a research institute, its generous contributions of financial, practical and scientific support have, to date, facilitated more than 160 marine research and conservation projects around the world.

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

Editors-in-chief
Michael C. Scholl
Lisa Boonzaier
Thomas P. Peschak

Editorial assistant
Philippa Ehrlich

Sub-editor & proofreader
Leni Martin

Additional editing
and proofreading
Nadia Bruyndonckx

Design & art direction
scholldesign.com

Published by the
Save Our Seas Foundation
Rue Philippe-Plantamour 20
CH-1201 Geneva | Switzerland
saveourseas.com
ISSN (Print) 2296-8199
ISSN (Online) 2296-8202

Reproduction by
Resolution Colour
8 Briar Road | 1st Floor
Salt River | 7975 Cape Town South
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Printed by Polygravia Arts
Graphiques SA | Route de Pra de
Plan 18 | CH-1618 Châtel-St-Denis
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