# SAVE OUR SEAS FOUNDATION ANNUAL REPORT 2015





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# **"AS LONG AS THERE ARE PEOPLE** WHO CARE, WE CAN AND WILL MAKE A DIFFERENCE." THE FOUNDER I SAVE



In 2015, we at the Save Our Seas Foundation not only continued to develop support for our Keystone and Small Grant projects around the world, our four centres and our five long-term partners, but also expanded our capacity to communicate via all available channels. We understand the value of maintaining a balance between funding experienced researchers and conservationists with our Keystone Grants on the one hand and, on the other, investing in the next generation through our Small Grants that are aimed at early-career professionals.

web formats.

Chris Lowe, president of the American Elasmobranch Society, wrote one of the magazine's pivotal articles, 'Good science and recognising recoveries'. In it, he encourages us to rethink current conservation strategies from combined research. political and communication points of view:

'Good science should be what dictates policy, irrespective of the implications and conservation mantra, and we should be very wary of the "the sky-is-falling" science business model. Right now we need more scientists looking for signs of recovery because that is what we should expect if all our previous efforts have been working. And if we don't see recovery, then we need to think seriously about developing new strategies.'

Our main website as well as our centre portals were launched in September, presenting our projects and project leaders in a new web environment to give our viewers a more versatile and user-friendly experience. The emphasis has always been on the people who lead the projects that we support, and communicating their results and life experiences to a wider audience remains paramount to the Foundation's ideology. Changes in attitude run parallel with understanding, and understanding originates from knowledge. And the driving force behind the Foundation and its project leaders is passion.

To celebrate the 25th anniversary of one of our partners, the Bimini Biological Field Station (which is better known to shark scientists as the Shark Lab and was founded by shark research pioneer Dr Samuel H. Gruber in 1990), we published

We published two new issues of our flagship Save Our Seas magazine, which featured, among other articles, the reef fishes in False Bay and solutions to human-shark interaction there: a discussion of how conservation and research strategies need to be re-evaluated and adjusted; the magical and unique ecosystem of the Great Bear Rainforest and Sea; the mysterious world of jellyfish; and how shark populations are affected by urbanisation. In October we also initiated the delivery of the magazine in a web edition to give our readers a more dynamic and interactive experience and enable them to enjoy the magazine in print, digital and

Shark Doc, Shark Lab, written by Jeremy Stafford-Deitsch. Describing how passion-driven dedication can triumph, this book demonstrates the importance of long-term studies that encompass not just a single species, but the ecosystem in which that species - and others - thrive. The book appeals to a wide audience and is testament to how perseverance and commitment can make dreams come true a philosophy dear to the heart of our Founder.

To strengthen our cornerstone role as a leader in elasmobranch research and conservation strategy, we welcomed a new scientific adviser in the person of Dr Dean Grubbs, associate director of research at Florida State University's Coastal and Marine Laboratory. Dean brings his scientific expertise to our team of advisers, complementing Sarah Fowler's proficiency in conservation strategy and Thomas Peschak's communication skills.

Over the years, we have noticed that trends are constantly changing and evolving, as reflected in the proposals we review. There were stable isotopes in 2013 and BRUVs (Baited Remote Underwater Video Stations) in 2014. Now there are drones, a technology that until very recently was prohibitively expensive and accessible only to the military, but is now available to anyone. The Save Our Seas Foundation has supported several projects that investigated the implementation of drones for population studies and surveys of marine species (such as reef sharks in French Polynesia, coastal shark species in the Bahamas and southern right whales in South Africa) and we used this same technology to create a very high resolution map of St Joseph Atoll in the Seychelles, which is the principal study area of the SOSF D'Arros Research Centre. This map, highlighted alongside a feature article in National Geographic about restoration efforts in the Seychelles, will serve for many years to come as a reference map with a level of detail impossible to achieve through more traditional methods, such as satellite imagery.

Remaining true to the nature of the Foundation since its inception in 2003, and inspired by our Founder's passion, in 2015 we continued to support research, conservation and education projects on charismatic marine megafauna worldwide, with a significant emphasis on endangered elasmobranchs. This support ranged from our primary role as a funder to helping projects and events from a logistical perspective and endorsing more effective and far-reaching communication to the public. The passionate synergy between our team and our project leaders has enabled the Foundation to grow further and mature, as well as act as a leader in elasmobranch science and conservation.

MICHAEL SCHOLL | CHIEF EXECUTIVE OFFICER

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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. Since then, the foundation has sponsored over 200 projects in more than 50 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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## 'BY 2010 UP TO 30% OF ALL SCIENTIFIC PAPERS PUBLISHED ON ELASMOBRANCHS MENTIONED POPULATION DECLINES, REGARDLESS OF THE RESEARCH TOPIC'

## THE RISE OF THE ENVIRONMENTAL REVOLUTION

A rising human population coupled with a focus on increasing economic growth has resulted in severe impacts on our environment, and the challenges of dealing with these impacts have been battled for decades in many countries, both developing and developed. It was in the early 1960s that scientists like Rachel Carson started sounding the alarm about how pollution, overfishing and the destruction of habitat were greatly affecting our environment and the organisms within it, kicking off what many refer to as the 'environmental revolution'. This brought forth a new form of activism, one that would highlight the largely ignored creep towards loss of ecosystem function and greatly reduced wildlife populations. Some of the impacts on the environment were clearly visible, yet science still needed to generate sufficient concern among the public – and policy-makers – to stimulate change. Thus the relationship between science, the media and the public became further entwined.

A case in point is the fisheries in the USA and abroad, where sharks, rays and skates – collectively known as elasmobranchs – faced many of the same problems that most other targeted favourites, such as cod, swordfish and tuna, faced. Many elasmobranch fisheries in the USA started when fisheries managers encouraged fishers to switch from an alreadydepleted species to an 'under-utilised' one. Because one fisher's trash is another's treasure, most elasmobranch fisheries evolved from being discarded by-catch (trash) to a target (treasure) with the help of new markets. While this strategy helped take pressure off overfished stocks, the distinct lack of basic life-history information for most elasmobranch species led many of these new fisheries down the same path as that of the past – only faster.

By the early 1980s scientists were becoming concerned about rapidly declining catch rates and growing market demand for elasmobranch products. Generating sufficient concern for declining elasmobranch populations was difficult, however, due to a lack of science and the public's perception of sharks as dangerous animals. In addition, the declines occurred during what many consider to have been the nadir of environmental health in the USA (the 1940s to 1990s), a period when there were minimal regulations regarding water or air quality, wetland protection or safeguarding fisheries.

## RECOGNISING THE PROBLEM

It wasn't until the early 1980s that the first studies describing population declines in elasmobranchs and the impacts of overfishing these species came to the scientific mainstream. Between 1980 and 1985, elasmobranch population declines were mentioned in an annual average of 43 scientific papers, the vast majority of which attributed direct or indirect fishing as the primary cause. Unfortunately, by 2010 this trend had greatly increased to more than 240 papers per year. Once again, it was a dedicated group of scientists (Jack Musick, Sonny Gruber, Bob Hueter, Merry Camhi, George Burgess, Enric Cortés, Greg Cailliet, Nick



Dulvy, Sonja Fordham, Dave Ebert and Colin Simpfendorfer, to name just a few) who started sounding the alarm, making managers and policymakers aware of the rapidly growing problem for some elasmobranch populations and the primary causes of the declines.

Despite the challenges of persuading a historically 'elasmophobic' public to care about these trends, the media has played a major role in disseminating bits and pieces of scientific information to the public. Slowly, better knowledge has helped change attitudes towards sharks and – to a much smaller extent – their flat cousins, the rays. In addition, since the public seems to have an innate fascination for 'doom and gloom' stories, its growing interest in all things sharkrelated has further fuelled mass media interest in the plight of shark populations. The rise in public and media interest is closely related to the increased focus from a wide array of elasmobranch conservation organisations, many of which religiously sound alarm bells, but often without any need or use for the supporting science.

Not unlike other environmental problems of the past, it was primarily the scientific community that brought to light issues of elasmobranch depletion, focusing research in ways that would provide managers and legislators with the invaluable information they needed for strategies, and education, that would promote the recovery of populations. This, of course, could not be done without public support and the willingness to fund research. Interestingly, by 2010 up to 30% of all scientific papers published on elasmobranchs mentioned population declines, regardless of the research topic or its relevance to concrete regulatory solutions. Today, there are still a lot of elasmobranch populations in serious trouble worldwide, and there is still a real need to make the public and policy-makers more aware of the problems. But at what point does this become more of an operational business model than a sciencebased conservation effort?

## HAS CONSERVATION WORKED?

Although it has been great to see elasmobranchs get more and more positive attention over the past few decades and to watch people worldwide voice concern for elasmobranch populations, unfortunately the prevailing message from many conservation groups is that only the more charismatic species are in trouble and worthy of protection. Often the solution they put forward is a ban on fishing.

According to Sonja Fordham of Shark Advocates International, dozens of regional, national and international regulatory actions have been put in place over the past 20 years for the specific purpose of better protecting elasmobranch populations – and they don't include the dozens of major ecosystemlevel protection measures enacted. Yet there has been surprisingly little mention of or attention paid to the success of these past regulations that have been dedicated to aiding the recovery of populations in trouble, or those deemed most vulnerable. Is that because all the previous conservation efforts have failed? Or perhaps because not enough time has passed to tell whether they're working? Or is it because some have worked and no one really cares to hear about them because their success doesn't lead to profitable conservation?

We all know that because of the special lifehistory characteristics of elasmobranchs, it's quite easy to fish them down quickly, but it can take decades or even a century for a reduced population to recover. It's hard to imagine that all that legislation, regulation and public education has had no effect on the recovery of populations.



## RECOVERY RIGHT UNDER OUR NOSES

Falling into the 'sharks-are-in-trouble' mindset is easy to understand, but it is surprising to see how it can affect your thinking as a scientist and how it might affect your interpretation of data. As an elasmobranch scientist for 25 years, I had come to expect to see signs of human-induced environmental decay, pollution and overfishing and the resulting negative impacts on populations, especially along the highly populated coastline of Los Angeles, California.

In 2002, my students and I began a collaborative project with Monterey Bay Aquarium in which we studied juvenile white sharks in southern California as part of the aquarium's white shark conservation research programme. We had heard that gill-net fishers in southern California would occasionally catch young-of-the-year and juvenile white sharks in their nets. We arranged a collaboration with willing fishers to bring incidentally caught juvenile white sharks back to the dock so we could assess their condition and measure, tag and release them offshore. Our primary goal was to determine whether sharks could survive being caught in a gill net. Secondly, we wanted to figure out where they went after being released.

At the same time, my students conducted an exhaustive survey of scientific and fishery records going back to the 1930s to determine how white sharks interacted with recreational and commercial fisheries in southern California. Fisheries data of this nature inevitably have problems and biases, yet despite these a surprising trend began to emerge. It suggested that a growing number of juvenile white sharks were being incidentally caught each year, even though there had been a significant reduction in overall gill-net effort due to increased regulation and reduced fleet size. A trend showing an increasing catch per unit effort typically suggests a population increase. However, I was still in the 'sharks-are-in-trouble' mindset and my initial reaction to the data was disbelief. Moreover, other researchers who were studying part of the adult population of white sharks off central California were arguing that the population was dangerously low, which stimulated several conservation organisations to submit petitions to the state and federal governments to list white sharks under their respective Endangered Species Acts.

How could the most enigmatic shark species be increasing in number off the coast of California with all its problems – habitat loss, pollution, overfishing and 28 million people? It just didn't seem possible. That was until I began to assume the trend was real and consider how the population could increase.

White sharks have been protected from fishing in California since 1994 (fishers cannot land or sell them) and throughout the US Pacific

since 2005. Our catch-and-release data showed that 94% of the sharks found alive in gill nets could survive if carefully released. This was great news, and likely helps to explain the increase in incidental catch rates. But is protection from just fishing enough to enable a population to recover?

Surviving fishery encounters is one thing, but if there aren't sufficient food resources, most white sharks would starve or leave the area. There is growing evidence that populations of marine mammals are making remarkable recoveries off California and the eastern Pacific due to better protection, and of course adult white sharks feed heavily on pinnipeds and cetaceans. So the recovery of the marine mammal populations should certainly benefit the white sharks. Healthy marine mammal populations require a stable food source, in addition to protection from fisheries. Most of our pinnipeds feed on the same prey items as juvenile white sharks (squid and fin fishes), so it's likely that improved fisheries management has allowed these prey populations to remain at high enough levels to sustain these growing populations of marine mammals and juvenile white sharks. In addition, coastal predators and their food are all dependent on water quality, which has improved significantly along the California coastline since the 1970s.

## 'I WAS STILL IN THE "SHARKS-ARE-IN-TROUBLE" MINDSET AND MY INITIAL REACTION TO THE DATA WAS DISBELIEF'



As I worked my way through the ecosystem data comparing trends over the past 40 years, I began to see that it had been possible for the white shark population to increase as the figures suggested, but such improvement has required much more than just fisheries protection for this particular species. In addition, my preconceived notions that all sharks are in trouble blinded me from actually seeing signs of recovery and it made me wonder why others aren't seeing these signs as well.

## LET'S NOT LOSE SIGHT OF SUCCESS

I was shocked at how this research changed my attitude and perspective on science, but pleased that it gave me renewed hope for the future. I think it's easy to forget how alarming, yet well-founded science can prompt hard-fought legislation, which can result in restoring coastal oceans and protecting populations for the future. Many do not remember, or simply weren't around to experience, the days prior to the Clean Air Act (1970), Clean Water Act (1971), Marine Mammal Protection Act (1973), Endangered Species Act (1973) and Magnuson-Stevens Act (1996), and what the ocean was like then. I can assure you that, at least in California. things are a lot better now than they were in the

1970s – and, surprisingly, with three times more people living along the coastline. To me, that is truly a testament to the fact that people care and are willing to sacrifice and pay for a cleaner, healthier ocean

While sounding the alarm is necessary and will always be needed to promote change and conservation, I worry about its effect on how we do science. I see an unfortunate trend where the best way to make our science important and relevant is to focus on 'the-sky-is-falling' issues. Of the past 20 elasmobranch-related grant proposals and manuscripts I've reviewed, more than 80% have resorted to 'the sky-is-falling' statements to justify the importance of their research, regardless of whether they offered a concrete remedy. In addition, there are already signs of 'the-sky-isfalling' science having the undesired effect of generating hopelessness among the public and, more disturbingly, among legislators. Crying wolf without good cause is weakening managers' ability to implement adequate strategies. If we can't demonstrate improvement after all that regulation, then how long will it be before some people try to reverse the regulation for nothing more than economic gain?

Good science should be what dictates policy, irrespective of the implications and conservation mantra, and we should be very wary of the 'the sky-

is-falling' science business model. Right now we need more scientists looking for signs of recovery because that is what we should expect if all our previous efforts have been working. And if we don't see recovery, then we need to think seriously about developing new strategies.

# **INSIDE STORIES** REPORTS FROM THE SAVE OUR SEAS FOUNDATION CENTRES AROUND THE WORLD





ur regular research activities aside, the year 2015 gave the Save Our Seas Shark Research Center (SOSSRC) team a wonderful opportunity to make new friends and welcome back old ones by hosting three international PhD students. Igbal Elhassan, our visitor from the farthest country,

Sudan, was with us for seven months to learn genetics lab techniques and data analysis skills. On realising how challenging it would have been logistically for Igbal to have accomplished genetics research at her home institution, we made it a team mission to teach her as much as we could in the relatively short time she was here. Not only was Igbal an impressively quick study, but she was one of the hardest working people we have met! Her project focused mainly on investigating the genetic structure of the worldwide population of spinner sharks, a widely fished coastal species, and how this shark from the Red and Arabian seas fits into the global picture. In addition, Igbal accomplished several side projects on the biodiversity of sharks that she sampled from her remote field sites in the Red and Arabian seas. It was delightful getting to know Igbal and I am sure we will be lifelong friends and collaborators; we could not have asked for a colleague more generous of spirit. Igbal's blog describing her visit can be found at SharkResearchCenter.org

We were also pleased to host PhD student Ornella Weideli, from Switzerland, for six weeks in the summer. Ornella's project at the SOSSRC involved learning genetic techniques and using them to identify the diet of her study sharks from the Seychelles. Ornella learnt the necessary lab techniques seamlessly and was up and running in her work to identify the prey items she had (so bravely, I might add) extracted from live sharks by conducting stomach lavages. Switching one's mindset from months of intense field work in a remote Sevchelles atoll to intense genetics lab work in an urban, large-city environment would be tough for anyone. Ornella adapted brilliantly and was rapidly generating and analysing DNA sequences that enabled her to zero in on what her sharks were eating. After the success of this pilot project, Ornella will be coming back to the Center in the summer of 2016 with many more samples of shark stomach content to analyse.

# save our seas shark research center

Her work will make an excellent contribution to understanding the feeding ecology of sharks at the spectacular St Joseph Atoll in the Seychelles. Ornella's blog about her experience at the SOSSRC is at SaveOurSeas.com

Lastly, we welcomed back our good friend Rodrigo Domingues, from Brazil. Rodrigo's work with us focused on finishing the laboratory portion of his PhD research on the genetic population dynamics of silky and night sharks in the Atlantic. This was Rodrigo's third visit to the SOSSRC and he has become an expert on the generation and analysis of genetics data. During his 2015 visit, Rodrigo analysed nuclear markers and pushed hard to get through the loads of shark samples he had collected from Brazilian fisheries. Given the amount of work he accomplished in the month he was here, I don't think he could have slept much! He has already submitted a manuscript on his silky shark work to a journal. As a side note, Rodrigo's football (or 'soccer' in the United States) skills are incredible. He almost became a professional football player in Brazil before he decided that research, especially tied to marine conservation, was his true calling.

We're looking forward very much to future collaborations with our international colleagues. We've even picked up some Arabic and Portuguese words, much to the amusement of our friends!

he SOSSRC's own research made substantial progress in 2015. We focused our efforts on the arenas of conservation genetics and, increasingly, genomics. Dr Andrea Bernard, now a research scientist at the SOSSRC,

used next generation sequencing methods to generate several thousand genome-wide markers for tiger sharks in order to understand the detailed global population dynamics of this highly migratory apex predator. Cassandra Ruck finished the lab portion of her thesis on the global genetics of the critically endangered oceanic whitetip shark, a species once thought to be one of the most abundant of open-ocean sharks. Cristín Fitzpatrick started her thesis genetics work on the critically endangered angel shark, a species that was once widespread in the western North Atlantic but is now rare outside the Canary Islands.

On the genomics side of things, we continued our research in collaboration with colleagues at Cornell University (USA) and Saint Petersburg State University (Russia). The overall goal of this massive project is to understand how sharks function at their most fundamental level, their entire genomes, and use that knowledge to enhance awareness of their remarkable biology and of their importance.

Our work on generating sequences of the white shark genome made large strides, followed by initial genome assembly. That in turn was followed by even more sequencing to improve the completeness of the assembly. This is a highly technical process and it works in that the next generation sequencing technologies we used produced millions of small snippets of white shark DNA sequence. These were then assembled into much larger sections of the shark's genetic code. One way to understand this procedure is to think of these small DNA snippets as analogous to short, incomplete sentences that make no sense as yet. The incomplete sentences have to be assembled into properly formed, complete sentences (comprising much longer DNA sequences), which in turn have to be properly ordered into paragraphs and then the paragraphs coherently connected into a very long book (the genome) that has, in this case, a biological story. This genome assembly work, known as bioinformatics, is computationally intensive and analytically complex, requiring very powerful computers. Our analysis has revealed the white shark genome to be almost twice the size of the human genome. Why it's so large and what genes reside in it are the overriding questions - and the subject of our ongoing investigations. This work was presented at two conferences: the American Society of Ichthyology and Herpetology Conference in 2015 and the Plant and Animal Genome Conference in January 2016. We have now achieved a statistically sound genome assembly with high coverage. The next step is genome annotation, which involves identifying which genes are present and which are unique to sharks.

However, to properly understand the evolution and function of sharks and rays (elasmobranchs) and what makes them such unique and amazing animals, we have to carry out all this high-tech genomics exploration in a comparative context. To achieve this we followed a two-pronged approach: we conducted highcoverage sequencing of the genome of the great hammerhead shark, a globally endangered species; and we obtained, assembled and annotated sequences of all the expressed genes (collectively known as transcriptomes) from the heart tissue of multiple elasmobranchs (white, shortfin mako, great hammerhead and yellow stingray) and of bony fishes (swordfish and the coral reef species, hogfish and ocean surgeonfish).

Comparison of the transcriptomes from these seven species, plus the zebrafish (a biomedical model) and human has revealed some very exciting findings that highlight novel aspects of the elasmobranch immune system. The whole genome sequences from the great hammerhead shark (a cold-blooded species) are currently undergoing computational assembly. Once assembly and annotation are complete, the genomes of the hammerhead and white shark (a warm-blooded species) will be compared in detail, with the goal of understanding which genes they share and which genes are unique to each to explain their very different physiological properties.

As a side benefit of these genome studies, the huge amounts of DNA sequence data generated are providing hundreds of genetic markers to trace the population dynamics of these and related species in unprecedented detail, providing pathways to improve their management.



# SOSF D'ARROS RESEARCH CENTRE RAINER VON BRANDIS





ince the Save Our Seas Foundation began managing the D'Arros Research Centre in 2013, the centre has grown significantly, both in its ability to conduct research and in its project portfolio. Our projects fall into three categories: long-term monitoring, targeted research and ecosystem rehabilitation.

We have continued to collect data for all the long-term monitoring programmes at D'Arros Island and St Joseph Atoll. Nesting turtle numbers are still increasing steadily and hard corals are making a strong recovery following the severe bleaching event in 1998 that decimated corals in the region. Fortunately, in 2015 the sea temperature remained below the coral bleaching threshold. So far our manta and turtle identikits include 110 mantas, 297 resident hawksbill turtles and 67 green turtles. Capture-mark-recapture models suggest that the manta population in the Amirantes island group exceeds 150 animals and that more than 600 hawksbill and 2,000 green turtles reside at D'Arros and St Joseph.

Our current targeted research projects investigate the ecology of sharks, mantas, turtles, stingrays and fish, and they all have a tracking component that utilises state-of-the-art technology. Acoustic tags have been fitted to 30 stingrays, 15 turtles and 30 bonefish; 84 turtles have been flipper-tagged; 277 juvenile sharks have been PIT-tagged; and three juvenile sharks have been tracked in the atoll using GPS tags. In addition, the diets and trophic ecology of many stingrays, juvenile sharks and bonefish have been investigated by means of lavage and stable isotope analysis. Although still in their early stages, each of these projects is already producing exciting and novel results and the prospects for high-quality scientific publication are good.

Forest rehabilitation efforts have focused on St Joseph Island, where we have cleared more than 2.5 hectares (six acres) of abandoned coconut forest. Our mangrove reforestation programme is making steady progress as a result of improvements to our planting methodology and the rapid growth of established trees.

## **A. LONG-TERM MONITORING PROGRAMMES**

A healthy coral reef at D'Arros Island.

Some coral reefs have recovered to the state they were in before the 1998 bleaching event.

## 1. CORAL REEFS AUTHOR: DR RAINER VON BRANDIS PRINCIPAL INVESTIGATOR: SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF

It is important to monitor the coral reef surrounding D'Arros Island and St Joseph Atoll so that we can measure its response to natural or man-made disturbances over long periods of time. For us as humans, the perception of change tends to be limited to our own lifetimes. Consider for instance a retired fisherman who as a child caught at least 10 times more fish in a day than he does now. In his eyes, fish stocks were healthy or even plentiful 'back in the day' when he was a youngster. However, his deceased grandfather probably caught 20 times more fish in his day – and his forefathers even more. Thus, the fisherman's perception of what is meant by 'healthy' fish stocks is undoubtedly incorrect. This tendency to apply inappropriate baselines to assess environmental health has been termed 'the shifting baseline syndrome' (Pauly, 1995) and is probably one of the most significant contributors to our global environmental problems. Not only does our coral reef monitoring programme alleviate the effects of this syndrome, but it also measures the rate of potential change and suggests its probable causes.

The Save Our Seas Foundation–D'Arros Research Centre (SOSF-DRC) operates a number of complementary projects to monitor the coral reef ecosystem at various locations around D'Arros Island and St Joseph Atoll. Individual facets of the programme as a whole are: sea surface temperature and sea level; benthic cover and composition; coral recruitment; coral growth and survivorship; coral bleaching; and reef fishes. These variables are monitored at 11 survey sites on an annual basis. 2016 marks the fifth year of consistent monitoring, making it the longest uninterrupted, multifaceted coral reef monitoring programme in the Outer Islands of the Seychelles.

#### AMBIENT ENVIRONMENTAL PARAMETERS

Anomalies in water temperature can have profound effects on coral reef ecosystems. In 1998, more than 70% of hard corals in the Seychelles region perished due to uncharacteristically extreme warming of the sea. Given today's changing climate and recent coral bleaching events, it is of utmost importance to monitor sea temperature and to integrate this data into coral health surveys. This will help us to predict the severity of potential bleaching events before they occur and estimate the corals' recovery and mortality rates. The data will also add to our global understanding of the effects of climate change on our environment and help to raise awareness. The SOSF-DRC has been permanently monitoring the sea temperature at 20 coral reef sites around the islands since 2011.

Sea surface temperatures during 2015 followed the usual annual pattern (figure 1). Fortunately the typical temperature spike in April and May was less pronounced than in the previous year and thus no coral bleaching was observed.

#### **BENTHIC COVER AND COMPOSITION**

Significant changes in the cover and composition of benthic communities may occur as a result of climate change, overfishing, pollution or physical damage. Nearly all marine organisms within the realm of D'Arros and St Joseph depend on the coral reef to some extent, so trends in its cover and composition represent major indicators of the present and future status of surrounding marine ecosystems.

The 2015 photoquadrat survey generated 26,400 random points that were identified and categorised using Coral Point Count software. Major categories were: bare ground (49.8%); hard corals (28.3%); coral algae (12.5%); sand (4.4%); sessile invertebrates (1.8%); soft corals (1.5%); macro algae (1.5%); and mobile invertebrates (0.1%).

Although coral recovery was slow in the first decade following the devastating 1998 bleaching event, recent years have seen a steady increase in coral cover (figure 2) and several areas have regained their pre-1998 glory. Because the rate of coral recruitment has more than doubled in the past few years, we can expect coral cover to improve at an ever-increasing rate until there is no more room on the reef substrate (as long as there is not another severe bleaching event).





Figure 1: Sea surface temperature at one of 20 sites around D'Arros and St Joseph over the past four years.



Figure 2: Benthic composition at D'Arros and St Joseph over the past four years. Note the steady increase in hard corals.



#### **RECRUITMENT OF POCILLOPORA AND ACROPORA CORALS**

Acroporidae and Pocilloporidae are dominant coral families at D'Arros and St Joseph that are highly susceptible to coral bleaching. The severe sea warming event in 1998 resulted in the death of most of the corals in both families. Since then, they appear to have been recovering steadily in numbers. This monitoring programme quantifies the recruitment rates of these corals and investigates sizespecific survival and mortality rates in concert with prevailing climatic conditions.

When all 11 sites are considered collectively, the number of *Acropora* and *Pocillopora* recruits per unit area has more than doubled and tripled respectively over the past four years. Consequently, we can expect these two coral families to become increasingly prominent on the reef in the years ahead.

## GROWTH AND SURVIVORSHIP OF *POCILLOPORIDAE* AND *ACROPORIDAE* CORALS

An investigation into the growth rate and survivorship of these two prominent coral families at D'Arros and St Joseph is important for developing a better understanding of coral reef ecology. How fast do these corals grow, what is their lifespan and what causes their mortality? Previous studies of coral growth have occurred over a relatively short term and usually involved destructive methods. Easy access to coral recruits will enable us to collect morphometric measurements of individually tagged corals over several years so that we can assess long-term growth and survivorship curves.

In 2013 50 recruits of each species were tagged along the north-facing reef crest of D'Arros Island. Three years later nearly half the corals of both species have perished, mostly as a result of mechanical damage caused by storms, fish and turtles. Some mortality also occurred during the minor bleaching event in 2014. Growth rates varied considerably between individuals. Generally, acroporids grew at least twice as fast as pocilloporids did. *Acropora* table coral recruits (less than five centimetres, or two inches) are capable of producing a diameter of 32 centimetres (12 inches) in just three years.

#### **CORAL BLEACHING**

We conduct broad- and fine-scale surveys in years when bleaching occurs. During periods when the sea water is abnormally warm, symbiotic algae that live in the coral skeleton are expelled, resulting eventually in the death of the corals. Fortunately, water temperature did not exceed the critical threshold in 2015 and no bleaching was observed.

#### **REEF FISHES AND MOBILE INVERTEBRATES**

Changes in reef fish and invertebrate communities may occur as a result of fishing practices, climate change and changes in benthic composition and cover. Some fishes (such as coral-eating species) and invertebrates are considered indicators of reef health, whereas population explosions of some invertebrates (such as crown of thorns and *Drupella* snails) cause damage to coral communities.

Although fish diversity has changed little over the past five years, general fish abundance has increased by 70%. This is mostly in response to the recovering coral reef and changes in local fishing practices. Fish families that have shown the most notable increases are damselfishes (Pomacentridae), butterflyfishes (Chaetodontidae), parrotfishes (Scaridae) and groupers (Serranidae). Blacktip reef sharks have also become a common sight on the reef. The numbers of mobile invertebrates have remained mostly unchanged. An outbreak of crown of thorns starfish was noted along a portion of reef in the south of St Joseph. However, when it was visited again a few weeks later the situation had normalised.



< Acropora corals have shown a high recruitment rate at D'Arros Island.

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Over the past five years, blacktip reef sharks have become common on the shallow reefs of D'Arros Island and St Joseph Atoll.

The current nesting turtle monitoring team measuring a turtle track: Gerard, George and Ralph

#### 2. COMMUNITY MONITORING OF NESTING SEA TURTLES **AUTHOR:** DR JEANNE MORTIMER **PRINCIPAL INVESTIGATOR:** DR JEANNE MORTIMER FIELD PERSONNEL: CHELONIA STAFF, DR JEANNE MORTIMER

#### PROGRAMME BACKGROUND

Sea turtles have long been of economic importance to the people of Seychelles. Historically they were killed to extract products for export. Calipee from green turtles was used in Europe to make turtle soup, and the scales covering the shell of hawksbill turtles were removed to produce 'tortoise shell', a semi-precious material originally exported to Europe and later (between 1960 and 1992) to Japan. In addition, turtle meat has always featured prominently in traditional Sevchelles cuisine.

In 1994 the Sevchelles government passed a law (Wild Animals [Turtles] Protection Regulations) that offered complete legal protection to all sea turtles and their eggs. The export trade ceased, but some human customs and habits die hard and many Seychellois, especially among the more traditional population in the Outer Islands, retained a taste for turtle meat.

There was a need to get people to see turtles in a different light and one of the best ways to do that is to encourage coastal people to take ownership of conservation programmes involving sea turtles. The D'Arros Research Centre achieved this by enlisting Seychellois labourers who work on D'Arros Island during the day to monitor the nesting beaches of D'Arros at the end of their work day and paying them overtime to do so. Once a week the workers go across to the more remote St Joseph Atoll and monitor nesting activity on the beaches there.

#### OUTPUTS OF THE PROGRAMME

The monitoring programme has three principal elements, conservation, social and scientific, and benefits can be seen in respect of each one. In terms of conservation, the part-time turtle workers develop a fondness for the living turtles, an appreciation of the need to protect them and a sense of ownership of the turtle conservation programme. As a result, they refuse to tolerate any poaching of turtles by members of their own community, and poaching ceases. None of the workers involved with the project have a scientific background, so the programme reaches members of the Seychellois community who might not otherwise get involved in conservation.

Social benefits are that the turtle workers usually enjoy the work and they appreciate the opportunity to do something meaningful outside normal working hours, while also making some extra money. Most of them are adult men engaged in physical labour, so having to fill in the data sheets gives them a chance to revive and enhance their literary skills. Some have staved with the turtle project for long periods (seven years in one case) and two of them went on to become full-time conservation rangers on other islands in the Sevchelles after they had left D'Arros.

From a scientific point of view, the D'Arros and St Joseph turtle monitoring programme was the first such study to be implemented anywhere in the Amirantes Islands when it was initiated in 2004. Over the years it has gathered valuable data that document many aspects of the status and biology of the turtle populations. These include the following:

- The species that occur. Hawksbill turtles *Eretmochelys imbricata* and green turtles Chelonia mydas nest on the islands and forage in large numbers. There is evidence of small numbers of loggerhead turtles Caretta caretta too (a dead juvenile loggerhead that washed ashore was recovered by members of the monitoring team).
- The number of turtles nesting each year. Based on the data collected during the past five seasons, we estimate that approximately 110 hawksbills nest on D'Arros Island and 180 at St Joseph Atoll; and about 30 green turtles nest on D'Arros and 170 at St Joseph. Considered as a single site, D'Arros Island and St Joseph Atoll host the largest nesting population of hawksbill turtles (290) in the Seychelles. This is important given that the IUCN lists the hawksbill as a Critically Endangered species and that the Seychelles hosts one of the four largest national populations of nesting hawksbills anywhere in the world.
- Population trends. In the early years of the monitoring project, numbers of nesting turtles remained relatively constant from year to year. Recently, however, the numbers have increased, indicating that conservation efforts are paying off.





Figure 3: Nesting seasonality of hawksbill and green turtles at D'Arros Island and St Joseph Atoll.



- Nesting seasonality. Hawksbill turtles everywhere in the Seychelles, including at D'Arros Island and St Joseph Atoll, have a nesting season that peaks from mid-October to mid-January (figure 3). Green turtle nesting is more variable, with seasons in the Western Indian Ocean that differ from one site to another. Generally, however, more northerly sites (near the equator) tend to peak during the austral winter and more southerly sites (away from the equator) during the austral summer (Dalleau et al., 2012). So we were surprised to find that the nesting season of green turtles at D'Arros Island from February to April (Mortimer et al., 2011) is consistently different from that at St Joseph Atoll, which runs from June to October (Mortimer et al., unpublished data). The reasons for this difference between two locations only two kilometres apart are unknown, but may be related to water temperature.
- The genetic characteristics of hawksbills appear to be relatively consistent at most nesting sites in the Seychelles (Phillips, Mortimer et al., 2014). However, preliminary data indicate that green turtles nesting in the Amirantes Group may be genetically distinct from those nesting in the southern islands of the Seychelles (Bourjea, Mortimer et al., 2015).

D'Arros Island and St Joseph Atoll have been recognised as one of the most important sites for sea turtles in the Western Indian Ocean, given the relatively high numbers of hawksbill and green turtles nesting on the same breeding beaches. With continued protection we can expect their numbers to increase.

A juvenile hawksbill turtle captured by Ryan Daly.

A juvenile green turtle in St Joseph Atoll.

#### 3. GROWTH RATES AND POPULATION SIZE OF RESIDENT JUVENILE HAWKSBILL AND GREEN TURTLES AUTHOR: DR RAINER VON BRANDIS PRINCIPAL INVESTIGATOR: SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF, RESEARCH ASSISTANTS

The objective of this long-term study is to gain a better understanding of population numbers, demographics, growth rates and movements of juvenile foraging turtles at D'Arros and St Joseph. Both hawksbill and green turtles recruit into the neritic environment when they attain approximately 35 centimetres (14 inches) in carapace length and will remain there for 10 or more years (Diez and Van Dam, 2002). Efforts to conserve foraging hawksbill populations are hindered by a lack of basic demographic and ecological information. Although there is an increasing number of foraging population studies in the Atlantic Ocean, fundamental data such as population demographics, habitat requirements, home range and movements of foraging hawksbill and green turtles are largely lacking for the Western Indian Ocean.

D'Arros and St Joseph support a high density of juvenile foraging hawksbill and green turtles and provide a unique opportunity to study and monitor the populations of these endangered species.

Although the hawksbill is less common in the area, the study so far has focused more on this species as it has suffered a global decline of more than 90% and is considered by the IUCN to be Critically Endangered, yet is also data deficient.

In 2015, 51 hawksbill and 33 green turtles were caught using the 'rodeo' method, which entails leaping off the front of the boat and grasping the turtle, and the 'beach jump' method, in which feeding turtles are stalked on foot in the shallows at low tide.

The SOSF-DRC has captured 297 hawksbills since 2006. Several turtles have been recaptured on multiple occasions (as many as 11 times) and the maximum period between first and last captures is 10 years. The annual number of recaptures versus new individuals has never exceeded 40%, which suggests that the number of juvenile hawksbill turtles residing in the D'Arros and St Joseph protected area is well over 600. Considering that the global population of hawksbill turtles has declined so dramatically, this is a highly significant population that requires strict protection. Recapture data show that hawksbill juveniles at D'Arros and St Joseph grow extremely slowly – about one centimetre

(less than half an inch) per year – and significantly more slowly than at other locations (2–5 centimetres, or 1–2 inches, is the norm). Since the density of foraging hawksbills at D'Arros and St Joseph is one of the highest in the world, we suspect that this slow growth rate is a consequence of competition for food resources.

Since 2006 we have captured and tagged 67 green turtles. This species is much more difficult to catch as the turtles are extremely fast and quickly take off at the sound of an approaching boat. Furthermore, they are seldom encountered on foot in shallow areas at low tide and thus can only be captured using the rodeo technique. Nevertheless, they appear to be much more abundant than hawksbill turtles and in 2015 we increased our flipper-tagging effort in an attempt to quantify their growth rates and to gain a better estimate of their foraging numbers. Of the 67 individuals tagged, we have had no recaptures. Based on visual estimates, we speculate that the foraging green turtle population at D'Arros and St Joseph exceeds 2,000 individuals.



#### 4. POPULATION STRUCTURE, RESIDENCY AND BEHAVIOUR OF REEF MANTAS AUTHOR: DR RAINER VON BRANDIS PRINCIPAL INVESTIGATOR: SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF

The SOSF-DRC undertakes opportunistic surveys to establish the identity of mantas present around D'Arros Island. This information enables us to determine the population size and structure of mantas in our area and, to some extent, their residency and behaviour. We also use a stereo-video camera to measure mantas at cleaning stations with a view to establishing growth rates. During surveys we document the underside of as many mantas as possible, as the pattern of spots and stripes is unique to each manta, much like fingerprints in humans. The photographs are then added to the identikit database to determine whether the individuals are new to the area.

To date, 110 individuals have been identified, which means that the Amirantes manta population is probably the biggest in the Seychelles. Of these, 63 are adults (35 females and 28 males), 37 are juveniles (13 females and 24 males) and 10 could not be categorised accurately. Although mating behaviour has been observed, mantas visit D'Arros and St Joseph mainly to feed on near-shore plankton aggregations and to visit the cleaning stations. So far, 28 individuals have been measured with the stereo-video system, of which the largest measured 3.78 metres (12.4 feet) across and the smallest 2.31 metres (7.6 feet).



5. WEATHER AUTHOR: DR RAINER VON BRANDIS PRINCIPAL INVESTIGATOR: SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF

In May 2014, the SOSF-DRC installed a new weather station (Davis Vantage pro2) on D'Arros that, in addition to the usual variables (temperature, rainfall, humidity, barometric pressure, wind speed and wind direction), records solar and ultraviolet radiation, both of which may play a significant role in coral bleaching.

Mean monthly temperatures followed the usual pattern, with the hottest month in April and the coolest in July (figure 4). The coldest and hottest temperatures recorded on D'Arros were 22.8 °C (73 °F; on 17 August) and 32 °C (89.6 °F; on 31 December) respectively.

Annual rainfall was 1,181 millimetres (46.5 inches), which is well below the average of 1,490 millimetres (58.7 inches). The highest amount of rainfall received in one day was on 26 December (109 millimetres or 4.3 inches).

Wind speed and direction were normal with the north-wester dominating from November until March and the south-easter from April to October (figure 5). Maximum wind speed was recorded in July at 56.3 kilometres per hour (35 miles per hour).

Mantas aggregate off D'Arros Island at certain times of the year to feed on plankton.





Figure 4: Average temperature (top) and total rainfall (bottom) at D'Arros Island in 2015.



Total monthly rainfall (mm)



Figure 5: Predominant monthly wind direction and average strength during 2015.



## **B. TARGETED RESEARCH PROJECTS**

An aggregation of juvenile stingrays in St Joseph Atoll.

A feathertail stingray (left) and a porcupine stingray (right) in St Joseph Atoll.

#### 6. THE ECOLOGY OF STINGRAYS AT ST JOSEPH ATOLL AUTHOR: CHANTEL ELSTON PRINCIPAL INVESTIGATOR: CHANTEL ELSTON FIELD PERSONNEL: CHANTEL ELSTON, SOSF-DRC STAFF, DR PAUL COWLEY

Research into elasmobranch ecology has traditionally been minimal, with studies on rays and skates in particular lagging behind those on sharks (Bizzarro et al., 2007; Tilley and Strindberg, 2013). However, this is starting to change as researchers realise the ecological importance of rays (O'Shea et al., 2012) while simultaneously noting their population declines globally (Dulvy et al., 2014). Three species of stingray are found throughout St Joseph Atoll: the cowtail ray *Pastinachus sephen*, the porcupine ray *Urogymnus asperrimus* and the mangrove whiptail *Himantura granulata*. Given its remote location and marine reserve status, the atoll represents a pristine ecosystem with limited anthropogenic impacts. This means that research done here can provide useful baseline insights into the ecology of stingrays in the absence of the effects of human activities.

An understanding of an animal's trophic ecology opens a window into its behaviour and the role it plays within an ecosystem (Navia et al., 2007). Although references in many field guides state that mangrove, cowtail and porcupine rays eat bony fish and bottom-dwelling crustaceans, there have been no detailed dietary analyses, with the exception of one study conducted in Australia on the porcupine ray (O'Shea et al., 2013). Therefore, part of our study is to determine what these species eat, whether their diets overlap and whether juveniles eat the same prey items as adults. In 2015 we performed the non-lethal technique of gastric lavage on 92 mangrove whiptail and feathertail rays in an attempt to collect stomach contents from them. The procedure yielded stomach contents from 66 of the rays, to add to the 55 stomach content samples we collected from porcupine rays in 2014. The analysis of data for the porcupine rays revealed that they are generalist and opportunistic predators, feeding on a wide variety of prey items but predominantly on those that were most abundant in the environment.

Stomach contents enable us to determine the dietary composition of stingrays with a high level of detail, but they don't inform us whether the stingrays change their diet as they age. To determine this, we collected muscle samples from 106 stingrays (spanning all three species) and these samples will be analysed to determine their stable isotopic composition. If the juveniles and adults show different stable isotopes, we can say they eat different prey. In addition, we collected 173 samples of potential prey items for these stingrays (including shrimps, worms, crabs and prawns). The stable isotopes of these prey items will be compared to those of the stingray muscle samples. This is to validate the accuracy of the dietary composition obtained from the stomach content samples, as the latter are subject to certain errors that may occur, for example if not all prey items are evacuated from the stomach during gastric lavage (Baker et al., 2014).

To protect these species, an understanding of their movement patterns and the drivers behind these patterns is also important (Filmalter et al., 2013). Juvenile and adult stingrays are abundant in St Joseph Atoll but are seldom encountered on the surrounding reefs. It is thus hypothesised that the atoll is an important area for these species, particularly the juveniles.

Thirty stingrays were tagged with acoustic transmitters in 2015, adding to the 30 individuals that were tagged in 2014 (20 individuals in total for each of the three species). The transmitters emit acoustic signals that are picked up by receivers strategically placed within and around the atoll. The stingrays are detected whenever they pass close to a receiver, which means we can continuously and passively monitor their movements. Data for juvenile porcupine rays have been analysed and it was found that the young rays display high levels of residency to the atoll over a period of a year. Their movements, moreover, are restricted and most detections occurred within one kilometre (1,100 yards) of their tagging locations. This provides evidence that the atoll serves as a nursery area to juvenile porcupine rays. Water depth and temperature were found to influence movement patterns and juveniles were found to seek out the shallowest waters, presumably to avoid predators.

It is vitally important to protect these species as the porcupine ray is listed as Vulnerable, the mangrove ray as Near Threatened and the feathertail ray as Data Deficient by the IUCN. The information gathered by this research project will help not only to devise a management plan for the stingray population of St Joseph, but also to understand and protect these species as a whole throughout their wide-ranging distributions.



#### 7. HABITAT AND RESOURCE PARTITIONING OF JUVENILE SHARKS AT ST JOSEPH ATOLL AUTHOR: ORNELLA WEIDELI PRINCIPAL INVESTIGATOR: ORNELLA WEIDELI FIELD PERSONNEL: ORNELLA WEIDELI, SOSF-DRC STAFF

Wherever related and/or ecologically similar species with similar habitat and dietary preferences co-occur, competition for similar natural resources are expected (Gause, 1934). To avoid such competitive interactions, animals segregate into different ecological niches either by using different parts of their habitat or by foraging on different prey. At St Joseph Atoll, the blacktip reef shark *Carcharhinus melanopterus* and the ecologically similar sicklefin lemon shark *Negaprion acutidens* utilise shallow water as their nursery ground. The sharks' early life stages, in which the species' movements are restricted to the shallow waters, provide us with an opportunity to study how mutually used nursery resources are partitioned among species. Using multifaceted study methods, the project's core aim is to understand what ecological patterns enable these two shark species to coexist, while baseline data are used to assess the populations for conservation and management purposes.

For each juvenile shark caught, a work-up is conducted that includes taking length and weight measurements, attaching a PIT tag, taking a photograph of the dorsal fin (for identification in case of recapture), extracting a small fin sample for DNA analysis and recording the environmental parameters of the catch locations. To test for segregation patterns in habitat and resource use, some of the juveniles are actively tracked through their nursery, while the diet of others is investigated using non-lethal gastric lavage and analysing blood and plasma for isotopic signatures. The combination of both these methods to investigate diet enables us to get detailed insight into the sharks' dietary patterns.

Since the initiation of this project in November 2014, 425 juvenile sharks have been caught at St Joseph Atoll (562 including recaptures from the first and second sampling season). Capture locations recorded in the three consecutive sampling seasons show that areas in the eastern part of the atoll and around its islands are most frequently used by juveniles of both species (figure 6). These areas are sheltered, shallow and rich in prey, which is probably why they attract a high number of sharks.

Of the 425 sharks caught, 200 were lemon sharks and 225 were blacktip reef sharks; 200 sharks were male and 225 were female. These results indicate



#### ∨ Figure 7

Two manual tracks of the same individual blacktip reef shark. The first track was conducted in November 2014 (light blue) and shows how the neonate shark (born in October 2014) used areas close to the protective island at high tide and moved towards the deeper and less protective lagoon at low tide. In October 2015, the same shark was tracked again (dark blue), only about 700 metres (765 yards) from where it was initially tracked. Again the shark was using areas close to the island at high tide and moved away from its protection at low tide.

a similar population size of juvenile blacktip reef and lemon sharks, with an approximately 1:1 sex ratio. Juvenile blacktip reef sharks ranged from 39.5 to 97 centimetres (15.5 to 38 inches) in total length and juvenile lemon sharks from 56.6 to 110.6 centimetres (22.3 to 43.5 inches) in total length. As both species are viviparous and therefore born with an open umbilical scar (healing time is approximately 2–4 weeks), the different stages of umbilical scar can be used to estimate the time of parturition. We found that the pupping season is between October and March, which is about the same time as the pupping season for both species at Aldabra Atoll (1,000 kilometres, or 620 miles, from St Joseph; Stevens 1984).

The combination of 26 manual tracks and the recapture locations of 137 tagged sharks indicate that both species use a very small part (1–2 square kilometres or 247–494 acres) of the atoll and that they stay in these areas for the first years of their life. This pattern has previously been demonstrated in the Atlantic lemon shark *Negaprion brevirostris* in Bimini, The Bahamas, where juveniles show very small daily home ranges that only slightly expand during their first years of life. Moreover, by repeatedly tracking a juvenile male blacktip reef shark over one year, we demonstrated that even if the shark experienced significant individual growth (16.8 centimetres or 6.6 inches per year) and doubled its weight, the size and location of its daily movements have not changed significantly (table 1 and figure 7). In summary, with our one year dataset we are not yet able to determine the level of segregation or overlap patterns between the two species, but we have obtained important and detailed insight into their ecology.

After attempts to collect stomach samples by everting the stomach during the first sampling season (November and December 2014) proved unsatisfactory, we are now using gastric lavage. This non-invasive method enables us to collect the shark's stomach contents by inserting a tube into the stomach and flushing it. Compared to stomach eversion, lavage is very fast and requires no anaesthetic, and the shark can be released immediately afterwards. During the second and third sampling seasons we were able to apply gastric lavage to a large number



Table 1. Measurements of a recaptured blacktip reef shark that was tracked in two consecutive years

|             | Date of<br>tracking<br>event | TL (cm) | Weight (gr) | Claspers<br>(mm) | State of<br>umbilical scar |
|-------------|------------------------------|---------|-------------|------------------|----------------------------|
| 1ST CAPTURE | 23/11/2014                   | 52.9    | 900         | 27               | Just closed                |
| 2ND CAPTURE | 22/10/2015                   | 69.7    | 1700        | 39               | Faint scar visible         |



of sharks. A first attempt to analyse stomach contents by means of molecular identification was conducted in June and July 2015 at the Save Our Seas Shark Research Center (SOSSRC) in Florida and resulted in positive identifications. In both shark species, largescale mullets *Chelon macrolepis* dominated the diet, although the number of samples was small and this finding should therefore be treated with caution. Stomach samples from the third (September and October 2015) and fourth (March and April 2016) seasons will be analysed at the SOSSRC later in 2016.

For the upcoming year, two field-work seasons are planned. The first was from mid-March to mid-April and the second will be from mid-September to mid-October. The first sampling season aims to finish collecting stomach and blood samples and complete the manual active tracks. The second field season will be dedicated to applying a new technique of tracking, which involves using GPS loggers in combination with VHF devices. During both sampling seasons I will continue to collect fin clips for DNA parental analysis. Laboratory analyses are planned for June, July and August.

Tracking a juvenile lemon shark manually.

#### 8. SPATIAL AND TROPHIC ECOLOGY OF BONEFISH IN ST JOSEPH ATOLL AUTHORS: EMILY MOXHAM AND DR PAUL COWLEY PRINCIPAL INVESTIGATOR: DR PAUL COWLEY FIELD PERSONNEL: EMILY MOXHAM. DR PAUL COWLEY. SOSF-DRC STAFF

Knowledge of bonefish in the Indian Ocean is lacking. Aspects such as the habitat the species depend on and which fisheries they support is relatively unknown. In contrast, Albula vulpes, a bonefish species in the South Pacific, has been extensively studied and its movements and patterns of habitat use have been documented, as have declining population trends. Information such as this, identifying the spatial and trophic ecology of bonefish in the Indian Ocean, is essential if they are to be managed and protected in this region. There is an important recreational fishing industry in the Seychelles that makes a significant contribution to the economy of many of the nation's isolated islands.

With the overall aim of improving our understanding of bonefish in the Indian Ocean, this project will undertake a global review of the state of knowledge of bonefish species and identify the gaps in our understanding of bonefish in the Indian Ocean; will investigate the spatial and temporal movements of acoustically tagged bonefish within and around St Joseph Atoll; and will determine the trophic ecology of bonefish within St Joseph Atoll.

Thirty bonefish were tagged at St Joseph Atoll with Vemco V13 transmitters on a field trip undertaken in May 2015 and the movements of the fish were tracked for six months. Of the 30 bonefish tagged, 10% survived the duration of the monitoring period, 3% survived for 104 days, 17% survived between one and two weeks, 40% survived for less than a week and 30% were either never detected or were detected on only one receiver. Literature suggests that the apparently high mortality rate can be attributed to the high abundance of predators in the atoll. Analyses comparing the last 100 hours of tag detections to general behaviour of bonefish are currently under way to test this hypothesis.

Of the fish that survived, analyses on residency, space use and the environmental influences on short-term space use are currently being conducted.

During a field trip in May 2015, muscle tissue samples were extracted from 32 bonefish for stable isotope analysis. These samples were sent to the University of Windsor (Canada) where they are currently being analysed. On a separate field trip, Chantel Elston and the SOSF-DRC research team collected potential bonefish diet items at St Joseph Atoll. The isotopic signatures of these samples are also being analysed and will later be compared to the bonefish tissue samples. In this way, we hope to determine predominant diet items.



Dr Paul Cowley uses his novel fish containment method that minimises capture myopathy and reduces the likelihood of potential post-capture predation by sharks

#### 9. MOVEMENTS OF JUVENILE HAWKSBILL TURTLES AT D'ARROS **ISLAND AND ST JOSEPH ATOLL** AUTHOR: DR RAINER VON BRANDIS **PRINCIPAL INVESTIGATOR:** SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF. RESEARCH ASSISTANTS

D'Arros Island and St Joseph Atoll support a dense resident population of foraging hawksbill and green turtles (Von Brandis et al., 2010). Hatchlings disperse from nesting beaches via oceanic currents and remain on the pelagic sea surface until they recruit into neritic habitats, such as those at D'Arros and St Joseph, at a carapace length of 25–35 centimetres (10–13 inches; Diez and Van Dam, 2002). Juveniles and adults generally do not share foraging grounds (Blumenthal et al., 2009), so our foraging population comprises exclusively juveniles. In comparison to other juvenile foraging sites, this area is unique in that it affords turtles a greater variety of habitats. The turtles utilise predominantly three of these: sea-grass beds on the outer reef flat (0-2 metres; 0-6.5 feet), mudflats on the inner reef flat (0-1)metre; 0-3.3 feet) and the deeper coral reefs (5-16 metres; 16.4-52.5 feet).

This project seeks to investigate the detailed movements of these Critically Endangered turtles in order to improve local management capacity; increase the little information there is globally about the ecology of foraging turtle populations; and confirm the importance of D'Arros and St Joseph for these species.

Coded acoustic transmitters have been deployed before on turtles to elucidate home range and habitat use (Blumenthal et al., 2009). However, because acoustic tags can only be attached externally, previous tag deployments have generally been short in duration (often for not more than six months). During trials conducted on 10 turtles at St Joseph Atoll in 2013, we devised an attachment method that has improved tag retention significantly. Indeed, after nearly three years most of these tags still appear to be attached.

#### HAWKSBILL TURTLES

A total of 25 tags have been deployed on hawksbills captured at various locations around the islands within the three dominant foraging habitat types. The first 10 tags were deployed in June 2013 and most are still active. The previous external acoustic tag deployments on similar-sized turtles report retention rates of less than a year. Our tag attachment protocol has more than tripled this record.



#### Figure 8:

Red crosses denote acoustic receivers and blue circles represent the number of detections. Resident hawksbill turtles utilise a variety of habitats at D'Arros and St Joseph. Some restrict their movements to the inner mudflats of the atoll [a], some utilise the outer reef slopes and flats of the islands (b) and others forage more widely (c). Turtles whose movements are restricted to the mudflats live in a non-abrasive, algae-rich environment and are thus often covered with algal growth (photo opposite).

To date, data suggest a variety of foraging strategies and home range sizes (figure 8). Specifically, 13 of the 25 turtles appear never to leave the inside of the atoll, spending most of their time on the food-rich mudflats in the south-east. Indeed, copious algal growth on the outsides of these turtles gives testament to this fact. In contrast, seven turtles appear never to venture into the atoll, but prefer to forage along the coral reef slopes and reef flats around D'Arros and St Joseph, feeding on cryptic sponges (Von Brandis, 2010). The remaining five turtles make use of the full variety of habitats, regularly moving in and out of the atoll.

At least three turtles have recently left the area. One turtle was last recorded on a receiver five kilometres (three miles) to the south-east of the atoll, while another was last detected on a receiver 20 kilometres (12 miles) to the north-west of D'Arros. The third turtle was captured by fishermen near Malindi in Kenya more than 1,400 kilometres (870 miles) away (figure 9). The fishermen caught it by accident in their net and delivered it for reward to the Local Ocean Trust at Watamu. This track constitutes the longest migration ever recorded for a hawksbill turtle of such a small size.



#### Figure 9:

A juvenile hawksbill turtle that was tagged in St Joseph Atoll on 2 July 2013 maintained a small home range in the atoll (inset) until 27 October 2014, at which time it embarked on a 1,480-kilometre journey to Kenya where it was captured by fishermen on 3 October 2015. It was released unharmed a few days later in the Watamu Marine Protected Area by the Local Ocean Trust.



# (b)



#### Figure 10:

Red crosses denote acoustic receivers and blue circles represent number of detections. Smaller resident juvenile green turtles appear to remain in the atoll at all times (a), whereas larger individuals move in and out in concert with the tidal pattern (b).

## **GREEN TURTLES**

The first green turtle tags were deployed late in 2015 and thus reported tracks only represent a few months of movement. Nevertheless, preliminary data suggest that green turtles also appear to maintain small home ranges (figure 10). Interestingly, larger turtles tend to move in and out of the atoll in concert with the tides. That is, turtles enter the atoll on the rising tide to feed on the productive sea-grass beds in the south-east of the atoll and then leave the atoll on the receding tide. This pattern has been reaffirmed through opportunistic scuba dives along the outer edges of the atoll at low tide, during which many turtles can be found resting under overhangs.

A freshly tagged green turtle is released after the epoxy holding the external acoustic tag has set and anti-fouling paint has been applied.



## **C. HABITAT RESTORATION**

10. FOREST REHABILITATION AUTHOR: DR RAINER VON BRANDIS PRINCIPAL INVESTIGATOR: SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF

Terrestrial ecosystems at D'Arros and St Joseph have suffered considerably at the hand of man. By the early 1800s the native vegetation had been almost entirely replaced with coconut plantations and nearly all the mangroves had been cut down for timber. Fortunately, management intervention can significantly accelerate recovery in the terrestrial environment, which is not the case for marine ecosystems. The SOSF-DRC currently manages an ambitious forest rehabilitation project in which abandoned coconut plantations are being systematically replaced with indigenous forest.

In 2010 a series of experiments were initiated on D'Arros in an attempt to develop a simple, cost-effective and yet efficient technique of coconut forest rehabilitation (Von Brandis, 2012). Although the primary aim of this research was to rehabilitate large sections of D'Arros, a secondary objective was to encourage the initiation of effective rehabilitation programmes on other islands affected in the same way. The resulting rehabilitation protocol was termed the 'canopy rehabilitation method' as it involves preserving the upper coconut canopy in order to provide a shaded environment on the forest floor. The benefits were improved survival and growth rate of planted native forest seedlings; reduced establishment of the herbaceous layer and other invasive plants; and enhanced natural regeneration of remnant native vegetation. Once the native trees have formed a mid-level canopy of their own, the remaining coconut palms are gradually eliminated by injecting herbicide into their stems.

Compared to clear-cutting, this method is less labour-intensive; does not require the use of heavy machinery or expensive equipment; improves the survival and growth rates of planted tree seedlings; promotes the natural establishment of native plants; and limits population explosions of invasive alien plants. Consequently a strategy for a large-scale programme was devised and implemented in May 2010. The average turnaround time from virgin coconut forest to self-sustaining broadleaf forest is just four years, giving testament to the efficiency of the canopy rehabilitation method. Today, more than 16 hectares (39 acres) are currently under rehabilitation on D'Arros Island (figure 11) of which more than half can be considered completed. A new rehabilitation site has been established on St Joseph Island in the vicinity of the camp (figure 12). In 2015 more than 2.5 hectares (six acres) were cleared of unwanted vegetation at this site by SOSF-DRC staff, who removed more than 600 mid-level coconut palms by chainsaw and thousands of coconut saplings by hand. Afterwards, thousands of broadleaf tree seeds were dispersed at the site, many of which have already taken root.

Fixed photography provides evidence of the efficacy of the ehabilitation method. The image above was taken in March 2011 and the one below in March 2015. ^ Figure 11: Forest rehabilitation sites on D'Arros Island.

> Figure 12: Forest rehabilitation site on St Joseph Island.



Figure 13: Mangrove reforestation sites in the south-east of St Joseph Atoll.



11. MANGROVE REFORESTATION AUTHOR: DR RAINER VON BRANDIS PRINCIPAL INVESTIGATOR: SOSF-DRC FIELD PERSONNEL: SOSF-DRC STAFF

Mangroves are a vital component of healthy atoll ecosystems in that they significantly improve biodiversity and productivity. Specifically, they:

- provide nursery grounds for fish, rays, sharks, crabs and several invertebrates
- create leaf litter, a valuable food source for many animals
- protect coastal environments from erosion
- provide roosting and breeding habitat for several seabird species
- provide suitable habitat for several fish, crab, mollusc and invertebrate species that would otherwise not be present in the atoll.

Although there is no historical record of the distribution and abundance of mangroves in St Joseph Atoll, they were almost certainly more abundant in the past. Mangroves were heavily exploited in the Seychelles during the 1800s and 1900s for timber, as the wood is resistant to termites. At one time more than 100 people lived on St Joseph Island and there is little doubt that mangroves were heavily depleted. Today, only remnant stands of the red mangrove *Rhyzophora mucronata* occur at Benjamin, Paul, Chien, Fouquet and St Joseph islands. Because these remnant stands are small (the largest is about 2,500 square metres or 26,900 square feet), current forest expansion is slow. Mangrove stands tend to gain momentum as they expand in size; over time, increasing numbers of prop roots trap more silt and slow water flow, thus making conditions more suitable for saplings. In order to accelerate the expansion of stands and create new ones in suitable areas, a mangrove reforestation programme was initiated in 2014.

After extensive trials we have designed a logistically feasible reforestation protocol that appears to be working well. Previous studies have shown that red mangroves can attain more than two metres (6.5 feet) in height in just seven years. Once these trees begin to bear fruit of their own, the reforestation process should show exponential growth.

Subsequent to reforestation methodology trials in 2014, during which 450 propagules were planted in site 1 (figure 13), 47 mangrove trees had taken root. In 2015 170 propagules were planted in the same area and 73 of these survived, bringing the total number of surviving plants to 120. Growth has been surprisingly rapid and many plants have already grown to more than one metre (three feet) in height.

Another 130 propagules were planted in site 2 (figure 13), but were washed away because the substrate was unsuitable (too sandy and not enough mud) and the tidal influence was too strong (the site was closer to the central lagoon). This experiment has improved our understanding of mangrove reforestation and has enabled us to refine our selection process of new reforestation sites (3-5, figure 13).

## **D. OTHER ACTIVITIES**

#### **12. RESCUE OF A MELON-HEADED WHALE**

A juvenile melon-headed whale *Peponocephala electra* was found stranded on the eastern reef flat of D'Arros Island in September 2015. This species is identified by its melon-shaped head, dark grey face, slender, torpedo-shaped body, long pointed flippers and tall pointed dorsal fin. It is most closely related to the pygmy killer whale and pilot whale. After re-stranding itself following its first release not far from the reef flat, the exhausted whale was transported further out to sea using a kayak. It was last seen swimming strongly away from the island.

## 13. REPAIRS AND IMPROVEMENTS TO ST JOSEPH CAMP

SOSF-DRC staff and visiting researchers have been making increasing use of the small outpost on St Joseph Island as an overnight location while working in the atoll. The outpost consists of derelict buildings from the coconut plantation era (the plantation was abandoned in the late 1970s) and includes a rudimentary kitchen, toilet and shower, a rainwater catchment and two bedrooms. Over the past two years we have revamped these facilities considerably in an attempt to make them more habitable. The roof, windows and doors have been replaced, new beds built, the kitchen and toilet improved and the rainwater catchment rebuilt. A barbecue fireplace has been built and a generator and solar panels installed. An outdoor shower has recently been added and a roof built over the outdoor cooking area.



Rescue of a stranded melon-headed whale at D'Arros Island.

The research camp on St Joseph Island. Prior to forest-clearing efforts in 2014, the camp was completely surrounded by coconut palms.

#### 14. REMOVAL OF FISH AGGREGATION DEVICES

Fish Aggregation Devices (FADs) are deployed at sea by purse-seine tuna fishing boats to help them catch fish. They consist of a wooden or metal frame approximately two metres by two metres (6.5 feet by 6.5 feet) with a GPS attached. The FAD floats on the surface and is usually wrapped in netting material, much of which hangs up to 20 metres (65 feet) below it. It is left to float at sea for several weeks before the fishing vessel relocates it. For unknown reasons, fish tend to aggregate underneath these FADs, so the fishermen deploy their purse-seine nets and extract all the fish. Because of the staggering number of FADs being used in recent years, we have noted an increase in the number of washed-up devices on surrounding reefs. Once stuck on the reef, FADs do significant damage to corals and pose a threat of entanglement to sharks, turtles, mantas and fish. Removing the FADs from the reef is time-consuming as they are difficult to untangle from the corals and need to be towed by boat to a place where they can be dragged ashore. In 2015 nine FADs were removed from the atoll and the surrounding reefs.



A Fish Aggregation Device entangled on the coral reef at D'Arros Island.

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# **SOSF SHARK** EDUCATION CENTRE ELEANOR YELD HUTCHINGS

Centre. Plans that had been put in place in 2014 were implemented and renovating the centre's exhibition space. This was the major focus of my there was real change on the ground. work during the year and we made huge progress, surpassing even our The year started off on a very inspirational note for me as the manager own expectations. First up was the garage, which we had turned into a ship-themed classroom of the SOSF Shark Education Centre, when the assistant educator Ntombizanele Maviva and I jetted off to the annual Marine and Coastal Educators Network late in 2014. Watching this project take final shape was extremely exciting. We conference in early January. This was my first introduction to the network. The had custom-built furniture installed and hung 'porthole' picture frames on the conference was held in the very unlikely location of Pretoria in the Tshwane wall, with underwater creatures and lamps, ropes and other marine-themed items Metropole, the executive capital of South Africa. Pretoria is nowhere near the sea giving the impression of the inside of a ship. This immersive, themed classroom so it's an odd place indeed to find a gathering of marine and coastal educators! creates just the right atmosphere for learners visiting the education centre to feel However, South Africa is unusual for a country with a long coastline in that that they are having a whole experience rather than merely a lesson. Plus, the most of its population lives inland, where the rich mineral resources that fuel seating capacity has improved enormously and we can now seat 48 children at tables in the classroom and many more just on chairs. Additional benefits are that the economic hub of the country are found. Any environmental education that is going to have any real impact needs to take that into account. And, of course, having tables means that we can use them for activities, crafts and projects, and the conference's location in Pretoria was a wonderful platform to introduce the with the newly refurbished and painted garage floor we can do wet-work or get concept of connectivity and how our actions all over the planet impact our oceans. messy and then just wash off the floor! Over the course of five days we were introduced to many wonderful educators Moving to the main building of the Shark Education Centre, the floor plan working in all spheres of education, from government to school and parastatal and layout proved to be challenging because the centre is located in a very to non-profit. They shared their work with us and took us through some of the beautiful, old building with heritage status and structural changes to it are not activities they have developed for use in and out of the classroom. It was truly permitted. The first thing to do was embrace a theme based on our mission statement from which to work. This theme then had to be fleshed out into a inspirational to see how much amazing work is happening around the country, to be recharged with new ideas and to think about the year ahead. In addition, we storyline so that a cohesive and logical flow of information, exhibit content and were taken on excursions to places that left us in awe of our natural environment progression could be followed as each part of the centre was developed. The theme and acknowledging how lucky we are to live in South Africa. As well as botanical we decided on was 'Sharks are awesome, not fearsome'. This helps those who are gardens and nature reserves, we visited the Maropeng Centre in the Cradle of afraid of sharks to realise that being afraid is completely acceptable, yet you can Humankind (a major influence in our own centre's revamp) and the Sterkfontein be afraid of something and still find it fascinating and appreciate its awesomeness! Caves, which gave us something to think about in terms of where we come from. It takes nothing away from the very real fear of sharks that many people have, but at the same time showcases the wonderful creatures that they are. The theme also gave us room to expand on the context in which sharks occur and thus bring the rest of the marine ecosystem into focus. We explored 'Sharks are awesome, not

# **Save our seas** shark education centre

015 was a year of making things happen for the SOSF Shark Education

n our return to Cape Town it was time to step up the process of



fearsome' further and developed it into a storyline that highlights what we want people to learn and incorporates the information that we provide, thus enabling us to use the centre itself as a teaching tool that supplements our lessons.

We lost no time in getting going with the various exhibits we had lined up. Firstly, we had two exceptionally talented artists come in and paint two beautiful murals for us. One is an interactive, three-dimensional mural painted and built in the short passageway under the stairs. Its touchable kelp, realistic-feeling kelp forest animal models and reef structure are superimposed on an immersive backdrop and give visitors the impression that they are really underwater, enabling them to explore the sub-tidal environment of False Bay without ever having to go diving themselves. This mural segued into the second one, a pelagic seascape rising up the stairwell that features some of the best-known and best-loved local pelagic predators. These two murals immediately gave a new feeling to the centre and we couldn't wait to get on with the rest of the exhibits.

Up next was the revamp of the aquarium tank, with a focus on 'Sharks in the Intertidal', 'Shore Sharks' and 'False Bay Ecosystem'. We had emptied the tank and returned its much-loved creatures to the sea at the end of 2014 and had put the new tank stand in place. We now added a custom-made, starfish-shaped

touch-pool and the two were joined and re-plumbed. Some white wooden cladding was attached, linking to the garage's ship theme, and the new aquarium was ready to roll! After a few collecting expeditions we were able to stock the tank and touch-pool with all sorts of weird, wonderful and wacky creatures.

To complete the intertidal and tank area, a special microscope neck was built and a powerful dissecting microscope added, connected to a large high-definition screen mounted on the wall. Now not only can visitors and learners look at and touch the various tide-pool animals, but also we are able to put the creatures under the microscope and project them to a group of people, sharing the wonders and beauty of close-up details that just can't be explained: the moving spines of a sea urchin, the tube-feet of a cushion star, the stinging tentacles of a sea anemone. We stocked the shelves nearby with a range of exciting marine items for investigation under the microscope, and signage around it showcases some of the 'up-close' wonders of ocean animals and plants.

In addition, a new exhibit called the 'scratch patch' was designed and built for the Shark Education Centre. Representing the sandy shore of a beach, it has items that might be found there, such as shells, shark eggs, shark teeth, sponges and pieces of coral. Each item matches up to a drawer below with a specially built handle in the shape of the item. The drawer contains more examples and information. This is a multi-tiered exhibit: young children can merely hunt through the sand to find treasures; older children can put items under the magnifying plate and examine them more closely; and those wanting to know more can find a wealth of information and interpretation in the drawers.

By now the centre was looking and feeling very different and the reactions we were getting from school groups were very positive indeed. But we were not done yet! The arrival of a large, touch-screen table with a custom-designed, hightech interactive 'shark game' generated huge excitement. The game comprises a vast amount of information about a number of shark and ray species - their appearance, unique features, habitat, size and distribution – a gallery of photos and videos, and news about Save Our Seas Foundation projects relating to each of really feels like!

Another new exhibit, which is just waiting for its wall mounts before going on display, focuses on hearing. It is our 'dial-an-animal' phone, which enables visitors to choose a local marine species from the directory and call it. The species will then 'speak' to the caller via the phone's handset, explaining about its life. We can't wait to put it up and see how much excitement it generates and how it opens up a whole new way of learning.

Towards the end of the year, although we were by no means finished, we had accomplished enough to announce with great excitement that we would soon be reopening the education centre to the general public. We did this during National Marine Week in October and the response from the community has been overwhelmingly positive! Much more is still in the pipeline, with some truly incredible exhibits and displays having been commissioned or in development and production. But that is for 2016, which is sure to be an even more exciting year as all our exhibit plans come to fruition.

those species. Designed for up to four players, it was an instant hit and is still one of the most popular of the new exhibits.

One of the aspects of learning that we wanted to incorporate in the new exhibits was the use of all the senses, so that people learn in different ways (and don't get too fatigued with reading!). So we focused on touching and hearing in addition to reading the signage and looking at the murals and aquarium tank. The touch-pool enables visitors to feel live animals, but there are a lot of other creatures that we are not able to keep in a touch-pool and that many people will never have the chance to get their hands on. We introduced touch panels, which are hinge-mounted frames hanging on the wall, each containing a model of different marine animal skin. Visitors can feel the skin and try to guess what animal it belongs to before lifting the panel to read the identity of the animal and some interesting facts about how the skin is adapted to oceanic conditions. This has proved very popular and many people are astounded by what a shark, penguin, southern right whale, Cape fur seal, yellowtail, lobster or porcupine fish





When school groups were not able to come to the centre, the education staff went to them, visiting on average one school a month in 2015 and reaching about 550 children between the ages of five and 18.

We also continued our very successful Marine Explorers Club programme, running two six-month clubs in 2015. One club was run with Capricorn Primary School and the other with Muizenberg Junior School, both located close to the shores of False Bay. During these programmes, 12 Grade 5 learners in each club were introduced to surfing for three months and then snorkelling for three months. We found that getting them into the gentle waves at Muizenberg, where they could stand safely and were still able to get used to being ducked under the waves, was a perfect introduction to having fun in the sea. Although all the participants are carefully selected and are able to swim before starting the Marine Explorers programme, we have found that being able to swim in a pool is a far cry from being a confident swimmer in the sea. With generous support from Xpression on the Beach, a surf shop in Muizenberg that sponsored board rental for the programme, and vigilant supervision by the wonderful volunteers from the University of Cape Town's (UCT) Underwater Club, we soon made enthusiastic surfers out of all the participants. Next up was their introduction to the underwater world with a course in snorkelling. Here we were very grateful to Pisces Dive Centre and PADI, who not only gave us access to their pool and training centre facilities, but provided an instructor and dive master to teach the necessary skills and supervise pool and sea dives, making sure that by the end of the three months every participant was awarded PADI diver certification. Once again, we were supported by UCT's Underwater Club volunteers, without whom we would not have been able to run these programmes. Reef Wetsuits also came on board, and we purchased all the equipment for the programmes from them at very generous rates.

Building on the Marine Explorers programme, we once again ran two Marine Awareness Camps at the Soetwater Environmental Education Centre in Kommetjie during the year: one in the mid-year school holiday and one at the end of the year. These camps were run for the same schools as the Marine Explorers and also with Grade 5 pupils. Because 30 children from each school attended the camp, we were still able to expose those who were not able to participate in the Marine Explorers Club to some of the wonders of our coastline, immersing them for three days in the best kind of learning: experiential, field-based, active and fun! The residential camps were fully sponsored, which meant that those who would normally never have the opportunity to do these kinds of activity were given a chance to experience them. On both camps we were joined by UCT's Underwater Club volunteers and on the December camp we partnered with the Save Our Seas Foundation's Youth Ocean Ambassadors (YOA) programme, offering its participants a chance to get involved in environmental education and see what it is all about – and, of course, offering the camp attendees an opportunity to meet young women from South Africa and the Seychelles who are passionate about the ocean and about making a career from their passion.

During three of the South African school holiday periods we again offered our popular Holiday Clubs for children aged between six and 11 who want to have fun and learn about the ocean. As has been the case previously, the clubs proved extremely popular and were fully booked long in advance, with 20 children





attending each day. Each Holiday Club varied between two and four days in length and included such activities as lessons about sharks, rock-pooling, science experiments (in our newly furbished ship-themed garage classroom), beach hunts, coastal walks, harbour tours and, naturally, a lot of swimming.

any other events that took place in 2015 formed part of the Shark rematch! Education Centre's activity calendar. We took part in National Science All in all, it has been a year of getting things done, enjoying the rewards that Week, exhibiting at the Expo for Careers in Science; Eleanor was one come with real change and sharing everything we have done with the community of the panel for the \$0Fathoms Film Festival in celebration of World and the public at large. However, it has also left me with an overwhelming sense of anticipation for 2016. I simply cannot wait to see everything that lies ahead for the SOSF Shark Education Centre and am eagerly looking forward to the expressions of awe and wonder that I know await us.

Oceans Day; we joined forces with Plastics SA, Saudi Basic Industries Corporation and Star of the Sea School in St James to host a very successful International Coastal Clean-up Day event under the auspices of the Ocean Conservancy; and we celebrated Nelson Mandela Day by coming together with the SOSF Conservation Media Unit to bring sharks, seas, snacks and sing-alongs to a crèche in Masiphumelele (a nearby township). In addition, we gave many, many public talks to clubs and associations over the course of the year and as a direct result have already been inundated with requests for bookings - and outings to the education centre - in 2016.

One event that must be mentioned is the 3rd Southern African Shark & Ray Symposium, which was hosted by the Shark Spotters and Save Our Seas Foundation in False Bay this year. It was a wonderful conference, with excellent scientific talks, events and networking opportunities. The Shark Education Centre and the Conservation Media Unit, together with our researcher-in-residence Lauren De Vos, ran a highly popular 'Science Communication' workshop at the symposium. The Shark Education Centre hosted the welcome evening, our first opportunity to showcase the amazing new exhibits and the centre's redesign. It was agreed by all that this was the best (and biggest) of Southern African Shark & Ray symposiums so far and it has set the bar high for those in future. To end off the year we participated in the annual Wavescape Film Festival, of which the Save Our Seas Foundation is a key sponsor. Once again we ran our

extremely popular 'Edutainment' area at the Wavescape Fish Fry event and this year for the first time we were invited to enter a team into the Sustainable Seafood Braai-off, a barbecue competition run by WWF-SASSI and Pick 'n Pay. Although we didn't win the main prize, we had a lot of fun and walked away with the award for the best work station and an invitation to come back next year for a


uring 2015, the Save Our Seas Foundation's Conservation Media Unit was a force to be reckoned with, delivering magazines, newsletters, updates and a new website for the foundation, co-organising a local symposium and other shark-related events and all while producing top-quality content for our Save Our Seas channels. Key to our success was the welcome addition of our designer, Miguel Oliveira, who joined us in July and provides an exciting new visual dimension to our work. Almost every month of the year held something new and exciting.

We kicked off 2015 with the third issue of the Save Our Seas magazine, featuring the work of the two inaugural winners of our Marine Conservation Photography Grant, Mac Stone and Joris van Alphen. Issue 3 was a visual feast with beautiful imagery of False Bay and its inhabitants from the grantees and an infographic from a Capetonian artist, with stories written by me and Philippa Ehrlich to accompany them. Philippa also contributed a feature about one of our project leaders, Iqbal Elhassan, who works with Sudan's sharks. In parallel with the magazine's epic False Bay showcase, we published an online immersive feature with additional multimedia content – interviews, video and more photos from Mac and Joris – to take the stories to a larger audience.

But this feature was just one of our achievements in the digital space for the year. Two notable milestones were reached that have contributed to our online presence. One was the launch of a fresh, new website to represent the Save Our Seas Foundation online (www.saveourseas.com). And the other was a website dedicated to the Save Our Seas magazine and the stories therein (www. saveourseasmagazine.com). Both websites, while beautiful to look at, offer much more than simply an attractive interface for navigating our content. Behind each one lies a database with information about all our projects and every story published in the magazine: quite an undertaking! Our aim with the new Save Our Seas Foundation website, as well as the four satellite centre portals that we launched in concert, is to provide our project leaders with a platform from which they can share their work with our audience. We are serious about our

# save our seas conservation media unit

communication and that of our project leaders, and our website is a vehicle for making effective science communication happen. To this end, during the course of the year we published 169 blogs from our project leaders and foundation updates about our activities.

Our new websites have helped to ensure that the online presence of the Save Our Seas Foundation is accessible and current. Social media have helped to support this through the sharing of marine-related content, particularly the stories of our project leaders, on Facebook, Twitter and Instagram. During the year our audience across all three channels grew steadily, with the biggest increase on Instagram (see graphic on page 72).

On social media and elsewhere online, one of the most significant campaigns we launched aimed to draw applicants to our 2016 Marine Conservation Photography Grant. This is the second time we've opened this important competition and one of the goals of the campaign this year was to attract applicants from all corners of the globe and see stronger representation from outside Europe, the United States and South Africa. The grant was advertised on blogs and social media, and although – as I write – we are still in the application phase, we're excited to see the calibre of the submissions and announce the winners.

We also had the chance during 2015, with the additional design capacity provided by Miguel, to help some of our project leaders with their local outreach endeavours. For Dipani Sutaria, who works regularly in fish markets on the west coast of India, a poster illustrating the local shark species and their relative sizes was a valuable tool we helped to create in order to inform fishers about the sharks they were catching and assist Dipani in communicating with them. Ruth Leeney sought a poster-size version of our sawfish infographic (published in issue 2 of the Save Our Seas magazine) translated into French and Malagasy for distribution among the villages where she works to raise awareness about these rare fishes.

As the year flew by, the fourth issue of the Save Our Seas magazine rolled around quickly and production was in full swing during Cape Town's winter





Social media growth in 2015

and spring. The highlight of the issue: a portrait of the Great Bear Rainforest, featuring beautiful imagery and writing from Ian McAllister and Janie Wray, and our director of conservation, Thomas Peschak.

artnering in our local capacity to host the Southern African Shark and Ray Symposium with the Shark Spotters was a highlight of the year. The symposium's peripheral events were what made it such a memorable experience, and much more than a gathering of scientists. This third time around, the symposium was held in Cape Town, South Africa.

The opening event, which was also the preliminary launch of the Shark Education Centre after its renovations, set the tone for a successful and sophisticated symposium – and this is what was delivered. While the presentations and workshops were of a high standard at the symposium, which was attended by 110 representatives of academic institutions, NGOs, government agencies and industry, it was the public #LoveFalseBay speaker evening that drew the biggest crowd. About 500 people showed up to see the speakers, including scientists, photographers, students, environmentalists and NGO representatives, who presented what's happening – biologically, scientifically and ecologically – in False Bay.

One of the symposium's side events – and to me, one of the Save Our Seas Foundation's great successes of the year – was an outdoor photo exhibition coordinated by the Conservation Media Unit. Running from Muizenberg beach to St James on the False Bay coast is a seaside walkway known locally as the Muizenberg catwalk. Visited year-round by locals and by tourists too, the walkway was identified by our team as a potential avenue for sharing – beyond our computers – the beautiful images from the winners of the 2014 Marine Conservation Photography Grant, which we work with daily. Jade Schultz, our content marketer and social media manager, led the project and the outdoor exhibition went up just in time for the symposium. The result was awe-inspiring. Throughout the day from early morning to evening, people strolling along the catwalk were treated to world-class photographs revealing the world beneath the waves. As the images were in a public space, they were free for everyone to enjoy: children and adults, the poor and the wealthy, locals and visitors, avid divers and those who have never ventured beneath the waves. The exhibition is still on display.



uring the last few weeks of the year another public event, the Wavescape Film Festival, enabled us to continue to engage with the public. The festival is an annual surf and ocean event – and a highlight on our calendar. It is organised during South Africa's summer every year, and for 12 years the Save Our Seas Foundation has sponsored it. We also take the opportunity of the festival to spread some #goodsharkkarma, and 2015 was no different. This time around we wanted to draw people into a shark-friendly space on the beach with a tempting combination of cold drinks, shade, fun and fins.

Free soft drinks were on offer. Body painters, a photo booth and props delivered fun, ambassadors spoke to anyone willing to listen, beach umbrellas cast shade and an outdoor photo exhibition from Thomas Peschak's book *Sharks and People* provided stimulus. The scene was set against an idyllic beach backdrop at the Wavescape Film Festival Beach Screening, held on Clifton 4th Beach in Cape Town, South Africa. The event was one that drew crowds of people into a world of sharks. The Conservation Media Unit team intended to spread one message: sharks are not the killers you may think they are; they are fascinating and awesome in so many ways. And for the hundreds of people who entered our space, this is what they found out. The success of this message is among the many feathers in the cap of the Save Our Seas Foundation for the year.









*Save Our Seas* magazine: Issue 03, Summer 2015



*Save Our Seas* magazine: Issue 04, Winter 2015



# OUR PARTNERS REPORTS FROM THE SAVE OUR SEAS FOUNDATION PARTNERS AROUND THE WORLD



# SARAH WARIES & ALISON KOCK









SARAH WARIES

ALISON KOCK

### MONWABISI SIKWEYIYA

015 is officially on record as the year with the highest number of shark bites. According to the International Shark Attack File, 98 unprovoked incidents, six of them fatal, were recorded worldwide. Given that millions of people used the ocean last year, the number of shark bites is statistically low. Nevertheless, just one incident is a high-profile event that can influence policy towards sharks and their conservation. In this context, Shark Spotters continues to stand out as a proactive, environmentally responsible solution to keeping people safe without killing sharks or harming the environment. We strive to achieve coexistence between people and sharks by protecting people and conserving sharks in the waters around Cape Town through innovative and responsible shark safety solutions, by increasing knowledge with applied research and by raising awareness for better understanding.

#### SAFETY

Last year Shark Spotters provided an uninterrupted service at eight of Cape Town's beaches from 8 am to 6 pm daily and recorded 104 shark sightings. This brings to 1,962 the total number of sightings since the programme began in 2004, most of which occurred in the summer months. Of these sightings, 52% resulted in temporary beach closures while the shark was in close proximity to water-users. In addition to spotting services, we deployed a shark-exclusion net off Fish Hoek beach for 116 days over peak recreation periods. This oneof-a-kind net is set up and retrieved on a daily basis to limit its impact on the environment and is safe for all marine life. Together the services provided by Shark Spotters keep people and sharks apart, thereby reducing the risk of shark bites.

We believe that collaborating with others and sharing knowledge are the keys to growth and improved services. Last year we provided logistical support and expertise to the KwaZulu-Natal Sharks Board during its trial of an electric shark-repellent cable at one of our beaches. Unfortunately, low shark activity made it impossible to test the cable's effectiveness for repelling sharks and more tests are needed. We also started testing an HD camera system with the objective of improving the detection of sharks along the coast. Eleven videos of sharks close to shore were recorded from our lookouts and the data from them will be used to determine the feasibility of such a system.

To ensure that our team of 40 shark spotters are prepared to deal with emergencies, additional first aid and emergency management training were provided. There were many occasions when the spotters' skills were needed on the beach, from attending to nasty gashes from surfboards to responding to drownings in progress. Early last year we welcomed two interns into our ranks, in the roles of research assistant and communications assistant, through the City of Cape Town's Sustainable Internship Programme. This had an immediate positive effect on our capacity and enabled us to increase our research and communication objectives.

In October 2015, an independent review of bather protection technologies was compiled for Australia's New South Wales (NSW) Department of Primary Industries. It considered 18 different options for either detecting or deterring sharks at NSW beaches and graded them using nine criteria, including the practicalities of deploying equipment along an exposed coastline, durability and longevity, human health, stakeholder opinion, expense and the efficacy of the technology at either deterring or detecting sharks. Shark Spotters was the only bather protection method that received a positive outcome for all nine criteria. This exemplifies the success of our programme and how it can be applied in other areas.

#### **RESEARCH AND CONSERVATION**

Understanding the behaviour of sharks close to shore is one of our key strategies for improving the management of important habitats, the advice on shark safety that we give and our public awareness campaigns. In 2015 we spent 50 days at sea tagging white and sevengill sharks and retrieving and deploying acoustic receivers. To date we have determined that white sharks are present all year round in False Bay, but that they use the bay very differently, depending on the season and their sex. Peak shark occurrence at Seal Island is during the austral winter months, whereas peak inshore occurrence is in summer. And the ratio of males to females around the island is equal, whereas females dominate in the inshore areas. We have also determined that most of the white sharks in False Bay are either juveniles or sub-adults, with few young-of-the-year or adults present. Although we have a good understanding that Seal Island is used primarily as a feeding area for maturing white sharks, it is still unclear what the primary function of the inshore area is. We have therefore increased our efforts to investigate this aspect of white shark ecology.

Members of the Shark Spotters team co-authored three peer-reviewed papers and one peer-reviewed book chapter in 2015, delivered four conference presentations and co-hosted the 3rd Southern African Shark and Ray Symposium.

We strongly believe in building capacity for marine science in South Africa and therefore supervise and support three post-graduate students and provide job-shadow and internship opportunities for young scholars. The students' research covered a wide range of topics: the effect of white shark predation on the spatial and temporal patterns of Cape fur seals at Seal Island; the fine-scale habitat use of white sharks around Seal Island; the first record of dusky sharks preying on a humpback whale calf; the deployment of the shark-exclusion net at Fish Hoek for the past two years; and the spatial patterns and trophic relationships of sevengill sharks.



One of the highlights of 2015 was co-hosting the 3rd Southern African Shark and Ray Symposium, which was attended by 114 delegates (the highest number to date) representing major academic institutions, government agencies, NGOs and industry. The symposium helped advance science by fostering collaborations and providing leadership to younger scientists and students.

Our research network and reach, and thus our opportunity to effect change, were expanded last year when we partnered on three major programmes. The first, called the False Bay Collaborative Met-Ocean Project, involves long-term oceanographic monitoring and aims to ensure that research on the physical oceanography of False Bay is coordinated and consistent. Understanding the bay's physical oceanography will give us greater insight into how it impacts shark behaviour and distribution.

Our partnership with the second programme came when we were nominated to join the Shark Advisory Group for the implementation of South Africa's Shark Biodiversity Management Plan (SBMP), led by the Department of Environmental Affairs. The SBMP aims to achieve and maintain a favourable conservation status for sharks and rays in South Africa and gives us the opportunity to meet regularly with policy-makers in shark management.

In the third project, we partnered with the Acoustic Tracking Array Platform (ATAP), which is a marine science programme affiliated to the Ocean Tracking Network (OTN) and monitors the movements and migrations of inshore marine animals. We are responsible for managing several receivers in Cape Town at three inshore sites between Cape Hangklip and Hout Bay and we tag various shark species that are monitored on the entire array, which stretches from Hout Bay to Mozambique.

We received generous sponsorship last year from the University of Cape Town (UCT), the Save Our Seas Foundation (SOSF) and the Two Oceans Aquarium. With the UCT grant we were able to purchase 16 additional acoustic receivers and could thus expand our array to Robben Island. In 2016 we will deploy four receivers on the west coast in Saldanha Bay. The funding from the SOSF enabled us to purchase more acoustic transmitters and covered most





of our running expenses. The Two Oceans Aquarium supports primarily our sevengill shark project, providing us with funds for equipment and supplies and assisting with logistics in the field, such as having a qualified vet available to conduct any surgical procedures that may be needed.

Education about sharks and awareness of their presence are vital components of an effective strategy for shark safety. Knowing about recent shark sightings ensures that people can manage risk and make informed decisions when using specific beaches. We therefore post online all shark sightings in real time via social media to let people know when a beach is closed, when it is open again and whether there are any high-risk conditions they should be aware of.

Over the December (summer) holidays we ran a very successful 'Be Shark Smart' awareness campaign with the aim to dispel common misconceptions about sharks and to inform the public about measures they can take to keep themselves safe while in the ocean. Every day over the holiday period we posted a new infographic and shark fact or safety tip. We also started to develop a mobile app that will give people access to all the shark sightings and more, such as prevailing weather conditions and which shark flag is flying at a specific time. Our shark information centre on Muizenberg beach has been operating for more than a year now and is open every day, enabling us to expand our interaction with the public on a daily basis. Thousands of individuals visited the centre last year and as well as hosting numerous talks for schools and clubs it served as a training classroom for our spotters. It also enables us to provide additional services to the public, from first aid to the storage of personal belongings while their owners are enjoying the beach.

Sharing our knowledge and experience with others is very important to us. We dedicate a lot of time to giving presentations to other organisations and one of the highlights in 2015 was being invited to a specialist workshop by the Prince of Monaco's Oceanographic Institute to discuss non-lethal

#### EDUCATION AND AWARENESS

methods to reduce shark bites. Back home, we gave presentations to local ratepayers' associations, schools and research groups – and even participated in a PechaKucha night at Cape Town City Hall, with an audience of more than 800 people. With the Save Our Seas Foundation we also hosted a hugely successful 'Love False Bay' speaker evening as part of the 3rd Southern African Shark and Ray Symposium.

In a more hands-on approach, and together with the City of Cape Town, we invited local politicians and resource managers to join us on 11 of our field trips to Seal Island. This gave us an opportunity to showcase the fantastic ocean life of False Bay. We also participated in or advised on a number of high-quality documentaries, which included the stunning series BBC Shark. Documentaries such as these reach a much wider audience than we can ourselves. Providing an accurate and balanced view of shark-related issues is important to us because there is still so much misinformation about sharks. In 2015 we provided interviews and quotes for at least 97 news stories that appeared worldwide.

Through the generous support of South Africa's top surfing magazine, ZigZag, we ran a 'Be Shark Smart' campaign over five issues. Each advertorial covered a major theme: shark diversity in South Africa, the ecological role of sharks, threats to sharks, safety tips for surfers and co-existing with sharks. We also wrote popular articles and blogs for the BBC website, the Save Our Seas Foundation and the Two Oceans Aquarium, and we contributed to the South African Network for Coastal and Oceanic Research newsletter. One of our articles for the Conversation Africa edition was read by more than 78,000 people.

#### FUNDING

Most of our funding comes from the City of Cape Town and the Save Our Seas Foundation and we are extremely grateful to them. In 2015 we also organised three successful fundraisers that managed to raise a significant portion of our annual shortfall. In June, the Ta-Da Creperie and Coffee Bar at Surfers Corner, Muizenberg, hosted a Shark Spotters comedy fundraiser. Local comedian Nik Rabinowitz had the crowd in stitches, and thanks to generous donations from local businesses and individuals we held a raffle, lucky draw and auction that together raised R58,000.

In October we ran a *#MyFalseBay* Instagram competition that invited people to send us their best photos showcasing the beauty of False Bay. Nearly 550 images were submitted and the top 100 were printed and displayed in Primi Piatti in Muizenberg to go on sale. For every photo sold, another copy of it was donated to the Children's Hospital Trust. Several well-known photographers donated stunning images that were framed and put up for auction. The competition as a whole raised almost R60,000.

In December we were once again supported by Wavescape through its Art Board Project and Wavescape Festival, which has been raising awareness and funds for ocean charities since 2005. Each year, artists turn surfboards into works of art for an exhibition that ends with an auction. This year the auction took place at the popular Tiger's Milk Restaurant in Muizenberg and all the proceeds from it were divided among Shark Spotters and several other ocean charities.

Public and corporate donations of funds, equipment or services enable us to make up the rest of our shortfall and we thank Terracor, Maskew Brands, Bondi Blu and Brian Roos Opticians for their contributions. We are deeply grateful to everyone for their ongoing support; without it we would not be able to provide the service we do. Nor could we continue in our endeavour to realise our vision – the sustainable co-existence of people and sharks.





# CETACEA LAB THE NORTH COAST CETACEAN SOCIETY JANIE WRAY & HERMANN MEUTER





**JANIE WRAY** 





he North Coast Cetacean Society (NCCS) has been stationed yearround at the remote field station Cetacea Lab on Gil Island off the coast of British Columbia, Canada, since 2001. Its purpose is to monitor whale activity by using a network of radio-linked hydrophones and conducting land-based and boat-based surveys. Prior to 2008, NCCS efforts to document the occurrence of cetaceans in this region focused primarily on the waters surrounding Gil Island, with occasional boat-based surveys into Caamano Sound. In June 2008 the society expanded its network of radiolinked hydrophones into Caamano Sound by installing a hydrophone station at Rennison Island. With the support of the Save Our Seas Foundation and the permission of the Gitga'at First Nation, a land-based out-camp was then established at the nearby Wall Islets. Its aim is to supplement visually the ongoing acoustic monitoring in order to document cetacean travel patterns in Caamano Sound and assess more accurately the frequency of cetacean occurrence in the region.

This report summarises our study of two orca populations and fin and humpback whales during the 2015 season.

# A. DETECTING CETACEANS

To detect the presence and movements of orcas and whales we rely on shorebased and boat-based observations and on a hydrophone network that alerts us acoustically to their presence. The shore-based observations are from two locations: Cetacea Lab on Gil Island and an out-camp on the Wall Islets.

#### 1. FROM SHORE

With the permission of the Gitga'at First Nation, Cetacea Lab was built in 2002 on Whale Point at the southern end of Gil Island in Taylor Bight. This is the only facility on the island and our team of researchers are the only people living in this remote location. There are no roads and we are completely off the grid, generating our own power with a micro-hydro plant and solar panels. We are situated right in whale territory and have a 180-degree view of the pristine ocean. Both humpback and fin whales pass just metres from the rocky shoreline. Each year a group of interns from around the world join us at Cetacea Lab to help us with research. From dusk until dawn, rain or shine, there is always someone on the deck looking out for whales.

The internship programme at Cetacea Lab enables students from across the globe to both participate in research for their own projects and support the work of the NCCS. Trained as land-based observers, they conducted scheduled scans of the entire viewable area and documented whales from May until the end of October 2015. Four to six observers would rotate in two-hour shifts in order to maintain a constant watch throughout daylight hours. During a shift an intern would keep casual watch for most of the time, but every 15 minutes would conduct a five-minute rigorous scan during which all marine mammal species were documented. The observers used a combination of naked eye, Nikon 8x40 and 7x50 hand-held binoculars and a tripod-mounted 20–60x80 Vortex spotting scope to search for marine mammals. They usually began at 7 am and finished at 10 pm daily, depending on the length of daylight.

When a whale was sighted, the observers determined its direction of travel and its behaviour. If possible, photos were taken of the dorsal fin and saddle of orcas,





the dorsal fin of fin whales and the dorsal fin and fluke of humpback whales. The photos were then compared to previously compiled photo-identification catalogues to identify individuals by means of their distinctive natural markings.

From the remote out-camp on the Wall Islets, just off Rennison Island, lead researchers Janie Wray and Hermann Meuter, with assistance from interns, documented whales from May until early September. The observers kept a lookout from a platform 29 feet (nine metres) above the tide-line that offered an unobstructed viewing arc greater than 180 degrees northward into Caamano Sound and, in perfect conditions on the lowest tide, enabled them to see whales at a distance of approximately seven nautical miles. They used Pentax 8x40 hand-held binoculars in combination with 25x100 OberwerkTM tripod-mounted binoculars.

A lookout was kept between roughly 6.30 am and 9 pm, with a 15-minute rigorous scan every half hour, and casual observation was continued until 11 pm. The signal from the hydrophone installed near the Wall Islets was monitored 24/7, actively during daylight and with a speaker by the tent throughout the night, at a volume that would wake the researchers. The times of the first and last audible vocalisations of each encounter were recorded.

When whales were sighted, the observers would stop scanning and focus their efforts on tracking and watching them, using the same methods as at Cetacea Lab. When possible, groups of whales were identified from memory by an experienced observer. For parts of the 2015 season, the Gitga'at First Nation Coastal Guardian Watchmen Programme made it possible to identify groups by means of boat-based photo-identification.

#### 2. FROM BOATS

Boat-based monitoring took place during daylight as dedicated weekly marine surveys or opportunistically after whales had been detected acoustically or visually by our observers or if we had received a report of a sighting from a third party. The two boats used are a 20-foot, aluminium-welded, centre-console vessel with a 50 hp Yamaha 4-stroke outboard engine and a GPS, and a 26-foot cabin cruiser powered by a 315 hp Yanmar diesel engine and with dual steering stations that facilitate our photo-identification work. Two welded tubes in the stern enable us to beach the boat in stormy winter months, and a two-person berth, diesel stove, refrigerator and toilet ensure that we can conduct multi-day surveys.

When the weather and sea conditions were good, the researchers from Cetacea Lab followed one of several predetermined routes in Caamano Sound, Whale Channel and Squally Channel to document humpback and fin whales and orcas. Such routes may have taken them into Campania Sound, around Gil Island, into the southern part of Estevan Sound or into the waters around Gribbell Island. During the survey they would periodically stop and turn off the engine for about 15 minutes in order to scan for whales with the naked eye or hand-held Nikon 8x40 binoculars and to listen for them using a portable hydrophone.

On encountering whales, the researchers recorded the time and location and then attempted to photograph the animals for identification purposes. To do this, the driver of the boat would position his craft about 100 yards (100 metres) from the group and follow a parallel course while a researcher took photos of as many individuals as possible. If lead researchers Janie Wray or Hermann Meuter were present, they would try to identify a whale from their memory of its natural markings. Otherwise, the latest photos were compared with images in the photoidentification catalogues to determine which individuals were present in the group most recently seen. As well as taking photographs, the researchers took notes on the whales' behaviour, any vessel traffic around the group and the whales' direction of travel. If possible, they also collected samples of prey and scat.



The Wall is the Cetacea Lab's summer field observation station located on the Wall Islets, a cluster of tiny islands just off Rennison Island in the middle of Caamaño Sound off the north coast of British Columbia.



#### **3. ACOUSTICALLY**

Listening to whale vocalisations is ideal for determining how the mammals use their habitat and gives us an acoustic window into the lives of cetaceans. Cetacea Lab maintains a network of seven radio-linked hydrophones placed strategically in the study area (in Whale Channel, Squally Channel and Caamano Sound) to provide maximum coverage of the waters around Gil Island. By relaying cetacean vocalisations, this network enables researchers to monitor continuously for whale activity in any environmental conditions and by day or night. Each hydrophone is positioned at a depth of between 50 and 100 feet (15 and 30 metres) and its live signals are sent continuously via radio transmitter to Cetacea Lab, where they are monitored round the clock. The only gaps occur when the equipment is damaged by adverse weather.

At Cetacea Lab the signals from all the hydrophones are fed into an audio mixer so that researchers can monitor all the stations at once. Researchers determine from which hydrophone the vocalisations originate by using the mixer to send each hydrophone's signal into the left, right or centre of the listener's headphones. To keep a permanent record of all acoustic encounters and to help identify groups and behaviour during analysis later, the cetacean vocalisations are recorded digitally from the moment they are detected until about 20 minutes after the last sound is heard. From these recordings we are able to monitor the movement patterns of different orca and humpback whale populations. Fin whale calls are below our hearing range and recordings are currently being reviewed by a student working on her Master's thesis.



Figure 3: The network of hydrophones deployed by Cetacea Lab.

Pitt Island

Figure 2: The total sightings of all cetaceans in our research area from all three platforms



# **B. CETACEANS DETECTED**

There are two species of baleen whale in our area: the humpback and the fin. Both demonstrate strong site fidelity to this region, but it is the humpback that has made the stronger return to the north coast of British Columbia.

#### 4. FIN WHALE

Next to the blue whale, the fin whale is the second largest mammal on the planet. It feeds on euphausiids (shrimp-like crustaceans also known as krill), shoaling fish such as herring and capelin, squid and copepods (small crustaceans) and strains them through baleen plates as other baleen whales do. Historically, fin whales were heavily hunted in British Columbia. More than 7,600 were taken by coastal whaling stations between 1905 and 1967 and thousands more were killed by pelagic whalers in the 1970s.

In British Columbia, fin whales are typically found in open water off western Vancouver Island and in Queen Charlotte Sound, Hecate Strait and Dixon Entrance. Sightings have been documented in summer and winter and acoustic detections from February at least until August. According to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; 2005), the population currently in the north-eastern Pacific is thought to be less than 50% of the population 60-90 years ago and it has been designated as Threatened by both COSEWIC and the Species at Risk Act.

Fin whales were first documented by NCCS in 2006. Since then there has been an increase in the frequency of sightings, which suggests that since whaling came to an end the whales have been re-occupying this area. Based on interviews with experts, documented observations and historical whaling records that formed part of the Pacific North Coast Integrated Management Area (PNCIMA) process, the Pacific coast of Canada has been highlighted as important for fin whales and it probably represents a unique near-shore habitat for the species. The return of these whales raises questions about the current and past importance of such fjords to species that in the past were considered to prefer offshore habitats. As the populations continue to recover from 20th-century whaling, we will determine not only how and to what

Individual baleen whales identified in marine surveys in 2015



extent they come to rely on this habitat, but also the potential importance of these whales to the ecological function of British Columbia's north coast.

While observing fin whales we have sometimes noticed them joining a family of resident orca. We believe that safety is part of the reason for this, as fin whales are often hunted by Bigg's, or transient, orca, the other population that occurs in our region. We are intrigued to know how the fin whales know the difference between the two populations, because a mistake would cost them their life. At present we assume they distinguish between the two populations by their different vocalisations.





Baleen whale sightings at Cetacea Lab



#### ^ Figure 4:

The number and species of whales seen per month and identified by comparison with images in photo-identification catalogues. There was an unusually high occurrence of humpbacks in May, with a steady climb to a peak in September. Fin whale sightings were consistent from June to September, with a peak in July. This record is consistent with other years since 2006, when fin whales first returned to our area. The marine surveys ended in late September due to bad weather.

#### < Figure 5:

The sightings per month of baleen whales from the Wall Islets out-camp in Caamano Sound. It was not possible to identify all the whales from this land-based camp so the numbers are higher than those from marine surveys. Many encounters were re-sightings from previous days. The peak for humpback sightings in July correlates with the bubble-net feeding behaviour seen more frequently here than at other locations at this time of year. The peak of fin whale sightings in September is consistent with observations in other years. The out-camp was shut down in mid-September due to bad weather.

#### √ Figure 6:

The number of sightings per month of baleen whales from Cetacea Lab. It was not possible to identify all the whales from this land-based camp so the numbers are higher than those from marine surveys. Humpback sightings were early, starting in April, peaked in September and were still quite high in October. This is consistent with sightings in other years, as many humpbacks move from the open water of Caamano Sound and travel into the fjord systems around Gil Island close to Cetacea Lab. At this time of year we observed a change from bubble-net feeding to feeding at depth and lunge-feeding on krill at the surface, as well more feeding at night. Fin whale sightings were consistent from July to September. Even when whales may have been present, they may not have been well documented because of bad weather.

#### **5. HUMPBACK WHALE**

The return of the humpback whale to our research area has been dramatic. Of the three species of whale that we study from Cetacea Lab, it is the humpback that we see every day during the field season. Thanks to this high abundance, we have had the opportunity to gain insights into the social behaviour of this robust cetacean and learn more about how it uses the habitat.

The humpback whale is a migratory species that feeds in high-latitude, nutrientrich waters between spring and fall. In early winter the whales migrate to the subtropical and tropical waters of low latitudes to calve and breed. They do not feed during this winter migration.

These whales were hunted commercially from the late 1800s until 1965, during which time it has been estimated that at least 28,000 of them were caught in the North Pacific (Department of Fisheries and Oceans, 2009). Based on the low density of humpback whales observed in British Columbia, COSEWIC originally listed the population as Threatened but, due to an increase in numbers, has recently downlisted it to Special Concern. This re-assessment is being challenged by a number of researchers.

In 2015, while observing humpback whales feeding, we opportunistically collected prey samples to determine the composition of their diet. Using a finemeshed pool skimmer attached to a six-foot (two-metre) pole, we scooped up both prey samples and faecal matter, the latter to answer other health-related questions as well as diet. The Department of Fisheries and Oceans analysed the prey samples and determined that the whales' primary food source is herring and krill.

Herring was also the source of scale samples collected when humpback whales were bubble-net feeding. Within our research area, groups of up to 14 whales are often observed feeding in this way. On each occasion we record the GPS location and identify each member of the feeding group. This information has enabled us to understand the importance of location with regard to bubble-net feeding, as there is a definite preference for using the slope of a deep fjord system. The whales often follow the shoreline and have specific 'hotspots' where they regularly bubble-net feed. Our identification work has shown that the same nine individual humpbacks have been practising this feeding behaviour together for the past decade or longer. We have observed other humpbacks try to join the group and some have been accepted, others not. We are not sure what the prerequisite is for joining, but it is obvious when a humpback fails the test: the entire group reacts with tonal blows and robust behaviour until the unsuccessful whale leaves.

Of particular interest is the fact that bubble-net feeding appears to be a behaviour that is learnt and passed on. We have noticed that individuals are now separating from the main bubble-net feeding group and developing their own groups. They use a distinct call type that is heard only when they are bubble-net feeding. By analysing this distinct call type and how it changes over time from group to group, we can match a specific dialect to particular whales and groups. We record all these calls with a hydrophone and portable recorder and add them to a database in which individual whales are identified. By means of this library of call types and whale identifications, the NCCS will eventually have an acoustic fingerprint for each whale that participates in bubble-net feeding.

Humpback whales that do not participate in bubble-net feeding forage at depth or by lunging or tail flicking. It is worth noting that bubble-net feeding is specific to our region and continues north into Alaska, but has not been documented south of the central coast of British Columbia.

Humpback whales have been observed resting by floating on the surface day or night and either close to shore or in the middle of channels or bays. Females and their calves are often seen resting side by side for up to six hours at a time. When recording resting whales, we noted the size and type of the group, the length of time spent resting and the whales' reaction to any acoustic or physical disturbance. It is when at rest that they are very vulnerable to ship strikes.

In early fall we witness a change from cooperative feeding to more robust types of behaviour such as breaching and slapping the tail or pectoral fins. Males form groups in which they posture and compete to escort a female, during which time they may become quite aggressive towards one another. On many occasions we have seen all the members of a group dive at once and then return



Figure 7

when not feeding.

#### Humpback behaviour





to the surface moments later, their tonal blows echoing around the channels and their bodies displaying the fresh, bloody scratches that are testament to their underwater battles. At the surface they breach and slap their tails and pectoral fins in very close proximity to one another.

During these social events we document group size, the sex of the whales and whether they are adults, juveniles or calves. When the whales resurface after a long dive we take photographs to look for fresh scratches that would suggest posturing behaviour below the surface and scan for old scars that would indicate an injury from a boat strike or entanglement in a net. We also record and photograph all surface behaviour such as pectoral slaps, breaching, tail lobbing and tonal blows. At an encounter with a lone whale we collect any skin samples on the surface for analysis and possibly to determine the sex of the whale. It is at this time that the males begin to sing their beautiful songs at night.

Sightings of mother-and-calf pairs show an increase per year in relation to the increase in the sightings of individual humpback whales. All mother humpback whales in our research area are residents and represent the highest level of site fidelity. Observations of mother-and-calf pairs indicate that the whales prefer to stay in one general area for several days at a time, mainly resting, feeding and travelling slowly in a large circular pattern a few kilometres across. Taylor Bight, the location of Cetacea Lab, is a favourite area for many mother-and-calf pairs to rest for the day.

A mother has one year to teach her calf all it will need to know to survive. At the beginning of the season the calves do not venture far from their mothers' side. As winter approaches and the humpbacks prepare for the migration south, the calves leave their mothers and begin their life as juveniles, searching for companionship and food – a very vulnerable time for them. In 2015 the number of humpback mothers with calves seen was 52% lower than in 2014. The number of sightings of juvenile humpbacks increased by 37% in 2015, however, compared to the number in 2014.

When a humpback whale is identified for the first time in our research area it is referred to as a new arrival. If the same whale is identified again the following



Some of our resident humpback whales travel to a group of islands east of Japan; others make the long voyage to Baja California or Hawaii. The migrations will take between four and eight weeks to complete and the estimated distance each way is 3,000 miles (4,830 kilometres) – one of the longest known migrations of any mammal. However, this pattern appears to be changing and we now have reports of humpback whales that do not migrate at all, but remain resident in our area for the entire year.

Humpback whales are extremely social and are often seen in the company of other whales, although there are a few exceptions that have chosen to lead a more solitary life. Curious about the whales' social bonds, we initiated a 10-year research project to explore their diverse relationships. So far we have identified that humpback relationships evolve through a series of events that lead to certain whales choosing companions based on gender, the time of year, behaviour and location. These social connections do not necessarily relate to any family bond. In the years ahead we hope to obtain a better understanding of the complicated and

year it is designated a possible resident, and if it is seen three years in a row it is known as a seasonal resident. In 2015 we identified 59 new arrivals, and 38% of the new arrivals from the 2014 season we recognised again in 2015. The seasonal resident population of humpback whales in our region now stands at more than 344. This is a steady increase from 2004, when the population numbered only 42. It is the females within this population that demonstrate the strongest site fidelity. Humpback whales are found in all oceans and follow the same migration pattern from cold-water feeding grounds in summer to warmer waters in winter for calving. Every fall we know that, one by one, the humpbacks that have filled our days will slowly begin their migration south. Mothers and calves are the first to leave, then sub-adults and then adult males. The last to leave the feeding grounds are the pregnant females, which will need every ounce of nutrition they can get to sustain them through the rigours of the long migration and then giving birth to and nursing their calves. There is no food for these mothers in the calving grounds and they will not be able to forage for their next meal until they arrive back next season, with their new calves at their sides.

intimate relationships of the humpback whales of the North Pacific.

We have also observed bonding between humpback whales and sea lions. Groups of young sea lions often follow and interact with juvenile humpbacks and mother-and-calf pairs. Play is clearly involved when they do so, especially between the whale calves and the sea lions. The sea lions also interact with feeding whales and benefit from any fish scraps left behind. Interestingly, when Bigg's orca prey on sea lions, we – and others – have seen humpback whales charging aggressively into the hunt or when the orca are feeding. We now wonder whether safety is one of the reasons that sea lions interact with humpbacks.

#### 6. ORCA

There are three populations of orca in our research area and each is different from the other in terms of its social structure, diet and behaviour. We see mostly northern resident orca and transient orca (now known as Bigg's orca). In the past 15 years we have seen the third population - offshore orca - on four occasions, three of those in 2015.

The resident orca exhibits extremely strong and complex family bonds. Unique to this species is the bond between sons and their mothers; a male will remain with his mother until death. A daughter stays with her mother until it is time for her to become the matriarch of her own family, at which point she may begin to break away. It is thanks to this close bond that every family has a distinct dialect, which enables us to follow and identify families using our network of hydrophones. Observations indicate that the primary food source for resident orca is Chinook salmon. During a feeding event the older females would share a catch with calves and juveniles. Males were often seen feeding at a distance, although they would often share their catch with their mothers.

The northern resident population is made up of three clans, each with a set of call types different from that of the other clans – in other words, its own language. Within each clan there are a number of pods that will share certain call types and different dialects. The NCCS has observed four 'social events' at which members



of different clans were present. The whales were extremely excited and very vocal during these encounters and it is possible that mating may occur at these 'all clan' meetings. Members of the same clan do not mate, always choosing a partner from a different clan. We believe that at these social events they are searching for a mate that does not speak their language and is therefore not related. Genetic research supports this theory of mating outside the clan and indicates that only the oldest males are fathers. Most of the resident orca observed in the 2015 season appeared healthy except for one male, I46, which was seen on three occasions at a great distance from his family and was lethargic, with a large, festering wound on his dorsal fin.

Bigg's (or transient) orca are often referred to as the 'wolves of the seas'. It is from them that the term 'killer whale' was coined, as they hunt marine mammals, including other whales. Orca in this population travel mostly in silence to prevent other species from knowing they are in the area. This minimises the opportunity for a specific dialect to be passed on to family members, so when we hear Bigg's orca calls over the hydrophone we know which population we are recording but cannot determine the family group. We have documented Bigg's orca to be very vocal once they have completed a successful hunt. Their prey in our research area comprises mainly Dall's porpoises, seals and sea lions, in that order of preference. There has been one documented record of an elephant seal kill and on two occasions we have witnessed a family of Bigg's orca attacking a young humpback whale, both times unsuccessfully. The family structure of Bigg's orca is much more fluid, with families breaking apart and joining other families for periods of time. The one consistent relationship is between a mother and her oldest son. This bond, like that of resident orca, lasts a lifetime.

We see resident orca between May and July when Chinook salmon, the main component of their diet, are most abundant. Bigg's orca are seen throughout the year as their diet consists of marine mammals rather than fish that are seasonal. In 2015 a juvenile transient orca that had been stranded during a seal hunt was found. We were able to rescue this young whale, keeping it cold and wet for the entire day until it was able to swim free on the tide. It is possible to view the

website forwhales.org/blog dwelling fish such as halibut.

#### Figure 8: Orca matrilines identified on marine surveys 2015



Figure 9: Orca matriline sightings at Wall Islets out-camp





encounter at *youtube.com/watch?v=GPCjr2AJj8M* or read about it on our

Also in 2015, offshore orca were seen in our research area for the second time in 15 years. The same family was observed on three different occasions and during each event we were able to collect identification photographs and acoustic recordings of its particular dialect, which is very different from that of a family of Bigg's or resident orca. This population is seldom encountered and relatively little is known about it, as it spends most of its time offshore near the edge of the continental shelf. Offshore orca are known to feed on sharks and large, bottom-

In conclusion, the 2015 season was extremely successful and we could not have achieved all that we did without the support of the Save Our Seas Foundation and the amazing team of researchers and interns who gave of their time and expertise to help Cetacea Lab and the Gitga'at First Nation protect this pristine habitat for whales. We thank you all.

Resident Bigg's

# Cetacean Habitat Use in Gitga'at Territory

#### he waters of Gitga'at Territory 📥 are a true safe haven for whales, dolphins and The people of the Gitga'at First Nation have been owners and stewards of these waters for millennia, and these species are deeply conne to Gitga'at culture. Three whale species orca, fin and humpback whales - have a ong presence here. Orcas have frequented ime immemorial. The map on this poster presents the results of a research partnership between the Gitga'at Guardians and the North Coast Cetacean Society over the past decade. There has been a dramatic increase in baleen whale abundance over the course of this partnership. Proposed increased shipping poses a threat to their recovery and to the health of this incredibly unique marine ecosystem.

8 **1**11

Pitt Island

Family Bonds 5

FOR

Why are there so many whales here? First, this nutrient rich area supports the feeding needs of the three main species. Second, the with greater development and higher vessel traffic. This map and at and how they are essential for ogically important giants. This habitat is like nowhere else on the of these and countless other specie

#### Bubble Net Feeding 🚺

few places in the world where such Nursing and Learning 2





Robust and Social Behaviour



#### Fin Whale Recovery 🍊 hese waters are quiet, nu

ants. What we do know is th the human ear, ar





A Bountiful Hunting Ground 6





Figure 11:

This poster shows how humpback and fin whales and orca use their habitat. We produced it in conjunction with the Gitga'at First Nation of Hartley Bay as part of our goal to work together to have this area designated as a marine protected area for whales.





# THE MANTA TRUST ISABEL ENDER





015 was a year of exciting developments and achievements for the Manta Trust. It is hard to believe that our organisation was founded only in 2011, yet to date our projects span 20 countries, we collaborate with dozens of institutions, governments and researchers around the world and we have become an integral part of the process that drives global mobulid conservation policy and legislation forward.

In my role as the head of conservation strategy, I was privileged to travel to some wonderful places over the past year to participate in conferences, run workshops and support our projects on the ground with new research and outreach activities. This work is very fulfilling and important, yet the highlight for me is always that moment when I go underwater myself, to dive and see the beautiful rays that I love so much. In such moments I feel so lucky and inspired to be part of this incredible team: my Manta Trust colleagues, the NGO partners, funders and collaborators, and all the volunteers and supporters out there who help us make real progress in safeguarding manta and mobula rays and their habitats.

A key highlight of 2015 was the launch of our Galápagos Manta Ray Project in collaboration with the Charles Darwin Foundation. We are honoured to have this opportunity to study manta and mobula rays in this unique place – a marine biologist's dream. The aim of the Galápagos Manta Ray Project is to collect baseline information, such as population characteristics and the locations of critical habitats and migratory pathways of the oceanic manta and mobula ray populations in the Galápagos Marine Reserve. Through photo-identification studies we are establishing a database to estimate the size of mobulid ray populations in the Galápagos and determine their sex composition. Our aim is to compare our data with international databases such as MantaWatch in order to determine any overlap and connectivity between populations.

Having secured a grant from the Convention of Migratory Species, we deployed our first satellite tags on the Galápagos manta rays to study their movements and habitat use in the Galápagos Marine Reserve and between the Galápagos Islands and the coasts of Ecuador and Peru. We are also collecting biopsy samples of manta and mobula rays as part of the Manta Trust's Global Genetics Project in order to further understand genetic relatedness among the populations in the Tropical Eastern Pacific (TEP). The results and data from this project will provide technical advice to the Galápagos National Park that will help to evaluate the effectiveness of the Galápagos Marine Reserve in protecting mobulid rays from targeted fisheries and incidental by-catch, inform management decisions and support the sustainability of manta tourism in the Galápagos Marine Reserve.

In July 2015 the Manta Trust organised a Mobulid Symposium session at the UK Fisheries Society of the British Isles Conference, which brought together the latest research and knowledge about these species from around the globe. Insights gained from declines in mobulid fisheries and landings in Indonesia were presented alongside tagging and movement studies of oceanic manta rays and data from consumer surveys to characterise the trade in manta and mobula ray gill plates in China and South-East Asia. The majority of the studies presented at the conference have already been published in scientific journals.

The Global Genetics Project was also presented at this symposium and several new collaborations were formed to share data and provide further samples for this study. Following the presentation, a workshop to review the progress of the IUCN Global Conservation Strategy for Manta and Devil Rays was conducted, which allowed all experts present to provide additional comments and identify focus areas to work on over the coming months. The conference brought together more than a dozen Manta Trust colleagues, researchers, staff, directors and volunteers and was thus also a fantastic opportunity to catch up face to face with all these fabulous people.



he National Geographic's CritterCam team and Scripps Institution of Oceanography at the University of California, San Diego joined forces with the Manta Trust to attach CritterCam cameras to wild mantas for the first time last year. So many questions about manta rays' behaviour remain unanswered. Why do they dive so deep? What do they eat in each season? Why do they congregate in certain areas? These questions are interesting from an ecological perspective, but also for conservation. If we can work out what manta rays are eating at certain times of year, it becomes easier to predict where they will be, based on those food sources. A big threat to the species is accidental fishing, or by-catch, so by identifying their feeding grounds we get a better idea of where they are most vulnerable to being caught.

To answer some of these questions and to gather information that could stem population declines, in November the team set out to the Revillagigedo Islands off central Mexico's Pacific coast and for the first time ever cameras were successfully attached to the mantas. The biggest technical challenge was finding a way to attach the cameras, as manta rays are basically big flat discs. Their dorsal fin, unlike that of sharks, is right at the back of the body, so a camera attached to it would show little of interest. The team looked at hooking the camera onto a manta's upper jaw or looping it onto a cephalic fin, but decided that in both these positions it would impact on the animals. Using suction cups was another option, but the researchers did not think the cups would work because manta ray skin is rough like sand paper and they were originally designed to move pieces of glass. Nevertheless, the team did give the suction cups a try, and *voilà*, they stuck on the mantas' backs for up to three hours. uch of our work in 2015 focused on supporting the effective implementation of policy and conservation legislation, such as the listing of reef and oceanic manta rays on Appendix II of the Convention on International Trade in Endangered Species (CITES). We also worked with governments to achieve national and regional level protective measures and we were involved in preparing for a potential CITES Appendix II listing of mobula rays at the next Convention of the Parties (CoP) in September 2016.

With the help of our funders and collaborators, we conducted more than half a dozen capacity-building training events and workshops, targeting in particular key mobulid fishing countries such as India, Sri Lanka and the Philippines. The aim of this training is to pass on to customs and fisheries officials the skills and knowledge they need to monitor the trade in mobulid products and track down illegal traffic. We also provide the tools and materials for countries to monitor mobulid fisheries and trade and to support enforcement, for instance through our mobulid gill plate identification guide. We are thrilled to see that countries like Indonesia are now clamping down repeatedly on the illegal trade in manta gill plates across their borders.

In October 2015 the Manta Trust, in partnership with the government of the Maldives and other collaborators, hosted a shark and ray conservation symposium for ministers of Indian Ocean countries. This special meeting between the Maldivian, Sri Lankan and Seychelles Ministers of Environment and Fisheries focused on the global crisis faced by sharks and rays and concluded with a declaration tabled by the Maldivian government and signed by all the ministers present, who agreed to work together to protect the sharks and rays across the Indian Ocean. The Maldivian government also declared its commitment to submitting a proposal to include all silky sharks under Appendix II of CITES at the next CoP, while the government of Sri Lanka vowed to propose all species of thresher sharks.

The Manta Trust's knowledge of mobula ray population status, declines and threats contributed significantly to the submission of a proposal by the government of Fiji to list mobula rays on CITES Appendix II. We have developed supporting materials for this CITES listing, including a fact sheet about mobula rays that provides signatory nations with appropriate information and is endorsed by a coalition of NGOs and partners. In addition, we recently completed and submitted to the IUCN a Red List of Threatened Species reassessment review for three key species of mobula ray (*Mobula japanica*, *M. tarapacana* and *M. thurstoni*). We seek to support Fiji in its pivotal role of paving the way for global mobulid ray conservation wherever we can and are planning to conduct further awareness campaigns about mobula rays during upcoming conferences and workshops.

ast year marked a milestone for manta conservation in Peru, as the government there officially declared national protection for manta rays within the nation's waters. This new measure is crucial for the region, as mantas migrate between

Peruvian and Ecuadorian waters and data show that this may be the largest known population of oceanic manta rays in the world. Peru's resolution comes after years of advocacy work by Planeta Océano, WildAid and the Manta Trust to ensure protection for mantas in that country. Working closely with coastal fishing communities, the three non-profit organisations have partnered in research on how mantas are affected by local fisheries – both directly and as by-catch – and on how to reduce manta mortality. Building on previous work in Indonesia to protect mantas in territorial waters and promote manta tourism, the Manta Trust and partner organisations are working to introduce manta tourism to the region. This would provide a valuable alternative livelihood to local communities as well as an additional economic incentive to protecting the species.

We also conducted a study and developed management recommendations on manta tourism in Palau, in collaboration with the Earth Institute's Master's Programme of Columbia University New York. As a result of this work, in December 2015 Koror State signed into law the Manta Ray Conservation Act, whose purpose is to restrict boat traffic around German Channel to preserve the manta ray population, and to improve the satisfaction and safety of tourists at the site.



At Baa Atoll in the Maldives we created and launched a community and educational programme that focuses on raising awareness about marine biology and conservation among local community members, students, staff and schoolchildren. We created new staff positions, such as an education officer for the Maldivian Manta Ray Project, as part of this programme, provided presentations to a number of schools in the Baa Atoll and throughout the Maldives and took students from Baa Atoll on field trips to monitor coral reefs and snorkel with mantas. As part of this programme we developed a PADI manta ray speciality course for snorkellers and divers and implemented it at several resorts across the Maldives.

We also participated in the annual Katti Hivvaru Artists Festival and were fortunate to have support from various Maldivian artists who created handmade crafts for us to sell at our stall, including manta ray key rings, bags, stuffed toys and T-shirts. Not only that, local artists created some beautiful manta ray paintings that we auctioned. Working closely with the community, educating people and integrating the public into our work continue to be a major objective for the Manta Trust in 2015 and the years ahead.

ignificant progress was made in developing the automated matching software for our global Manta Ray Catalogue and we established the new position of a manager to support the launch of the global manta ID database software, in collaboration with the University of Bristol and MantaWatch. Thousands of images of manta rays in the Maldives have been added to the software and a test facility has been set up in the cloud for easy access. After pilot tests in 2015, the system was refined and the platform is now ready for testing on a large scale. Currently the manta project has more than 4,000 individuals in the database recorded from over 40,000 sightings throughout the Maldives alone.

Our ongoing collaboration with like-minded projects that focus on environmental conservation and increasing awareness of and education about endangered species has continued to encourage the development of our project work. By establishing international ties through such partnerships, we will be able to initiate additional interesting projects that are built on the concept of united efforts for conservation.

During 2015 the Manta Trust continued to grow its public outreach and now has followings of more than 14,500 on Facebook, 10,600 on Twitter and 8,500 on Instagram. We organised and ran awareness stands, presentations and education activities at the London International Dive Show, Birmingham International Dive Show, Jakarta Dive Show, London Aquarium and, for the first time, at WhaleFest in Brighton, UK, in March. We also attended our first dive show in France, Le Salon de la Plongée. Our global projects are expanding due to the increased interest from the general public and citizen scientists who contribute to our research by submitting images of mantas they have encountered around the world. In 2015 alone we conducted 15 Manta Expeditions in four countries and at two new resort bases.

Finally, during the past year we increased our work in the South Pacific. We joined an Advisory Committee that supports Pacific nations in their development of shark and ray assessments for their National Plan of Actions and we established two new manta projects in New Caledonia and French Polynesia. Working in collaboration with Conservation International, our project in New Caledonia has created a database of more than 100 individual manta rays and deployed the first satellite tags to study the movement of manta rays in the UNESCO World Heritage area of the Loyalty Islands.

In French Polynesia we have teamed up with the research institute Centre de Recherches Insulaires et Observatoire de l'Environnement (CRIOBE), the Observatoire des Requins de Polynésie (ORP) and two dive operators to learn more about the local manta ray population, develop a photo-identification database and determine the spatial ecology, habitat use and movement patterns of local reef and oceanic manta rays, including in the area covered by the Society, Tuamotu and Marquesas islands.

We would like to thank the Save Our Seas Foundation for its continued support over the years and for the incredible opportunities created and progress made as a result of its funding for research, outreach education and the conservation of manta and mobula rays around the globe.



# BIMINI BIOLOGICAL FIELD STATION FOUNDATION TRISTAN GUTTRIDGE & SAMUEL GRUBER

AND REAL PROPERTY AND INCOME.

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#### SAMUEL GRUBER



### TRISTAN GUTTRIDGE

he Bimini Biological Field Station Foundation (BBFSF) was established in 1990 to advance our knowledge of shark biology, improve the conservation of sharks and educate young scientists and the general public alike about them. The BBFSF is an isolated research facility located on the island of Bimini, 85 kilometres (53 miles) east of Miami, Florida. The environs provide access to diverse and abundant sharks and rays that occupy varied marine habitats from mangrove edges and shallow lagoons to coral reefs sloping to deep waters.

Since its inception the BBFSF has contributed significantly to the scientific knowledge and conservation of sharks and to education about them. Our extensive peer-reviewed publications, our outreach to the local community through various projects and our accommodation and training of large numbers of national and international interns and undergraduate and graduate students are testament to this. So too is the key role we have played in establishing improved management practices and protection for sharks in The Bahamas and the USA.

Given this 25-year history, together with its renowned research reputation and diverse accomplishments, the BBFSF is uniquely placed to develop and carry out innovative projects that will contribute to a basic understanding of the behaviour and ecology of elasmobranch species, the recovery of global shark populations and the effective sustainable management of future generations of sharks. The facility is also in an ideal position to improve marine science Figure

Movements of a diversity of sharks and rays in early August

education and the public's perceptions and understanding of these charismatic predators.

We are extremely proud to have completed our 25th year of operation – and what a year it was! We achieved so much, from the breath-hold tagging of great hammerhead sharks to the acoustic tracking of southern stingrays and from the capture and holding of baby tiger sharks to the catching of newborn lemon sharks (to take their DNA) for the 22nd consecutive year of our PIT-tagging programme.

### **A. SCIENTIFIC RESEARCH**

#### LONG-TERM PROJECTS

### 1. MOVEMENT NETWORKS AND HABITAT PREFERENCES OF ELASMOBRANCHS

One of the most exciting projects we have developed over the past two years is an extensive array of stationary acoustic receivers positioned throughout Bimini's environs to track the movements of a diversity of sharks and rays. Its long-term aims are: to identify drivers (abiotic and biotic) of movement and migration; to establish which species are associated with which habitats; to examine mechanisms of spatio-temporal habitat partitioning; and to identify hotspots for the management and protection of local populations.

In February our team expanded the acoustic array from 29 to 49 receivers. The habitats we now monitor extend to sites at a depth of 30 metres (100 feet) off the west of Bimini running north-westward to Moselle Bank, a shallow-water coral reef. The new mooring locations, some of which required drilling into bedrock to ensure stability and longevity, open up a variety of questions regarding habitat connectivity and ecosystem dynamics.

Early analysis, from our array download in August (see Figure 1), revealed that some species use diverse habitats throughout Bimini (adult lemon sharks were detected on 34 receivers), whereas others are apparently more restricted in their activity space (southern stingrays on only seven receivers). Some receiver locations (habitats) appear to be important corridors for local shark movements. For example, many of the receivers west of Bimini picked up more than 20 individual sharks and some more than 30. Furthermore, we detected individuals on many days over long periods (one lemon shark over 254 days, a great hammerhead over 285 days and a bull shark over 135 days). When we calculate a residency index (the number of days / number of possible days detected in the full receiver array), it shows a range of values from 0.01 to 0.9 (a value of 1 means always present; zero means never present). Interestingly, not all species followed our expectations. For example, looking at the seasonal residency for hammerhead, lemon and bull sharks, one hammerhead had an IR of 0.54 (present on the array 285 of 530 days), a lemon shark had an IR of 0.73 (239 of 328 days) and a bull shark had an IR of 0.67 (135 of 202 days). Such IRs are comparable to reef sharks, which show high residency annually in other studies.

We have also received information about movements on a broader scale. Two male nurse sharks tagged at Bimini were recorded on receivers at Andros and Grand Bahama. Similarly, adult lemon sharks tagged at Jupiter Inlet, Florida, migrated to Bimini and some individuals acoustically tagged at Bimini were recorded in the Florida Keys. Using this amazing array as a tool, we are keen to learn more about movements and species interactions and will explore our dataset further over the coming year, incorporating abiotic information such as water depth and temperature in addition to tracking the movements of sharks between receivers within certain time frames.

8 Kilometers

| Total | Anir | nais | Det | eci | ea |
|-------|------|------|-----|-----|----|
|       |      |      |     |     |    |

| $\bigcirc$ | 1 - 6   |
|------------|---------|
| $\bigcirc$ | 7 - 14  |
|            | 15 - 21 |
|            | 22 - 29 |
|            | 30 - 47 |

#### **Species Composition**





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Figure 2: The size-frequency distribution of juvenile lemon sharks *Negaprion brevirostris* captured during the PIT-tagging programme at Bimini.





The frequency distribution of juvenile lemon shark Negaprion brevirostris captures in gill-net sectors at Bimini. A is nearest to the mangrove edge and D is farthest from it.



### 2. QUANTITATIVE GENETIC STUDY OF LEMON SHARK SURVIVAL AND MATING CHARACTERISTICS

2015 marked our 21st annual PIT (Passive Integrated Transponder)-tagging programme. This is our longest-running shark census, in which gill nets are set and manned for 12 nights in two mangrove-fringed nursery habitats at North Bimini to explore the mating system, population dynamics and life-history traits of the lemon shark. On capture, each shark is marked with a PIT tag (a microchip the size of a grain of rice) and it is processed, which involves taking a sample of its DNA, measuring it, determining its sex and weighing it.

Small pieces of fin containing DNA are sent to Dr Kevin Feldheim at the Pritzker laboratory, Chicago Field Museum, and are genotyped at 11 species-specific microsatellites. With these results we are able to infer parent/offspring and sibling relationships between sampled individuals and thus reconstruct genetic information about the shark's parents, most of which we have never seen or caught. In this way we are able to add new members to our already large lemon shark family tree (approximately 4,000 individuals) and investigate questions such as how many females pupped in Bimini in 2015; how large were their litters; had these mothers visited Bimini in previous years, and if so how many times have they given birth in the lagoon; and were they on a biennial cycle (giving birth every other year). Our final and most intriguing question was whether the females giving birth in Bimini in 2015 were born in Bimini themselves decades previously – in other words, do they practise natal philopatry as turtles do – and if so, how common is this behaviour?

In 2015 we were particularly excited to learn that one of our adult female lemon sharks implanted with a 10-year acoustic tag in 2014 was detected on a receiver in Bimini's North Sound nursery in early April. This suggested to us that she had become pregnant in 2014 and had returned to Bimini after a year to give birth in the North Sound nursery. She was only detected on our acoustic array for 10 days, so it seems reasonable to ask if she was dropping her pups at Bimini during this time



period. To answer that question we await the results of genotyping in the Chicago laboratory to see if we captured her pups in our June 2015 PIT-tagging programme. Such information is important as it will enable us to determine when female lemon sharks actually arrive at Bimini, how long they stay before parturition and whether the litter sizes we derive from the DNA of the pups are a good representation of actual litter size.

A total of 209 juvenile lemon sharks were captured during our 2015 tagging programme. Interestingly, both nurseries produced similar numbers, with 107 in Sharkland and 102 in the North Sound. Historically, we have captured far greater numbers of lemon sharks in Sharkland (1996–2015; mean = 115 vs. 80 for the North Sound). When we investigate further we are likely to find that this year's numerical similarity is due to a higher number of newborns in the North Sound (75 vs. 55 in Sharkland), which is also reflected in our size–frequency distribution (see Figure 2). As in previous years, most sharks were captured in net sectors closest to the mangrove edge (see Figure 3; A and B), which emphasises the importance of these mangroves to early development in juvenile lemon sharks. Sadly, towards the end of 2015 Resorts World Bimini began extending its property by dredging a channel on the west side of the North Sound. This will certainly impact negatively on the quality of the habitat through increased sedimentation and will probably influence the growth and survival of new lemon shark recruits. Our 2016 PIT-tagging programme should provide crucial data to examine such impacts.

#### **3. GREAT HAMMERHEADS: A CRITICAL NEED FOR DATA**

Over the next five years, the BBFSF team aims to improve our understanding of the movement and behaviour of the great hammerhead shark by means of acoustic and satellite tracking in The Bahamas and the USA. We aim to provide critical spatial data to improve the management of this endangered species through collaboration and communication with the National Marine Fisheries Service.

Great hammerheads are particularly prone to dying during capture, with studies showing at-vessel mortality ranging between 60 and 90%. Last year at Bimini, with

the help of world champion diver William Winram, we used breath-hold diving techniques to tag sharks externally with acoustic transmitters and pop-up archival satellite tags. The results gave us an insight into great hammerhead numbers and the sharks' movements around Bimini and suggested new receiver locations for deployment. However, a major problem we encountered was the rate of retention for acoustic tags: only one remained in place for longer than a year and we suspect that a high percentage of them detached within six months.

A key aspect of our project is to determine the migration patterns of great hammerheads. Where do Bimini's great hammerheads come from, where do they go and for how long do they remain in and around Bimini? With this in mind, in March and April 2015 we adapted the successful capture techniques we have developed over a decade at Jupiter Inlet, Florida, to the Bimini great hammerheads. Using these techniques, we captured two great hammerheads, took accurate measurements and tissue samples for genetic and isotopic analyses and surgically implanted each shark with a 10-year acoustic device. Both tagged animals were detected on our acoustic array at Bimini for up to three weeks after their release. In the 2016 season we aim to implant 20 transmitters that will provide crucial long-term data about site fidelity and to deploy additional satellite tags that will identify thermal and depth preferences and improve our understanding of the great hammerhead's use of space and habitat outside Bimini's waters.

#### 4. CAUSES AND CONSEQUENCES OF LEMON SHARK PERSONALITY

We are delighted to report that PhD candidate Jean-Sebastian Finger completed his doctoral field research in July 2015 and is now writing up and analysing his data at Humboldt Berlin University. Jean's research set a baseline for continued studies that will expand our understanding of the underlying causes and consequences of personality in a large marine vertebrate.

PhD candidate Felicie Dhellemmes arrived at Bimini in February 2015 under a full scholarship from the BBFSF. Her research on the ecological consequences of personality for sharks continues and expands Jean's work, investigating more specifically the connection between foraging specialisation and personality. The long-term nature of this research project will enable her to attempt to determine whether personality traits can be inherited and to explore the relationship between the traits of predator and prey.

After our annual juvenile lemon shark census in June 2015, 55 lemon sharks were transferred to holding pens and tested for behavioural traits in sociality (are some more social than others?) and exploration (how do they explore a novel environment?). As part of Felicie's doctoral project, she added two further tests for 35 lemon sharks: how do sharks investigate a novel object and how quickly do they recover from being frightened, such as by a splash or exposure to a predator? We are eager to explore the connections between these traits and to determine whether sharks that were tested last year display long-term consistency in their behaviour. It is particularly difficult to monitor behavioural traits in animals over a number of years, so it will be interesting to understand how these traits are expressed as sharks grow and learn about the environment. Analyses are under way!

In a bid to discover whether the personality of captive lemon sharks is reflected in their free-ranging behaviour, in August Felicie implanted acoustic transmitters into 12 juvenile lemon sharks, having previously evaluated the behavioural traits of the sharks as explained above. Individuals were tracked until the end of the year with a combination of active (from a moving boat) and passive (by stationary receivers) techniques. So far Felicie has found correlations between the number of receivers on which a shark was detected and its exploration score in captivity. Early results indicate that the behavioural traits of experimental subjects (in this case, lemon sharks) in captivity may be a good proxy for their behaviour in the wild. If confirmed, this will be a great help in our interpretations of Felicie's findings with free-ranging lemon sharks.



### **B. TARGETED RESEARCH** PROJECTS



Understanding population dynamics is essential for implementing the effective conservation and management of coastal sharks. Fishery-independent surveys can offer valuable information for data-limited species. Since 2004, our team has conducted standardised, shallow-water, long-line surveys every month in the eastern coastal waters of Bimini. Each survey comprises five long-line sets of 15 hooks each (over a 500-metre, or 1,640-foot, length) with a soak time of 24 hours. The lines are checked every four hours and when sharks are captured they are restrained briefly alongside the vessel and processed (measured, tissue samples collected, tagged and released). In the 2015 campaign we captured 79 sharks of seven species, including tiger, lemon, nurse and blacktip, which comprised 95% of the catch. Seasonal trends indicate an abundance of nurse, blacktip and lemon sharks during the warmer summer months, which is consistent with results from the 2004–2014 period.

Current MSc student Alex Hansell (University of Massachusetts) will publish a summary paper in 2016 on the seasonal and annual trends for Bimini's populations of large sharks. Importantly, our monthly long-line sets are being continued by doctoral student Matt Smukall (University of Alaska), who is focusing his efforts on the ecology of the tiger shark using acoustic telemetry, stomach lavages, stable isotope analyses, behavioural trials and both deep- and shallow-water long-lining.

#### 6. OCCURRENCES OF THE SMALLTOOTH SAWFISH AND ITS HABITAT USE ACROSS THE BAHAMAS

The smalltooth sawfish *Pristis pectinata* is a rarely encountered species that is listed as Critically Endangered by the IUCN Red List of Threatened Species<sup>™</sup>. In the USA it is afforded specific protection and listed as Endangered under the federal Endangered Species Act. Importantly, this led to the implementation of a recovery plan in which shallow, mangrove-fringed coastal areas have been identified as critical habitat for juveniles. This improved knowledge notwithstanding, little is known about this species outside US waters, although neighbouring countries such as The Bahamas can boast reliable sightings and suitable habitat.

This study documents and discusses recent (2002–2015) sightings and captures of the smalltooth sawfish in The Bahamas. The movement patterns and habitat preferences of five sawfishes were examined, another two were tracked with acoustic telemetry at Bimini (see Figure 4) and three were tagged with pop-up archival satellite tags at Andros, 90 kilometres (55 miles) east of Bimini. Historically, the smalltooth sawfish may have been well distributed throughout The Bahamas, but since 2002 only 61 encounters have been recorded: 30 at Andros, 19 at Bimini and 12 at other islands. At Bimini, all smalltooth sawfishes were longer than 225 cm (88 inches; total length), which suggests that this is not used as a nursery area. The smalltooth sawfishes at Andros ranged from approximately 80 to 450 centimetres (32 to 177 inches), indicating that this island might be an important nursery and breeding habitat. The sawfishes tracked at both islands remained at depths of less than three metres (10 feet), often adjacent to mangrove habitats, and were resident from 42 days (Bimini) to 180 days (Andros). These preliminary findings confirm that The Bahamas is an important habitat for the smalltooth sawfish and emphasise the urgent need for national protection and management for this population.



2

Figure 4: Bimini have been enlarged.



The spatial distribution of smalltooth sawfish Pristis pectinata encounters across The Bahamas, 2002–2015. N = 61. The size of the yellow circles is proportional to the number of sightings at that location. Andros and

#### 7. GENETIC STRUCTURE AND POPULATION DEMOGRAPHICS OF BLACKTIP SHARKS

During our long-line surveys between 2004 and 2014 we investigated the demographic population structure and seasonal abundance of the blacktip shark Carcharhinus limbatus at Bimini. All 242 individuals sampled were sub-adults or adults ranging in pre-caudal length from 70 to 145 centimetres (27 to 57 inches); none were neonates or young-of-year. The number of blacktips was highest in September, coinciding with the largest ratio of female to male sharks and a peak in fresh mating wounds on females.

Mitochondrial control region (mtCR) DNA sequences were obtained from blacktips at Bimini to test whether the population is most closely related to neighbouring populations sampled on the south-eastern coast of the USA, the nearest known nursery areas for this species. Nine mtCR haplotypes were observed in 32 individuals sampled at Bimini (haplotype diversity [h] = 0.821, nucleotide diversity  $[\pi] = 0.0015$ ). Four of the haplotypes observed from Bimini matched those previously found in the northern Yucatan–Belize area and two matched a haplotype previously found on the south-eastern coast of the USA. Four Bimini haplotypes were novel but were closely related to the northern Yucatan-Belizean haplotypes. Analyses indicated that the blacktip population around Bimini was significantly differentiated from all the populations previously sampled (US Atlantic, US Gulf of Mexico, northern Yucatan, Belize and Brazil). This indicates that blacktips sampled from Bimini were not derived from US nurseries.



#### 8. PUBLICATIONS

Six papers were accepted in high-impact, peer-reviewed journals (such as Journal of Fish Biology and Marine Ecology Progress Series) on topics varying from the distribution and habitat preferences of the smalltooth sawfish across The Bahamas to the genetic structure of blacktip sharks and the behaviour of lemon sharks. In addition, three papers have been accepted on lemon shark ecology, including longevity, personality and population trends.

### 9. PRESENTATIONS

BBFSF scientists and students presented 15 papers at five international conferences in 2015. Five of our team presented at the Fisheries Society of the British Isles Elasmobranch Symposium, (Plymouth, UK; July), three at the American Elasmobranch Society, (Reno, USA; July), one at Behaviour Conference (Cairns, Australia; August) and three at the Gulf and Caribbean Fisheries Institute's Caribbean Shark and Ray Symposium (Panama City, Panama; November). Finally, our founder Dr Samuel Gruber was the keynote speaker at the European Elasmobranch Association meeting in Portugal, where two of our students also gave presentations.

#### **10. MANAGEMENT OUTCOMES**

At the start of 2015 the BBFSF was delighted to host the Pew Charitable Trusts and Caribbean leaders for a day of interacting with sharks in Bimini. Over the two day meeting we discussed the importance of creating safe havens and improved protection for sharks. On one of the days Sir Richard Branson attended and led a brunch meeting at the Bimini Sands Resort, where he advocated the creation of shark sanctuaries and improved protection for sharks throughout the Caribbean www.virgin.com/richard-branson/shark-protection

# **C. SCIENTIFIC OUTPUT**

Our paper about the smalltooth sawfish has led to discussions with The Bahamas' Department of Marine Resources to implement species-specific protection throughout Bahamian waters for this Critically Endangered batoid. BBFSF researchers presented updates on the status of shark and ray populations in The Bahamas during the Caribbean Shark and Ray Symposium held in Panama City. Our team will work with Dr Rachel Graham and others to establish the Caribbean Chondrichthyan Network/Society and will assist with potential IUCN Red List assessments for sharks and rays across the Caribbean in 2018.

## **D. EDUCATION & OUTREACH**

#### **11. DOCTORAL RESEARCH**

Lauran Brewster (Hull University, UK; Bio-energetics of the lemon shark) and Jean-Sebastian Finger (Humboldt University, Berlin; Causes and consequences of personality in the lemon shark) completed their doctoral field studies in March and July 2015 respectively. Three new doctoral candidates - Matt Smukall (Alaska University; Tiger shark ecology of Bimini), Felicie Dhellemmes (Berlin University; Ecological consequences of personality in lemon sharks) and Maurits Van Zinnicq Bergmann (Florida International University; Movement ecology of sharks and rays) - have started their three-year tenure with us, supported by BBFSF scholarships.



Cover illustration for Shark Doc, Shark Lab book.

#### 12. MASTER'S DEGREE RESEARCH

Liam Dickson (Erasmus Mundus MER Consortium; Lemon shark personality) and Bryan Keller (Coastal Carolina University; Lemon shark social group behaviour) completed their field projects.

#### **13. VOLUNTEERS**

The BBFSF hosted 49 volunteers for between one and six months. The volunteers represented eight countries, including England, Canada, the USA and Brazil.

### **14. UNIVERSITY COURSES**

The BBFSF hosted 98 students across six university courses in shark and marine biology.

#### **15. RESEARCH EXPERIENCE**

The BBFSF hosted 48 members of the public in five-day courses of intense, hands-on research techniques with several species of shark, including bull, lemon, nurse, great hammerhead, tiger and reef.

#### 16. HIGH SCHOOL SHORT COURSES

High school students from Mote Marine Lab, Camp Live Oak, Young Persons Organization and Shedd Aquarium were hosted in marine and shark biology classes.



### 17. PUBLIC TOURS

About 750 members of the public were given tours of our facility that included discussions about current research, field techniques and shark conservation. The tours culminated in a hands-on visit to field pens housing lemon sharks, nurse sharks and southern stingrays.

### 18. BAHAMAS SCHOLARSHIPS

In partnership with Bahamas Marine EcoCentre, the BBFSF provided two onemonth scholarships to four Bahamian university students.

### **19. BIMINI TOURISM**

In collaboration with Bimini Tourism and Resorts World Bimini, the station hosted weekly ecotours to communicate the importance of Bimini's marine fauna and flora to island visitors. This is particularly pertinent considering the continued expansion and construction of coastal development on North Bimini.

### 20. TRI-ANNUAL VETERINARIAN CLINIC

The BBFSF hosted spaying and neutering clinics for mostly feral cats and dogs on three occasions, providing important management for the ongoing Bahamaswide feral cat and dog problem.

### 21. TRASH CLEAN-UP

The BBFSF organised and took part in beach and roadside clean-ups, collecting and disposing of up to 500 kilograms (1,100 pounds) of trash.



## **E. MEDIA**

### 22. FILM TEAMS

The BBFS hosted nine international film production teams, including ones RENOVATION AND DEVELOPMENT OF THE SHARK LAB from National Geographic and, more recently, the BBC, which was focusing on In 2016 we hope to organise and raise the funds to re-build a new green facility that will give us the platform to succeed for another 25 years. our ground-breaking lemon shark personality research. Teams came from Canada, GREAT HAMMERHEAD England, the USA and France, and produced feature-length films, television series We aim to write our first paper highlighting the regional and international connectivity of the great hammerhead and its seasonal and documentaries. Shooting lasted anything from one to five days and featured residency at Bimini and Jupiter Inlet, Florida. a range of content from the capture and tagging of bull sharks to using laser-SMALLTOOTH SAWFISH We will continue our efforts to ensure protection in The Bahamas for this Critically Endangered batoid. photogrammetry to obtain length estimates on great hammerhead sharks and NEW PROJECTS performing a stomach lavage on a mature tiger shark. A study of the deep-sea sharks of Bimini; an investigation into the predator-prey relationship between sharks and turtles; a regional We were particularly excited to film with Jeremy Wade of Animal Planet's River assessment of the sharks and rays of The Bahamas using standardised shallow-water long-lines; and the use of a baited remote underwater video to determine the abundance and distribution of prey and predators across diverse habitats. Monsters on his latest exploration of the oceans. Airing in April 2016, the episode The BBFSF is officially recognised as a charitable organisation in The Bahamas and as a 501 (3)c US non-profit. It has officially features a hammerhead shark stealing bait on a GoPro, the rod-and-reel capture of purchased the land on which the station is situated and is coordinating the raising of the current station for improved a reef shark and implanting an acoustic tag into a large tiger shark. hurricane protection.

### 23. SOCIAL MEDIA

Through our online media platforms we provide updates on our various research projects that are often live. We have 15,000 followers on Instagram and 5,000 on Twitter, 6,700 likes on Facebook and about 6,500 unique visitors per month to our website.

### 24. SHARK DOC, SHARK LAB

In partnership with the Save Our Seas Foundation, Jeremy Stafford-Deitsch, Peter Scholl and Marc Dando, the BBFSF worked to create this remarkable book that tells the inspirational life story of our founder, Dr Samuel Gruber.

# **F. FUTURE**

#### **BOOK ABOUT LEMON SHARK BIOLOGY**

Our team is working on a review book with shark experts Dr Kevin Feldheim, Dr Bob Hueter, Dr John Morrissey, Dr Dean Grubbs, Dr Frederik Sundstroem and Dr Samuel Gruber.
## **PROJECT LEADER PROJECT LEADERS WHOSE PROJECTS** WERE FUNDED DURING 2015







### CHARACTERISING THE EMERGING DEEP-WATER SHARK FISHERIES IN BELIZE

MARALLIANCE

2015

#### **BELIZE, CENTRAL AMERICA**

RESEARCH. CONSERVATION HEXANCHUS GRISEUS, H. NAKAMURAI, HEPTRANCHIAS PERLO. Carcharhinus signatus

#### WHOIAM

If you ask anyone who knew me as a child, they I also conducted several life-history studies on will probably tell you that all I ever wanted to be was different shark species, including the deep-water Atlantic angel shark, which was the subject of my a marine biologist. Other than a short-lived dream to be a 'marine biologist artist', I never grew out of Master's degree. In 2013, I moved to Belize to work with my infatuation. I grew up landlocked in Louisiana MarAlliance, a small marine conservation NGO. and Arkansas, but every summer my family rented a beach house in Dauphin Island, Alabama. That The transition from the US government to an NGO week at the beach was one of the highlights of my in a developing country has been a fun challenge! youth and I can remember noting the annual changes Belize has a wealth of natural resources, but it is in our crab traps, sea trout catches and the beach starting to see the negative effects of overfishing on erosion as time passed. When I was 15 we moved to its top predators. Living and working here has been Hawaii, which further solidified my devotion to rewarding, and I look forward to expanding my knowledge of marine science and conservation. I also the sea. bring my love of deep-sea sharks with me to Belize.

#### WHERE I WORK

I spent 10 years as a contract employee for the WHATIDO National Marine Fisheries Service in Panama City, Working with local fishers during our annual Florida. I was privileged to work with a group of surveys, I learned that many fishers are starting talented and hard-working scientists, many of whom to explore the deep sea as a potential new fishing acted as mentors to me. During my tenure with the ground. The topography of Belize's barrier reef fisheries service, I worked alongside stock assessment enables them to fish at depths greater than 200 scientists to ensure that the data necessary for their metres (650 feet) while within sight of land. Fishers assessments were collected and properly formatted have also reported catching 'weird' sharks with big, green eyes and dark, smooth skin. The fishery is and processed. I learned the importance of data management and communication. Along the way, largely artisanal, its lines deployed and retrieved by

hand, but it is unlikely to remain small.

Our knowledge of deep-sea fishes and sharks is extremely limited, and this is especially true in developing countries. We hope to build upon local knowledge by means of a standardised survey about deep-sea fishes and elasmobranchs that can be easily reproduced in other developing nations. Many deep-sea fisheries are already in decline before scientists know that they are being exploited. By gathering data about a fishery before it becomes highly targeted, we hope to provide a rare example of forestalling the decline. To do this, we are working with traditional fishers to capture, tag and release deep-sea sharks and to gather life-history information about them and other fishes of the deep.

This project is in its infancy and I am excited to see what the coming year will bring us. We hope to gather data from Belize's three offshore atolls (Lighthouse Reef, Turneffe and Glover's Reef), as well as along the Mesoamerican Barrier Reef. With so little known about deep-sea sharks and fishes, we can't wait to find out what inhabits our deeper waters!

# DARGY BRADLEY

ACCOUNTING FOR SHARK BEHAVIOUR IN ESTIMATES OF REEF SHARK POPULATION SIZE AND ABUNDANCE **BREN SCHOOL OF ENVIRONMENTAL SCIENCE &** MANAGEMENT: UNIVERSITY OF CALIFORNIA SANTA BARBARA & PALMYRA ATOLL RESEARCH PALMYRA ATOLL, U.S. NATIONAL

CONSORTIUM 2015

WILDLIFE REFUGE

Research, Conservation REFE SHARK [C. MELANOPTERUS]



GRFY REEF SHARK [CARCHARHINUS AMBLYRHYNCHOS], BLACKTIP



'Our goals are shared with the SOSF in that our project aims to improve shark conservation through novel research initiatives. Wherever our results take us, our work represents an exciting opportunity to provide sound scientific recommendations to agencies that actively manage shark populations throughout the US Central Pacific and around the globe.'

## WHOIAM

The first shark I ever saw was a leopard shark, swimming slowly beneath the shallow Californian waves. I was a small child surfing on a body board and my instinct drove me to ditch the board and dive in towards the shark to take a closer look. A keen survival instinct has never been my strong suit, but my fascination for sharks has continued and never wavered. Whether snorkelling or diving, I am always the person looking out towards the open ocean, waiting, hoping, willing something big to swim by.

My shark fascination became a commitment to shark conservation when, while living and working in Thailand, Indonesia and Western Australia, I witnessed at first hand the severe overfishing of sharks that resulted in their near disappearance from various Indo-Pacific reefs in the span of a few short years. Now, as a PhD candidate at the University of California, Santa Barbara, I work with a dedicated

and inspiring team of researchers to address directly the gaps in our knowledge and understanding of the abundance, movements and behaviour of reef sharks. In order to improve the management – and promote the recovery – of reef sharks around the world, we have to plug these gaps.

## WHERE I WORK

Palmyra Atoll is a US National Wildlife Refuge in the central Pacific Ocean and it is the only remaining uninhabited island in the remote Northern Line Islands chain. The atoll has been touted as one of the few remaining 'pristine' coral reef ecosystems globally. Unlike neighbouring islands, where overfishing has largely removed sharks from the reefs, Palmyra is unique in that it supports a large population of top predators, including grey reef and blacktip reef sharks.

Palmyra is a marine scientist's wonderland: its marine food web is intact, its coral cover is solid and it is home to a diverse array of invertebrates, fishes, sea turtles, marine mammals and, of course, sharks. Yet in recent years researchers have reported seeing fewer and fewer of the reef sharks for which the 'predator-dominated' atoll is known. This came as troubling news to those managing the island: the sharks aren't being fished at Palmyra, so why are researchers seeing fewer of them?

As anyone who has been fortunate enough to dive with sharks has experienced, reef sharks often respond to divers behaviourally. This is particularly true of the grey reef shark, which has been described as both curious and agonistic. We want to know if the increased human presence at Palmyra over the past decade has led to temporary or chronic changes in the behaviour of reef sharks in a way that could explain the reported decline in sightings.

In most places, it is impossible to disentangle observed changes in shark abundance due to behavioural changes from those due to fishing. Palmyra is different. Here, at this remote, wellprotected atoll, we have a unique opportunity to study a coral reef ecosystem in the absence of fishing and we can therefore isolate the behavioural response of reef sharks to human activities.

#### WHAT I DO

We want to know if traditional marine reserves and areas closed to fishing can lead to the successful recovery of heavily overfished shark populations. Specifically, we are concerned that reef sharks may avoid areas frequented by people, thereby avoiding the reserves that were designed to protect them.

At Palmyra, we are working to quantify the behavioural response of reef sharks to various non-fishing human activities, including diving, snorkelling and boating, in order to inform the spatial management of these species. With support from the Save Our Seas Foundation and others, we are able to explore a variety of methodologies to achieve this goal.

In recent years, my colleagues have fitted acoustic transmitters to roughly 50 grey reef and blacktip reef sharks. These communicate with several underwater acoustic receivers that are moored around the island, enabling us to track passively the sharks' movements throughout the year. As researchers are only present on and in Palmyra's waters during the summer months, we are looking for changes in movements and space use by grey reef and blacktip reef sharks that may be the result of increased human activity.

We also use Baited Remote Underwater Video Surveys (BRUVS) to gather additional information about shark abundance and shark behaviour. BRUVS use a mounted camera aimed at a small amount of bait to bring reef fishes and sharks into view. We conduct video surveys at sites heavily used by research divers and at sites that rarely, if ever, experience scuba diving activity. We then assess differences in the relative abundance of shark species, overall species diversity and shark behaviour. This information will be used to understand the effect of non-fishing human activities on reef shark behaviour and movements.







#### DO HUMAN ACTIVITIES DRIVE THE DISTRIBUTION AND ABUNDANCE OF COASTAL SHARK SPECIES? FRIENDS OF THE ENVIRONMENT

2015

#### THE ABACOS, THE BAHAMAS

RESEARCH. EDUCATION

LEMON SHARK [*Negaprion Brevirostris*], blacktip shark [CARCHARHINUS LIMBATUS]. AND CARIBBEAN REEF SHARK (C. perezi)



#### WHOIAM

I grew up off the coast of Florida in the USA and have always been drawn to the sea. I spent much of my time in the water, but it wasn't until I went to college that I got my first hands-on experience of shark research, helping the Florida Shark Research Program with a monitoring project in the Gulf of Mexico. I will never forget my first day on the boat, trying to keep my balance while I held a shark in my hands and shouted length measurements to my colleague. I was hooked! One summer I found myself in The Bahamas as an intern at the Bimini Shark Lab, the next I was working with tiger sharks in Shark Bay, Western Australia. From these incredible experiences, I knew I wanted to dedicate my life to ocean conservation and help protect shark populations. Currently I am working on my PhD, investigating human impacts on near-shore subtropical communities. Specifically, I am asking how development and human activities may drive the distribution and abundance of coastal shark species.

## WHERE I WORK

The Bahamas is a country made up of numerous islands that people travel to from around the world to swim with sharks or film them. In fact, shark ecotourism contributes about US\$78-million annually to the Bahamian economy. In 2011, The Bahamas became one of the leading countries in shark conservation when it converted its national waters into a shark sanctuary by prohibiting

commercial shark fishing and promoting a catchand-release programme for recreational shark fishing.

Specifically, I work on Great Abaco Island, where mangrove tidal creeks, sandy beaches and scalloped bays wrap around the shoreline. When you jump into the water, you will find a mosaic of sea-grass meadows, patch reefs and sand flats. Abaconians are working very hard to help protect these natura wonders through education and stricter fishing regulations, as well as by proclaiming protected areas on land and at sea. Although many people support the conservation of the marine environment. there is currently a gap in the understanding of how local impacts on land, such as construction and runoff pollution, can drastically alter marine ecosystems nearby and negatively affect the animals that live in them.

#### WHAT I DO

With the support of the Save Our Seas Foundation, I hope to help fill this gap by using a novel approach to survey how human activities may drive the distribution of coastal shark species Using a DJI Phantom 2 Vision+ aerial drone, I will take continuous HD video footage over the shallows around Great Abaco Island to explore how human activities may affect marine life in the vicinity. Within these shallow waters are prolific nursery systems that provide critical foraging grounds and

refuges for juvenile shark species. This summer I will assign three locations along the shoreline as 'high human activity' (such as shoreline development, boat traffic and dredging) and three locations as 'low human activity'. Throughout the summer I will monitor these locations repeatedly and record shark densities and the species present. There are two main objectives to this study: to test personal aerial drones as an inexpensive and non-invasive method of monitoring Bahamian shark populations; and to provide baseline data about the densities of marine megafauna within two proposed protected areas. These two areas are unique in that they will prevent shoreline development, but will still permit recreational activities, such as angling for bonefish. Our data will be available to local conservation and management organisations.

Another inspiration for this project is to garner the support and understanding of the public for the 2011 shark ban. For this there are two outreach components. First, with the support of a local NGO, Friends of the Environment, I will develop Abaco's first shark-focused summer field course (for ages 15 to 18-plus) during which shark ecology and conservation will be reviewed. Secondly, with the help of the SOSF Conservation Media Unit, we will compile underwater and aerial footage and combine it with interviews with local fishermen and educators to create short educational videos about shark conservation in The Bahamas.



#### EXTERNAL SHARK ANATOMY AND SENSES MOBILE APP AND VIDEO CURRICULUM

## SHARKS4KIDS, INC

2015

BIMINI, BAHAMAS EDUCATION SHARKS 'Thanks to the generous support of the SOSF, Sharks4Kids is able to bring our passion for sharks to the masses. The more time I spend in classrooms and speaking with students around the world, the more I realise how tied we are to technology. We want to use this technology to help people learn about sharks.'

#### WHOIAM

I am a nature lover through and through. I grew up spending most of my time outdoors in Michigan, USA. Hiking, camping, boating, swimming – it didn't matter. As long as I was outside, I was happy. I have always felt a passion for water, whether it is fresh or salt or in a lake, river or ocean. When I was a child our family used to travel to Florida on vacation and to visit family friends. It was on one of these trips, listening to the naturalist on a boat tour of the Everglades, that I decided I wanted to be a marine biologist. When you're eight years old and you've decided what you want to do with your life, sometimes you change your mind. But not for me – my decision stuck! My love for water and the ocean pulled me in.

As for the sharks – well, how can you not love working with sharks? The amazing diversity of sharks gives rise to countless questions and working with them provides a perfect platform for finding answers. The beauty, power and grace of sharks in the water and their vital role in our oceans highlight the need for the conservation and management of these animals on a global scale.

#### **WHERE I WORK**

I have been fortunate to travel around the world pursuing the career that I love. From Florida and The Bahamas to the Caribbean and Australia, I have been able to learn about sharks, sea turtles, sea grass and everything in between. The one thing that I have learnt from all the work that I have done over the years is that the marine realm and the plants and animals in it are overwhelmingly connected. I am fascinated by how everything works together and how, in one way or another, all the organisms rely on one another. Everything is connected, and it is also

## **REK BURKHOLDER**





'connections' that have brought about the group I am working with: Sharks4Kids Inc. Sharks4Kids is an educational non-profit organisation that is based in Florida but has a worldwide footprint. The international team comprises the founder and president Jillian Morris, the media manager Duncan Brake and myself, and we are working together to bring our passion for sharks to kids around the globe. We were lucky enough to connect with a very talented app developer, Mike Schmidt of Kinetic Concepts, who has developed such ground-breaking apps as 'Find My Class'. Mike loves the ocean and jumped at the opportunity to assist Sharks4Kids in the creation of an app.

Sharks around the world face what sometimes seem like insurmountable challenges and many of their populations are crashing as a result of overharvesting, being taken as by-catch, habitat loss and pollution. Our educational curriculum has a dynamic range and we share our passion for sharks, the purpose of shark science and the need for shark conservation by means of Skype shark lessons, Google hangouts and hands-on field experience. Through education, outreach and adventure, Sharks4Kids is working to create the next generation of shark advocates.

#### WHAT I DO

As Sharks4Kids evolves, so too are the materials we are producing. Our knowledge of sharks expands every day and we want to translate it into fun and educational tools that we hope will inspire students to do their part to help protect these amazing animals. The students in many of the schools we connect with use iPads and we would like to take advantage of this by using technology and the media to encourage shark education and conservation. The way the world learns is changing and thus the way we teach must follow suit. We hold the world in our hands: with the tap of a button on our cell phone or computer we can be anywhere, see anything, learn anything we want to. With this technology we can employ an interactive, engaging tool to tell people about sharks.

The world of mobile apps is exploding. There's an app for just about any topic you can think of, yet when our team searched for 'shark' apps we ended up wanting more! So we decided to combine the unique backgrounds and skill sets of the Sharks4Kids team –scientists, educators and underwater photographers/videographers – and use them to develop an app that is all about sharks.

The premise of this project is to explore the external anatomy of sharks and their unique senses. Using ultra high-definition videography and macro photography, we want to bring sharks into homes and classrooms around the world. With the touch of a button, we want to help people understand what makes a shark a shark – and to do it in a fun and interactive way that hasn't been done before.

The combined media, film and photography backgrounds of Duncan Brake and Jillian Morris have created a unique resource that is able to capture the intricate details of many species of sharks. Their imagery, paired with the resources generously provided by the SOSF, will enable this programme to come to life.



**GREAT BEAR LIVE: USING REMOTE CAMERA TECHNOLOGY AS A MARINE MAMMAL CONSERVATION TOOL** PACIFIC WILD ALLIANCE BRITISH COLUMBIA, CANADA

Research, Conservation, Education NOVAEANGLIAE



'Thanks to the support of the SOSF, we will be able to combine and expand the hydrophone and camera programmes, as well as expand our campaign efforts to achieve a tanker-free coast.'

KILLER WHALE [ORCINUS ORCA], HUMPBACK WHALE [MEGAPTERA



## WHOIAM

I first came to the Great Bear Rainforest while at university to attend an ecology field school in the Koeye watershed, a fantastically beautiful river system that supports five species of salmon and where grizzly bears roam white sand beaches in open view of the Pacific.

After six weeks immersed in the rainforest, I was hooked. I moved to the Great Bear four years ago to work for Pacific Wild, an organisation that shares my passion for and dedication to protecting this coast.

## WHERE I WORK

The central and north coast of British Columbia. known as the Great Bear Rainforest, is the world's largest remaining intact temperate rainforest and is also home to one of the most biologically rich, yet fragile coastlines on earth. It comprises a thousand

uninhabited islands and hundreds of deep mainland fjords and river valleys backed by a snow-capped coastal mountain range. For the most part, the waters are clean and cold, and the wild places to explore are endless.

Pacific Wild is based on a small island with about 100 residents, next to the larger Heiltsuk First Nation community of Bella Bella (population 1,500). Indigenous people in this region are reclaiming stewardship over their territories and are working hard to protect wildlife and habitat, from herring to grizzly bears to salmon-bearing watersheds. We strive to design research programmes that will help local First Nations to make informed resource management decisions.

Until recently, conservationists in this area focused primarily on protecting old-growth forests, but industrial shipping has now become the



the globe.

Great Bear Sea.

biggest environmental issue facing the Great Bear Rainforest. In addition to the Northern Gateway Pipeline project, an oil export pipeline that would introduce oil supertankers to the region, there are 14 proposals to ship liquefied natural gas from north coast ports to markets abroad. If they come into effect, the Great Bear Sea could potentially go from having no tanker traffic to seeing more than 2,500 supertanker trips per year, with no assessment of cumulative effects.

These projects would put cetacean populations in the Great Bear Sea that are already at risk including killer, fin and humpback whales – under direct threat. The potential for thousands of supertanker transits through these coastal waters each year would exponentially increase the risk of ship strikes. If an oil spill were to occur, it would destroy habitat for cetaceans and their prey. In

addition, the dramatic increase in commercial shipping could lead to damaging levels of underwater noise that would interfere with the cetaceans' social, feeding and navigational behaviours.

## WHAT I DO

As the threats to the Great Bear Sea mount, we set out to better understand the baseline levels of ambient noise here and to monitor noise and marine mammal populations over time. Inspired by the work of OrcaLab to the south and Cetacea Lab to the north, we have set up six remote hydrophone stations that record underwater sound around the central coast 24 hours a day, seven days a week.

Pacific Wild has also developed an innovative conservation project that live-streams wildlife video cameras from the heart of the Great Bear Rainforest onto our website. This real-time video

technology gives us unprecedented insight into wildlife behaviour along this threatened coastline, in addition to providing an engaging tool to inspire the public. Our cameras move from location to location throughout the year, from rivers where bears and wolves feed on salmon in the fall to herring spawning grounds in the spring and outer coast sea lion rookeries in the summer.

This summer we will be replacing our camera on the outer coast with one that has an automated windshield wiper, so that we will be able to conduct real-time cetacean surveys and photo identification remotely in all types of weather. We will then be able to move our current camera to one of our hydrophone locations along the Inside Passage.

With the power of audio and visual technology at two sites, we will be able to study vocalisation rates of killer whales so that we can better



understand what we might be missing by using only hydrophones, as well as how cetaceans may be responding to boat noise in the area. With success, we expect that this technology will serve as a model for other marine mammal research efforts around

The live audio and video streams are broadcast online so that people anywhere in the world can tune in. We plan to make our web portal more interactive by adding educational content and ways that people can take action to protect the Great Bear Sea, as well as by developing a forum for viewers to post their observations from the live streams.

We hope you will take a look at our Great Bear LIVE project at *www.pacificwild.org* and help us to build the case for marine protected areas in the



## PAUL CLERKIN

EAST RIDGE PACIFIC SHARK RESEARCH CENTER 2015 SOUTHERN INDIAN OCEAN RESEARCH, CONSERVATION, EDUCATION Sharks



#### **RETURN TO THE UNKNOWN: EXPLORING THE** SOUTHERN INDIAN OCEAN'S MYSTERIOUS 90





'People don't realise it, but we are living in a time of shark exploration. In this past decade, new shark species have been discovered at a higher rate than ever before in human history. They're out there. We just have to search for them.'

## WHOIAM

I have loved sharks for as long as I can remember. I was raised on Discovery Channel's Shark Week, watching every show and memorising all the facts that I could. It's a dream come true that I've grown up to work directly with sharks and contribute to research about them. Working with and discovering species has been the focus of my life for the past four years.

I am a fourth-year San Jose State University graduate student of marine science at Moss Landing Marine Laboratories in California, with a focus on shark ecology at the Pacific Shark Research Center (PSRC). During my second semester of graduate school in 2012, I designed a comprehensive sampling protocol that enabled me to examine systematically the trawler's shark by-catch while I was aboard the fishing vessel Will Watch in the Southern Indian Ocean. Since then I have been fortunate enough to

help teach shark identification and sampling protocol at several workshops for the United Nations Food and Agriculture Organization.

Before studying at Moss Landing, I was deployed for several seasons aboard long-liners and trawlers in the Bering Sea by the National Marine Fisheries Service. As an undergraduate at Cornell University, I also participated in the Sea Education Association's Semester-at-Sea programme, conducting openocean research during a 4,800-kilometre voyage on a research/sailing-school vessel in the equatorial Pacific. All told, I have more than 12 months of atsea research.



## WHERE I WORK

The Southern Indian Ocean has long been recognised as one of the world's last unexplored regions, where sea mounts and ridges slope steeply into its depths. Because of the difficulty and expense involved in surveying this area, very little scientific effort has been made so far to probe the sea mounts' highly productive ecosystems. Although they are a hotspot of biodiversity and endemism, virtually nothing is known about their ecology.

Sharks are keystone predators, controlling fauna populations in the food web. Deep-sea elasmobranchs are known for their low fecundity and slow rate of reproduction. If they are overexploited, the vulnerable and unique ecosystems of the region's deep-sea sea mounts could be seriously affected.

The remoteness of the Southern Indian Ocean has meant that its depths have only recently become accessible, mostly to commercial deep-sea fisheries that are driven by an increasing demand for certain species of seafood. Just as our understanding of the sea mounts' ecosystems is still limited, so we know little about the impact that commercial fishing has on their population structure, community dynamics and predator-prey interactions.

#### WHATIDO

I've been on two expeditions to the Southern Indian Ocean aboard the commercial trawler *Will Watch*. Both times the crew ventured more than 1,600 kilometres south of the island of Mauritius to fishing grounds near underwater sea mounts. My mission was to collect deep-water sharks taken incidentally as by-catch during the vessel's routine fishing operations and to examine these specimens systematically, recording biological data, photodocumenting them for the record, taking tissue and organ samples and collecting intact specimens. When sharks were accidentally caught in the trawl nets the crew gave them to me to study, enabling me to make a contribution to scientific research. Any sharks that came up alive were immediately returned to the ocean.

Both voyages proved successful and, in addition to discovering a dozen new species, I collected valuable data on other sharks that are rare and poorly known. My time at sea is very exciting, and I see a lot of amazing things that have never been seen before – like the live birth of a 1.3-metre false catshark.

My goal is not only to contribute to the scientific understanding of sharks, but also to educate the general public about sharks and the Southern Indian Ocean, the last frontier of ocean exploration and discovery. I find it amazing that as a student I can make a serious contribution to science. It's taken a lot of hard work to get where I am, as well as lots of help and luck, but I absolutely love what I do. People don't realise it, but we are living in a time of shark exploration. In this past decade, new shark species have been discovered at a higher rate than ever before in human history. They're out there. We just have to search for them.





| MARINE P  | ROTECTED AREAS TRAINING PROJECT |
|-----------|---------------------------------|
| CENTRO D  | E EDUCACIÓN Y PROMOCIÓN POPULAR |
| 2015      |                                 |
| ECUADOR   |                                 |
| EDUCATION |                                 |

MARINE SPECIES



## WHOIAM

I'm passionate about the conservation of nature 30 years of experience developing educational and and about education. Ever since I was a little girl I environmental awareness programmes. have had a special interest in the wonders hidden in During this time I have realised that this Ecuador's natural protected areas. As my parents organisation is more than a place of work; it has used to develop educational material for park rangers become a second home to me, giving me the chanc working with local communities, I was lucky enough to engage and interact with different people from to visit a wide range of national parks located in the diverse cultural backgrounds, including park highlands, the Amazon basin and the coastal region, rangers, volunteers and academic professionals. It including the spectacular Galápagos Islands. This has also enabled me to experience at first hand the was the beginning of my journey as a naturalist that incredible impact that education has on people's later led me to study biology at university and get lives, and to understand that conservation is truly involved in projects that seek to manage Ecuador's possible only when there is a synergy between civil natural resources. However, my main focus has been action and government involvement. to contribute to the sustainable use and management of natural resources in terrestrial and marine WHATIDO protected areas through education. Since 2012 CEPP has been part of an initiative

## WHERE I WORK

For the past decade I've been working hand in hand with different organisations involved in the preservation and protection of nature in Ecuador. For eight years now I have been an active member of the Centro de Educación y Promoción Popular (CEPP; Centre for Popular Education and Promotion), an Ecuadorian NGO that has more than

'Thanks to support from the SOSF, this year we have begun professional training in marine protected areas. This, added to the financial support of other organisation such as EcoFondo Foundation and PNUD, will enable us to train approximately 400 park rangers."

called Aula Verde, the first systematic training programme for environmental protection in Ecuador. Aula Verde focuses on one of the most important elements of conservation: human talent Park rangers, administrators and environmental technicians are at the front line of conservation. Their training and professional development are essential if relevant conservation and environmental goals are to be reached in the future, and if

Ecuador's national network of protected areas is to be strengthened.

My main activities relate to the development of the programme's educational material in areas such as the management of biodiversity and natural resources, patrolling, tourism and environmental education and interpretation. Once the material is ready, the next part is to coach local instructors, who will then go out to protected areas to train park rangers on the ground.

Every month I visit certain areas to evaluate the impact of the training programme and see the improvements in management activities. This is a great opportunity to get to know the people behind conservation efforts on the ground, understand their hard work and their passion, and discover what they need and what solutions our programme can provide.

Today, 50 natural protected areas – terrestrial, marine and coastal, representing 19% of the country's territory – are part of this revolutionary programme. We keep working to expand this initiative in the hope that it will become a model that other countries in our region will follow.



'Before we can start the science, though, we need to access the sharks. With the generous support of a scientific grant from the SOSF, we're able to access our study site, a remote and challenging spot known for its tiger sharks, which otherwise would go unstudied.'

#### REFUGES AND RISKS: ARE TIGER SHARKS SAFE IN THE SOUTH-WESTERN INDIAN OCEAN? BAYWORLD CENTRE FOR RESEARCH

#### AND EDUCATION

#### 2015

#### MOZAMBIQUE AND SOUTH AFRICA, SOUTH-WESTERN INDIAN OCEAN

Research, Conservation

TIGER SHARK [*GALEOCERDO CUVIER*]



#### WHOIAM

I was born in one of the largest cities in Africa, but grew up with the innate desire to seek wild places. I love the ocean for its wildness and as a kid the idea that there was this completely untamed place without barriers or fences on my doorstep, a place where I could explore on my own, captivated me. From a young age, after my family moved to the coast, I spent every spare moment surfing, diving and exploring the shoreline and rock pools of South Africa.

I didn't want to stop exploring, so at university I decided to study zoology and oceanography. But I quickly discovered that studying the ocean didn't necessarily involve being in the ocean or even being at sea. I wanted to immerse myself, literally, to observe my study subject at first hand in the wild rather than under a microscope. And as an oceanuser, I wanted to study something that I felt a deep respect for. There was no better subject than sharks. In my years of diving and surfing, I've had many encounters with sharks. In all those encounters, a sense of fascination has always outweighed any fleeting fear. I'm motivated by my love for wild places and my fascination for sharks. As a shark researcher, my aim is to preserve the integrity of the systems that I love.

## WHERE I WORK

Our study site lies within Africa's first transboundary marine protected area. It straddles the international border between South Africa and Mozambique and is fringed by the world's highest vegetated sand dunes along some of the most pristine coastline in southern Africa. It is an exceptional place, with high-latitude coral reefs and a remarkably diverse array of large shark species.

## **RYAN DALY**





## WHAT I DO

A typical day in the field starts with the launching of Chance, our trusty rigid-hulled inflatable boat, from a sandy beach and through breaking surf before we navigate 10 miles (16 kilometres) along the coast and 2-3 miles (3-5kilometres) offshore. The objective is to find a tiger shark. Many people think that the ocean is teeming with sharks, but finding a single shark in the wide expanse is often exceptionally challenging. Because tiger sharks are highly mobile, occurring within a huge area, we spend a lot of time searching for them and waiting for ideal conditions: warm, clean water and a north-south current. We also spend a lot of time diving to get an idea of the changing conditions and of where the sharks are. It is often during this time spent in the water that we witness the things that make our study site so special. On any given day we may encounter between six and 10 species of sharks, as well as massive fish aggregations, manta rays, ancient leatherback turtles and migrating humpback whales. Among all of this is where we find tiger sharks and discover more about them.

Our research seeks to answer the question of the balance between the refuges of marine protected areas and the risks faced by tiger sharks throughout the south-western Indian Ocean. Because of their roaming nature, it is likely that the tiger sharks we locate at our study site spend a considerable amount of time outside the marine protected areas we find them in, and are thus probably exposed to risks such as unregulated shark fishing or shark culling programmes. We use data from telemetry and genetic analysis to examine this balance between refuge and risk.

Before we can start the science, though, we need to access the sharks. With the generous support of a scientific grant from the SOSF, we're able to access our study site, a remote and challenging spot known for its tiger sharks, which otherwise would go unstudied. With the means to access these sharks, we are able to tag them. Using short-term satellite transmitters and longer-term underwater transmitters, we can track the habitat use and migration patterns of tiger sharks.

In the short-term the satellite transmitters give us a broad idea of tiger shark movements, whereas over time the fine-scale data from the longer-term underwater transmitters enable us to understand more about the conservation status of these sharks in relation to their refuges and risks. Additionally, we use genetic analysis to determine the links between various regional and global populations of tiger sharks. This in turns helps us to quantify the level of risk that tiger shark populations are exposed to and determine the current conservation status of the species. Finally, we can use this information to propose ways in which to reduce the risks that these sharks face and improve current conservation management practices within and outside marine protected areas in the region.



REPUBLIC USING DERMAL DENTICLE ASSEMBLAGES 2015 PANAMA CITY, PANAMA Research, Conservation, Education Sharks



## RECONSTRUCTING MID-HOLOCENE SHARK BASELINES IN PANAMA AND THE DOMINICAN

#### SMITHSONIAN TROPICAL RESEARCH INSTITUTE



'With the SOSF's support, our study aims to provide the first pre-exploitation baseline of shark communities on Caribbean reefs. It is our hope that this baseline will help ecologists to assess human impacts on sharks and provide policy makers and ecosystem managers with real conservation objectives. We look forward to working together to make this happen.'

## WHOIAM

My avid fascination with the ocean started at a young age. From my earliest memories of snorkelling I know I was captivated by the intricate beauty, elusiveness and complexity of marine ecosystems, and I have naturally been drawn to sharks as a manifestation of these traits.

While studying abroad and doing research in Australia, Palau and the Northern Line Islands during college, I experienced the unspoiled splendour of protected reef ecosystems and observed at first hand the impact of destructive human activities on them. I realised that I didn't want to study coral reef ecology or sharks just for the sake of doing science, but rather to enhance conservation and management efforts, particularly within local communities.

However, it quickly became apparent that I was dealing with shifting baselines. Even the most pristine ecosystems I visited had not entirely eluded the human imprint. This prompted me to approach

the issue of coral reef health and resilience from a different perspective. Instead of focusing solely on the modern ecology of the reefs, I turned to the past to gain a better understanding of their present predicament and thus ensure their future protection.

This led me to get involved with a marine palaeoecology project at the Smithsonian Tropical Research Institute - to which I currently belong that had not yet begun to explore shark baselines. Having previously studied the tremendous role that sharks play in shaping modern-day reef communities and immediately recognising the conservation potential of this project, I sank my teeth wholeheartedly into the opportunity to investigate how shark numbers have changed over the entire timescale of human interaction with the ocean. I am now referred to as the 'shark girl' of the lab. Having been obsessed with sharks as a child, it seems I have serendipitously come full circle.



Silky shark - Carcharhinus falciformis





Scalloped hammerhead shark - Sphyrna lewini





Caribbean sharpnose shark - Rhizoprionodon porosus





### WHERE I WORK

Mounting evidence demonstrates that shark populations worldwide have been decimated by overfishing, reef degradation and pollution. However, how can we effectively restore them if we don't know what constitutes a natural, 'pristine' population?

This question is particularly relevant in the Caribbean, where the human imprint on shark communities is ubiquitous. While diving on reefs around the Bocas del Toro archipelago in Panama for my research, I was struck by the absence of sharks. Reef surveys from myriad other locations across the Caribbean have reported a similar scarcity of sharks, contrasting sharply with the considerable body of anecdotal, historical and ecological evidence that suggests sharks there were once present in numbers unheard of today. To reconcile this age-old problem, our study takes a novel, paleoecological

approach. It turns out that the story of the missing sharks could be in the sediment.

To unravel this tale, we venture back in time. Intriguingly, our 'time machine' is a suite of mid-Holocene reefs in Panama and the Dominican Republic that date back 6,000 to 8,000 years and have been exquisitely preserved in situ.

Imagine strolling along a dry, flattened coral reef. Although the living corals, invertebrates and fish are long gone, their remnants have been preserved like artefacts in a museum. Everywhere you look there are fragments of fossilised branching corals and massive coral heads marking the different zones of what was once the living reef. Shells are scattered about, and the occasional shark tooth or urchin test can be spotted. This reef structure continues as you dig deeper into the sediment, revealing layers of reef history deposited one on top of another. Off in the

distance, mangroves and the sparkling turquoise waves of Panama's Almirante Bay mark the horizon, demonstrating just how close in space this ancient reef is to its modern counterparts – and yet so distant in time.

Exposed and undisturbed sites such as these are rare. In fact, Panama's Bocas del Toro and the Dominican Republic's Enriquillo Valley are home to the only two in the entire Caribbean. Together they represent a unique 'window into the past', showing what pre-exploitation reefs were like when sea levels and other environmental conditions were similar to those of the present. By sampling sediment at these sites we are able to rewind reef history and assess what pristine reef communities were like before they were subjected to subsistence harvesting by indigenous communities or, more recently, the commercial extraction of fish.

## WHATIDO

Establishing baseline conditions for shark interact with their environment, their denticles fall populations is central to understanding how humans off and accumulate in sediments, where we have have altered the abundance, species diversity and discovered that they are well preserved. distribution of sharks over time, and can thus not The challenge lies in extracting them from this only influence their conservation status, but also reef sediment. Not only are denticles very small inform more accurate management practices when typically less than half a millimetre across – they're current ecosystem changes are put into an historical also rare. Finding them involves excavating massive context. However, this requires data prior to modern amounts of sediment from the fossil reefs. After surveys and historical evidence, prompting us to collecting the sediment, the carbonate is digested using acetic acid and the remaining particles are turn to the fossil record. picked under a microscope to isolate and identify the Being cartilaginous, sharks don't preserve as complete fossils, and their teeth are too rare denticles. We're also sampling comparable modern to document past populations comprehensively. reefs across different habitats and shark abundances Instead, we're exploring whether shark dermal to document spatial variation in the denticle record and understand the process of denticle accumulation denticles found in fossil reefs can be used to reconstruct pre-human shark communities. Dermal on reefs.

denticles can be thought of as miniscule 'skin teeth' that line the bodies of sharks. As sharks swim and





Nurse shark - Ginglymostoma cirratum





Tiger shark - Galeocerdo cuvier

Bull shark - Carcharhinus leucas

It's a lengthy process, but worth the effort as this sediment has begun to reveal empirical data about

the status of sharks prior to human harvesting, unfiltered by personal memories and biases. Already we have refined the laborious extraction methodology and are building a reference collection to facilitate denticle identification.

The Save Our Seas Foundation and the Smithsonian Tropical Research Institute make it possible for us to visit reef sites and undertake the large-scale sediment processing necessary to extract the denticles and hone this novel technique. This partnership has also provided the platform for us to disseminate our findings more effectively to a broader and more diverse audience, bridging the gap between science and conservation.

## MAREIKE DORNHEGE

STUDIES, SOPHIA UNIVERSITY, TOKYO 2015 JAPAN, NORTH PACIFIC RESEARCH. CONSERVATION Sharks



## THE OLD MEN AND THE SEA: USING FISHERMEN'S KNOWLEDGE FOR SHARK CONSERVATION **GRADUATE SCHOOL OF GLOBAL ENVIRONMENTAL**



'With the generous help of an SOSF grant I was able to extend my time in the field, interviewing more survey participants and observing more shark landings to gain a better insight into this fishery and how its potential environmental impacts could be mitigated with the help of the community.'

## WHOIAM

Water – the ocean, lakes and canals – were part of my life when I was growing up in northern Germany, where the white sandy beaches and strong winds off the North Sea make for a rough but beautiful landscape. We lived next to a large lake and I spent much of my childhood sailing on it and the Baltic Sea with my family, who were avid sailors. I also played along the lakeshore, watching grebes disappear under water and guessing where they would resurface. My grandfather loved to tell us the tale of Störtebecker, a famous German pirate who was convicted in Hamburg but managed to free all his men by means of an amazing scheme. Our staple foods were not ham and sausage, the traditional fare in Germany, but smoked salmon, trout and the tiny North Sea shrimp.

When I was nine, my godmother gave me a coffee table book about sharks, which I still keep.

stained and dog-eared, on my bookshelf. I remember my mother's surprise when I presented her with a painting of a blue shark I had copied out of it. While my family was happy to sail and swim, I was far more interested in what is under the water. I got my first scuba licence at the age of 14 on the Canary Islands. I vividly remember my first dive: large schools of barracuda, keeping still in the water like arrows frozen in mid-flight; and a playful octopus on my hand, its texture amazingly velvety, more like a cat's than a mollusc's.

Although I dived often, it would take several more years before I finally saw sharks underwater. My first encounter was with great whites in Gansbaai, South Africa, and I was awed at how calmly they approached the cage and boat, unlike anything I had seen in the media. My next encounter, with a single whitetip reef shark on the Great Barrier Reef, had me wondering why it was so hard to find them! By this time I was studying for a degree in environmental management and had begun to be aware of the impact humans have on the ocean. My decision to channel my passion for the ocean into sharks came during a research project in Honduras, where I was comparing the biodiversity of various reef sites depending on their location inside or outside marine protected areas and their proximity to sea grass and mangroves. Two months, two dives a day, 30 researchers, numerous locations and dive sites – and we could find only one, one single leopard shark, on all the hundreds of dives we logged. Clearly something was going on.

#### WHERE I WORK

Located on the north-eastern coast of Japan, Kesennuma can be freezing in winter. At 5 am, hopping from one foot to the other to keep warm, I make my way up and down the fishing dock, looking at the catch that comes in. The fishermen group everything neatly by species: long rows of salmon sharks, piles of blue sharks, smaller heaps of mako. These are the three main species targeted by the Japanese pelagic long-line fishery and by a local drift-net fishery in Japanese waters. Occasionally there are also longfin mako, thresher or hammerhead sharks. A multi-species fishery, the long-liners also targeted tuna, but since the tuna population in the Pacific crashed about 15 years ago, the fishermen switched to billfishes and sharks. Previously, the latter were often not much more than by-catch.

I chat to the fishermen and shark buyers as I inspect the rows. Where did they catch the sharks? Why are most of the mako sharks juveniles? Which shark species do the buyers prefer and what are they used for? And the most important question: would they be willing to participate in my survey? Later, throughout the morning and afternoon, I interview fishermen and boat owners and go over maps with them, or I talk to shark processors and tour their production plants.

#### WHAT I DO

What I learn from these interviews is important if we are to understand the market for shark products as well as the biology and ecology of sharks. Many of the fishermen have detailed knowledge of how sharks segregate by sex and size and can tell me what today's stocks are like compared to 40, 50 or even 60 years ago. A Japanese long-line fisherman will spend up to 11 months a year at sea, hauling in more than 200 sets per year. Multiply this by decades of work experience and you have a data set and knowledge most scientists cannot rival. It is not always easy to find willing interviewees and the strong local dialect makes communication, which is solely in Japanese, sometimes even harder. But this anecdotal, qualitative data – or 'soft' data – can be a valuable supplement to the usual 'hard' catch and landing data, which is what we rely on for fisheries management at the moment.

In addition to providing new insight into shark ecology, information about where juveniles congregate or when females reproduce can be utilised for conservation management. In addition, a component of the questionnaire indicates whether the fisherman accepts conservation measures such as marine protected areas or seasonal catch limits and is willing to comply with them, or he can even make his own suggestions for conservation. Community involvement in fisheries management can greatly increase compliance and lead to the success of conservation measures.





'Support from the SOSF is particularly important, as a pioneering expedition such as this is logistically challenging. I am grateful for the foundation's foresight in investing in an important project that has truly global implications for one of the most fascinating, yet at-risk fishes in the ocean.'

## ASSESSING THE STRUCTURE AND HABITAT USE OF A NOVEL AGGREGATION OF HAMMERHEAD SHARKS OFF JAPAN PANGEASEED 2015 JAPAN RESEARCH SCALLOPED HAMMERHEAD [SPHYRNA LEWIN]

## WHOIAM

I have a deep respect and sense of wonder for species that need to kill in order to survive. This is a concept that we as humans have been disconnected from for thousands of years. As long as I can remember, I have felt a sense of great joy when trying to understand how large predators were able to make a living.

I was brought up in coastal New England, an area with a rich maritime history, and at an early age I gravitated towards marine predators with a special interest in sharks. I can vividly remember visiting the New England Aquarium as a child. It had a wall of shark silhouettes that depicted the life-size lengths of many species and on each visit I would spend time underneath this mural, purposely returning to experience the humbling feeling of being dwarfed by giants.

That feeling still courses through my veins, and I consider myself lucky to work on a variety of predatory species – including sharks – in ecosystems around the world. Broadly, my interests focus on the ecology of survival in sharks, both acutely (daily activities, life-history variation, and predator– prey interactions) and long-term (vulnerability and extinction risk). I am a generalist in that I use tools from multiple domains, although primarily behavioural and physiological tools to answer questions that are fundamental and applied by nature.

## WHERE I WORK

Despite the growing human pressures on biodiversity in the ocean, there are still locations that teem with life and contain a strong abundance of sharks that are otherwise rare or also highly

# AUSTIN GALLAGHER

threatened in other parts of their range. My research is conducted off south-eastern Japan, an area that boasts one of the strongest currents in the Pacific Ocean as well as one of the final aggregation locations for hammerhead sharks in the northern hemisphere.

A global epicentre for technology and at the same time one of the world's primary consumers of ocean-related food products, Japan is an important and inspirational location for marine conservation research, especially on sharks due to its proximity to the hub of the shark-fin trade. The features of our study location are comparable to those of places such as the Galápagos and Cocos Island: deep underwater crags and canyons, regions of cool oceanic upwelling, and high densities of large pelagic predators and fishes. It is these attributes that make shark research here not only challenging, but also highly rewarding.

### WHAT I DO

I am interested in trying to describe, characterise and follow the movements of scalloped hammerheads throughout the summer in Japan and into the winter throughout the rest of Asia. My research team is both international and interdisciplinary, bringing together skills in animal ecology and tracking, energetics and metabolism, and social network theory in order to conduct new analyses of hammerhead shark behaviour over space and time. In particular, we will use a combination of passive acoustic telemetry and satellite-based tagging technology to answer questions about behavioural ecology, with the goal of advancing our knowledge of the risks that face these seemingly abundant yet threatened sharks in this part of the world. Telemetry tags will be attached to sharks in *situ*, utilising the breath-hold skills of world-class surfer and free-diver Mark Healey. My project also partners with Pangeaseed, an incredible organisation that uses art and education to raise awareness and rally support for sharks around the world.





## WHOIAM

THE ESTABLISHMENT OF SHARK SHARE GLOBAL,

AN ONLINE ELASMOBRANCH TISSUE DATABASE

SHARK SHARE GLOBAL

RESEARCH. CONSERVATION

2015

GLOBAL

Sharks

I am without a doubt a shark nerd. It all started laboratories and research groups). It is common for geneticists to require samples from different ocean one morning when I was about 10. I was watching a documentary about the Pacific Ocean and a small basins, so to save money we often share samples and segment of it featured sharks. I can't even remember collaborate with others. the commentary, but I turned to my father and said, 'Dad, I'm going to study sharks when I get older.' WHAT I DO My father laughed and probably thought it was a Together with Lauren Meyer, I run the not-forphase. It wasn't though, and as the years passed profit organisation Shark Share Global. At its core, I slowly found myself obsessed with the idea of Shark Share is a simple database that serves as a becoming a marine biologist and dedicating my life tool for research teams around the world to share to understanding sharks and rays. I feel blessed to be samples. Scientists will submit tissue samples to in the position I am, able to follow my dreams and the database, making them available for other spend my life working in the ocean. research teams.

## WHERE I WORK

I have recently begun my PhD at the University of Tasmania, where I assess populations of sharks and rays in the Papua New Guinea region using genetic tools. This involves spending many hours in a laboratory extracting DNA, identifying gene sequences and comparing the sequences of one individual to those of another. Collecting tissue samples takes up a lot of time, not only out in the field (by harvesting a small fin clipping), but also in the lab (by requesting tissue samples from other



'We see a bright future for Shark Share and are so grateful to have the SOSF supporting our novel idea. By investing in our database project, the foundation has invested in hundreds of future projects we hope will be created via the Shark Share platform."

We have two very simple goals in mind. The first is to increase the efficiency of sampling for sharks and rays, which means ensuring that when samples are taken, as many different tissue types are harvested so as to maximise what researchers can learn from each shark or ray. Our second goal is to create a platform to facilitate global collaboration between lab groups and institutions. By increasing the ease with which tissue samples can be shared, new relationships will be formed between research teams with differing expertise from around the world. In addition, we are creating a user-friendly

way to request samples, as we all know how painful it can be to send out e-mails begging for samples or searching out potential collaborators at conferences. Addressing these challenges may be as simple as using modern technology to bring us all into a virtual community of researchers who are able to collaborate at the click of a button.

At the moment we are in the developmental phase of the database, making sure that we account for functional and non-functional requirements. This includes considering factors such as data input and acknowledgements, and arranging shipping costs. We are currently working alongside a software design team that is helping us to create a userfriendly database we can all one day enjoy. It will, moreover, be a database that will carry on helping shark and ray researchers for years to come, improve multidisciplinary research and save costs associated with field work without reducing the number of studies undertaken.





## HABITAT USE. RESIDENCY AND POPULATION **GENETICS OF THE ENDANGERED SMALLTOOTH** FLORIDA STATE UNIVERSITY RESEARCH



'Thanks to funding through the SOSF and support from Flamingo Cay Lodge on Andros, we will be able to develop the Andros sawfish project. We will seek to fit smalltooth sawfish in The Bahamas with archiving pop-off satellite tags, to complement the more than 40 individuals we have tagged in Florida.'

## WHOIAM

I am a fish ecologist and much of my research is geared towards providing answers needed for the sustainable management and conservation of coastal and deep-water sharks and rays. A Florida native, I grew up fishing and exploring the waters of the north-eastern Gulf of Mexico, which led to an early interest in marine biology in general, and a fascination for sharks and rays in particular. Studies at the University of Miami, a PhD through the College of William & Mary's Virginia Institute of Marine Science, and a post-doctoral stint at the University of Hawaii gave me the opportunity, and good fortune, to work under the guidance of some of the academic giants in this field. I have now been studying sharks and rays for more than 25 years and have tagged and released more than 10,000 sharks from over 40 species during that time.

#### WHERE I WORK

I am based at the Florida State University Coastal and Marine Lab in the USA, although I spend as much of my time at sea doing research as I spend on land, and for much of that time I am working in the same ecosystem studying the same shark populations that inspired me in my youth. I lead a very active lab of bright graduate and undergraduate students and maintain a core of talented collaborators that allows me to work on an array of subject areas.

My SOSF-funded project focuses on the biology and ecology of the smalltooth sawfish. The sawfishes are a small group of large tropical batoids (relatives of skates and rays) that are considered by the IUCN Shark Specialist Group to be the most imperilled of all families of sharks and rays. All five species in the group are currently listed as Endangered or Critically Endangered. As most species reach lengths of five metres (16 feet) or more, sawfishes are among the top





predators in the ecosystems where they live. The smalltooth sawfish is listed as Critically Endangered by the IUCN and was the first native marine fish ever listed as Endangered under the US Endangered Species Act. The primary threat to sawfishes in the USA is by-catch, particularly in traw fisheries. Our work on smalltooth sawfish in the Florida Keys and the Florida Everglades uses fisheryindependent surveys and satellite telemetry to examine their movement and migration patterns. Understanding these patterns will help us to predict areas where sawfish are most likely to be taken by the fisheries so that management efforts can be implemented to decrease by-catch. In addition, we use blood chemistry to assess physiological stress in captured individuals, as well as their reproductive status.

The recovery of this Critically Endangered species will depend on the number of viable populations

that remain. Most recent records outside Florida have come from The Bahamas, primarily from Andros Island. Andros is a very large, remote island that is home to as much mangrove backcountry – preferred sawfish habitat - as the Florida Everglades. In 2010 we conducted a pilot study to examine the feasibility of conducting sawfish research on Andros to complement the work we are doing in the USA. Thanks to funding through the SOSF and support from Flamingo Cay Lodge on Andros, we will be able to develop the Andros sawfish project. We will seek to fit smalltooth sawfish in The Bahamas with archiving pop-off satellite tags, to complement the more than 40 individuals we have tagged in Florida. The aim of this is to examine migration and habitat-use patterns and to assess possible movements between Andros and other Bahamian islands, or even between The Bahamas and the USA. We will also use state-ofthe-art genetics techniques to determine whether Bahamian and US sawfish populations are distinct

or whether significant mixing takes place.

Prior to this project, sawfish pupping had not been documented anywhere in the western North Atlantic outside Florida. During our first trip in 2015, we documented for the first time the presence of youngof-year sawfish on the west side of Andros, the first evidence of sawfish giving birth in The Bahamas. This region has recently been designated the Andros West Side National Park. Current evidence suggests that the smalltooth sawfish population in US waters is slowly increasing. This positive trend probably stems from the sawfish being fully protected from harvesting, and from the fact that a significant amount of its primary habitat in US waters is federally protected within Everglades National Park and the Florida Keys National Marine Sanctuary. Through our SOSFsupported research, we are perfectly poised to assess whether the newly designated national park in Andros could have a similar effect on the sawfish population in The Bahamas.



'The generous support from the SOSF will be used to fund the tracking technology we need to study shark movements and the blood analyses that enable us to look at the sharks' feeding patterns and energy stores, as well as their physical and mental health.'

#### URBAN SHARK: THE EFFECTS OF HUMAN-INDUCED STRESSORS ON THE ECOLOGY OF SHARKS OCCUPYING URBANISED LANDSCAPES UNIVERSITY OF MIAMI, ROSENSTIEL SCHOOL OF MARINE & ATMOSPHERIC SCIENCE 2015

FLORIDA, USA

RESEARCH, CONSERVATION

Sharks



## WHOIAM

I'm a marine ecologist based in Miami, Florida. My research centres broadly on the behavioural ecology, conservation biology and movement ecology of marine predators, especially sharks. I was born in South Africa, where my passion for the ocean first began, but my family emigrated to Canada when I was young and I spent most of my childhood there. Graduate school eventually brought me to Florida and I have lived and worked here ever since.

From a young age, I was exposed to the ocean and its wonderful creatures through family vacations to the beach that inspired me to become a marine scientist. I studied at the University of Toronto for my undergraduate degree in biology and became fascinated by behavioural ecology. All my school breaks were spent volunteering for different marine research organisations so that I could get experience in this field of science. I had the fortunate opportunity to study the behavioural ecology of a variety of species, but after being exposed to shark research and learning about the conservation needs of these animals, I was 'hooked' and decided to make them a focus of my future research.

#### WHERE I WORK

Miami is a great place to work since the ocean is my backyard. In particular, the coast around South Florida is a mosaic of habitats ranging from pristine, mangrove-lined shorelines to skyscraper-dominated beach fronts. There are many different species of sharks in these habitats and they provide great opportunities to investigate our research questions on how coastal urbanisation impacts their behaviour and health.







## WHAT I DO

Coastal marine habitats are some of the most ecologically and socio-economically important ecosystems on the planet. Coastal development and urban sprawl are major threats to these ecosystems, yet the extent to which increasing human activities in coastal areas, such as pollution and habitat modifications, impact the marine species living there is poorly understood. This is especially true in the case of predators such as sharks. There is thus a need to investigate how urbanisation impacts the behaviour and health of sharks and how aspects of urbanisation can be managed to protect sharks while maintaining socio-economic growth. Our team will be conducting surveys off Miami to understand how coastal urbanisation affects the movement, feeding behaviour and physical and mental health of two common coastal species, bull sharks and blacktip sharks.

We will use various tools to accomplish this research. First, we will be going out on boats to several areas around Miami to find, capture and sample blacktip and bull sharks. We will catch them with special shark fishing gear that puts minimal stress on the animals. Once a shark has been caught, we will measure it, attach a small transmitter tag to it and take a small blood sample for laboratory analysis, then quickly release it back into the wild. The transmitter will enable us to track the shark's movements in and out of urban areas. We can evaluate each shark's health by measuring how 'fat' it is as well as by assessing its energy store, hormone levels and immune function from its blood sample. Finally, we can gain insights into shark feeding patterns by analysing the chemical signatures in the blood.

## EUAN HARVEY

**BETWEEN HUMANS AND SHARKS CURTIN UNIVERSITY** 2015

GALAPAGOS ISLANDS, ECUADOR Research, Conservation, Education

Sharks

## THE GALAPAGOS MARINE RESERVE: PROVIDING A MODEL FOR A SUSTAINABLE COEXISTENCE



'Thanks to support from the SOSF, our video imagery and data will help to inform local people about the importance of the shark populations and will be used to guide management of the Galápagos Marine Reserve.'

## **WHOIAM**

Growing up in New Zealand, I developed a love of bush-walking and surfing that fuelled an interest in conservation and led me to undertake a degree in conservation management. During my studies I was fortunate to be exposed to pioneers in marine conservation research, in particular Bill Ballantine. the grandfather of marine reserves in New Zealand, and Steve Dawson and Liz Slooten, both marine mammal experts. Following the management degree I was inspired to take a broad and practical view of marine conservation and undertook a PhD in marine ecology and sustainable fisheries management tools.

I have carried out research in marine ecology at Otago University in New Zealand, at the University of Western Australia and at Curtin University, which is also in Western Australia and where I currently hold the position of professor of marine science.

## WHERE I WORK

Over the past 20 years I have pioneered the use of baited remote and diver-operated stereovideo systems so that we can collect data without having to capture or disturb the animals we are studying. These techniques are now well accepted internationally and are being used in ecology. Although I work mainly in the temperate and tropical areas of Western Australia, I am collaborating with community groups and other researchers from all over the world, such as South Africa, the Dutch Caribbean, Hawaii and the Galápagos Islands. Because we collect data in the same way, using the same techniques, our information can be shared and merged to gain a more global understanding of the status of fish and shark populations.

The Galápagos Islands are the birthplace of evolutionary ecology and conservation. Underwater Galápagos is world famous for its diverse marine life, including turtles, marine iguanas and schooling hammerhead sharks. It is also recognised internationally as a hotspot for sharks, yet there is little or no information about the status of its shark populations.

## WHATIDO

Using remote camera techniques, we will conduct research to understand the conservation status of key shark species as well as local people's perceptions about sharks. The knowledge acquired will be translated into management proposals and educational campaigns to share the ecological and socio-economic importance of sharks for the Galápagos Islands.

Thanks to support from the SOSF, we will use bottom and mid-water Baited Remote Underwater Video systems to document the distribution, habitat use and numbers and sizes of key shark species in the Galápagos Islands. Our video imagery and data will help to inform local people about the importance of the shark populations and will be used to guide management of the Galápagos Marine Reserve.









| 1ANTA RAY GENETICS PROJECT        |
|-----------------------------------|
| THE MANTA TRUST                   |
| 2013, 2015                        |
| VORLDWIDE                         |
| Research                          |
| 10bulids [Manta spp & Mobula spp] |
|                                   |

#### WHOIAM

My earliest memory of the ocean is a little unusual. I was on a family beach holiday in the UK when I was faced by this enormous, deafening wall of water and ran away as fast as my little legs would carry me, crying my eyes out. My parents' response was to pick me up and throw me straight back at the wave - no messing about. I can't thank them enough for that!

Growing up, I read endlessly about wildlife and the ocean, eager to know everything there was to know. Then one day it struck me: there must be people out there who go and make these discoveries in the first place. That was when I decided I wanted to be a scientist. Not only that, but I wanted to help secure the future of the awesome wildlife that we are so lucky to share the planet with.

I started by studying zoology at the University of Sheffield, where I was introduced to the field of conservation genetics. This involves preserving diversity at the level of the gene and applying knowledge of the genetics within and between wildlife populations to conservation. While taking a Master's degree in biodiversity and conservation at the University of Leeds, I began to realise just how broad and exciting the applications of genetics in conservation really are. You can figure out which geographical area an illegal wildlife product came from. You can investigate the links between

populations of animals: are they interbreeding or are they isolated? Is there inbreeding? Do they move between habitats? Have the answers to these questions been different in the past? You can study how animals evolve, how they adapt to changing environments, how they diversify and form new species, and even work out what a species really is. The possibilities are almost endless, and it's awesome! To top it all off, I now work on the genetics of manta rays and devil rays, so I feel like I have the best job in the world.

#### WHERE I WORK

For those who have never been in a laboratory, they are fascinating places, with so much going on behind the scenes. Gone are the days of the stereotypes of strange, boring scientists skulking around in their white coats, never seeing daylight. The average day might involve extracting DNA, amplifying individual genes for study, or visualising them on a special gel to check DNA quality. It never ceases to amaze me, though, that recent advances in next generation sequencing technologies now enable us to sequence sections of DNA from across the entire genome with relative ease. With these techniques it is possible to unlock the genetic code contained within every one of the cells of every living thing – including me, you and even the salad I just

had for lunch! It paints the ultimate picture of what really makes an organism tick. What's more, I can do all this while standing in my white coat. Do labs seem boring now? Didn't think so!

The Molecular Ecology and Fisheries Genetics Laboratory where I am based for my PhD is part of Bangor University, but I also have links with the Royal Zoological Society of Scotland and the Manta Trust.

## WHAT I DO

Manta rays and devil rays are under threat globally both from targeted fisheries and as by-catch. The fisheries supply the trade for the rays' gill plates, which are used in some traditional medicines even though there is no evidence that they are effective. Unfortunately, populations of these rays cannot easily recover from fishing, as the species have low rates of reproduction. Although global legislation regulating the trade in gill plates was passed in 2013, the sad reality is that it still goes on. Worse still, it is very difficult to identify plates to the species level or know which part of the world they came from. This is where conservation work is most sorely needed.

In 2014 I started my PhD, which aims to develop genetic tools for the conservation of rays. Working alongside colleagues from the Manta Trust, I aim to produce a global genetic ID kit for manta rays and

devil rays. Scientists and enforcement agencies will be able to use this kit to identify a ray, or any of its parts, to species level and later determine where it came from. The beauty of this is that it will work at any stage of the exploitation process, from when the ray is first pulled from the sea to when dried gill plates are sold – and there's no arguing with DNA! To do this, we need to look at sections in the genome that are consistently different between species and between populations. This also enables us to investigate how individual populations may be adapted to their local conditions – and therefore understand how they may respond to changes in the environment.

I use a technique called Restriction Site Associated DNA sequencing (RADseq), which involves cutting long strands of DNA into pieces with a restriction enzyme and sequencing the ends of the resulting fragments. In short, I am able to take a reduced representation of the whole genome without the biases of looking at individual genes, which may be under selection.

To do this, first of all I need a sample to extract the DNA from. This is very much a global project and I have been talking to other scientists all over the world, many of whom have been kind enough to contribute tissue samples they have collected.

## ALISON KOCK







'My role is to conduct applied research on the ecology and behaviour of Cape Town's white shark population. So far my team and I have answered questions relating to the "when" and "where" of white shark occurrence."

## WHOIAM

'My goal is to be a marine biologist.' This is the hand-made banner that I displayed above my desk all through high school. I have always wanted to be a marine biologist and was fortunate to have parents who fostered my love for the ocean. When I was very young I used to accompany my dad on boat trips to harvest crayfish. We would spend hours at sea, deploying nets and waiting for the crayfish to climb inside. When we retrieved the nets, it wasn't only crayfish that we found, but small shysharks too. The little sharks would curl up into a ball with their tail covering their eyes and my dad instructed me to kiss them on the head and gently release them back into the water. When I did so, the shysharks would uncurl and swim back down to the bottom.

After high school I enrolled at the University of Cape Town to pursue my career in marine biology and at every opportunity I spent my free time scuba-

diving and exploring the incredible underwater world around Cape Town. After my undergraduate degree I had the opportunity to go out on a white shark viewing trip to Seal Island. That was the first time I saw a great white shark launch itself two metres into the air chasing a Cape fur seal. I was hooked. I decided then and there that I was going to be the one to discover the answers to all the questions nobody could answer.

Following a four-year period when I worked as a field guide on the ocean with the sharks and in the terrestrial environment with other wildlife, I went back to university and initiated a research project on the behavioural ecology of white sharks in False Bay, which was one of the six inaugural projects funded by the Save Our Seas Foundation. Seventeen years since my first great white shark sighting, I am still studying these sharks, now in the role of research



manager for Cape Town's pioneering Shark Spotters programme. I no longer kiss the sharks on the head, but I did achieve my goal and have my dream job.

#### WHERE I WORK

Cape Town, South Africa, is a major city with an ocean wilderness as a backyard. It encompasses False Bay, a special place where you can visit African penguin colonies, view massive southern right whales breaching up to 15 times in a row from shore, encounter thousands of common dolphins on a boat trip, watch fishermen hauling in nets filled with yellowtail and, if you're lucky, sit at a mountain lookout and watch great white sharks swim lazily by.

Just six kilometres from the coast is a small granite island that is home to 70,000 Cape fur seals at the peak of the season. It is here that you can witness the incredible raw power of the sharks as they pursue their seal prey in a game of survival. Nowhere else on earth can these encounters be observed with such consistency and it is a spectacle that deserves to be preserved.

One of the best things about working in Cape Town is that it is a hop, skip and a 20-minute boat ride to get to my field sites. This means that I can regularly and consistently conduct field work throughout the year. So far, my team and I have established that False Bay is a critical area for the conservation of white sharks because a significant proportion of South Africa's white shark population uses the area throughout the year. But the sharks' high fidelity to this coastal area has implications for them, as the environment is heavily impacted by fishing, pollution and disturbance resulting from coastal development. It also has implications for the large proportion of Cape Town's four million residents who swim, surf, kayak, windsurf, kite-board, fish and dive along these shores. Shark incidents have increased over the years and conserving a threatened apex predator in conflict with people is a major conservation challenge. To maintain the balance between white shark conservation and public safety, I believe it is imperative that we have a strong scientific foundation on white shark ecology and behaviour, coupled with non-lethal mitigation methods to reduce shark incidents and supported by a comprehensive education and awareness strategy.

### WHATIDO

My role is to conduct applied research on the ecology and behaviour of Cape Town's white shark population. So far my team and I have answered questions relating to the 'when' and 'where' of white shark occurrence. We have discovered that they are present all year round in False Bay, but use the bay very differently depending on the season. In autumn and winter, male and female sharks spend most of their time around Seal Island, preying on naive seal pups. However, come spring and summer, the sharks spend little time around the island and instead many of the female sharks move inshore, closer to the coast.

Although we have a good understanding of why white sharks visit the island, our understanding of strategies. why they spend so much time inshore is still limited. Furthermore, I will examine the interactions between white sharks and their prey to define the We do know that within the inshore area there are specific hotspots, like the northern shores of False species' ecological role in a temperate ecosystem. Bay, which are used significantly more than other Predators can shape the ecosystems in which they live in a direct way by reducing prey numbers, inshore areas. But we don't know what makes the inshore area so attractive. We have also determined which in turn can affect populations lower down that most of the sharks are juveniles and sub-adults. the food chain. They can also influence the structure

My research now focuses on the 'why'. To achieve this goal I will use a combination of direct observation, photo-identification, acoustic monitoring and animal-borne cameras. With a hypothesis-driven approach, I will investigate the drivers of white shark presence in False Bay, both environmental (such as water temperature) and biological (such as prey availability). This will enable us to model which factors relate to high shark activity and can be incorporated into shark safety strategies. and function of the ecosystem by causing prey populations to modify their behaviour in response to predation risk. I hope that with enough information we can predict what would happen to the ecosystem if their populations changed significantly.

The overarching goal is to contribute to the conservation of the South African white shark population, its critical habitats and its prey resources. Even though white sharks have an extensive range, their high site fidelity to False Bay gives us an opportunity to contribute to the long-term conservation of this critical habitat and continue to foster co-existence between people and sharks.



'Many of the threats to sawfishes are the same all over the world, especially by-catch in trawl fisheries and the loss of mangroves, an important habitat for juvenile sawfishes, through deforestation.'

#### DOCUMENTING AND PROTECTING CRITICALLY ENDANGERED SAWFISHES IN MADAGASCAR BENGUELA RESEARCH & TRAINING 2015

#### WESTERN MADAGASCAR

RESEARCH, CONSERVATION

GREEN SAWFISH [*PRISTIS ZIJSRON*], FRESHWATER SAWFISH [*P. pristis*]



### WHOIAM

I have always been fascinated by the underwater world, encouraged perhaps by watching Jacques Cousteau documentaries as a child, and when I learned to scuba dive in my early 20s, my world changed forever. I began my career as a marine biologist by studying whales and dolphins and, searching for a niche to fill, realised that there was remarkably little known about them in African waters. I began working in The Gambia in 2007 and have since been involved in projects in eight countries on both the east and west coasts of Africa.

Through my experience in providing training to local communities and interviewing fishers, I landed a short contract to collect information about sawfishes in Guinea-Bissau. I soon became fascinated by this group of unique and rapidly disappearing species. We have even less information about where in Africa sawfishes still exist and the local threats they face than we have about whales and dolphins.

I set up the Protect Africa's Sawfishes project in 2012 in order to address this gap in knowledge and to work in collaboration with local communities and governments to protect any remaining sawfish populations in African waters. To my mind, sawfishes can act as flagship species for marine conservation. By addressing the threats to sawfishes, which include unsustainable fishing practices and the loss of mangrove habitats, we address threats to marine and freshwater ecosystems throughout Africa and to the fishing communities that depend on these ecosystems for food and income.

#### WHERE I WORK

Recently, most of my efforts have focused on the East African (Indian Ocean) coast and they include my current SOSF-funded work in







Madagascar. Africa is a huge continent with an amazing diversity of cultures, and I have learned much from each of the places I have been fortunate to work in. A lot of my work involves wandering through fishing villages or fish markets, sometimes in freshwater environments hundreds of kilometres upriver, and I often feel far from the beaches and underwater world I love. However, during my field work in Madagascar this year I visited some remote regions where communities seldom see outsiders. I encountered the rare sight of swathes of pristine mangroves and small, artisanal fishing communities where fishers maintain a respect for their local fishing grounds and the taboos and traditions that their ancestors followed. It is heartening to know that such places still exist.

Many of the threats to sawfishes are the same all over the world, especially by-catch in trawl

fisheries and the loss of mangroves, an important habitat for juvenile sawfishes, through deforestation. Other threats are specific to certain locations. For example, deforestation in Madagascar's inland areas causes erosion, which leads to the build-up of sediment thousands of kilometres downstream, at the mouths of rivers. As river mouths and mangrove areas become shallower, the movements of sawfishes may become more limited, making the fishes easier to catch or possibly preventing them from accessing nursery areas.

Visiting various fishing communities in coastal and freshwater areas in Madagascar to collect interview data has enabled me to experience at first hand the living conditions and struggles of these communities. According to the United Nations' Human Development Index 2014, Madagascar is one of the poorest countries in the world. Conservation

efforts in such places can never prioritise the protection of wildlife over the well-being of human communities, and even if they did, such conservation efforts would be ineffective. My hope is that sawfish conservation in Madagascar will be a community effort and that, through education and the development of more sustainable fisheries and alternative livelihoods, it will benefit local people as well as sawfish populations.

## WHAT I DO

Protect Africa's Sawfishes addresses a simple but critical problem: we need to protect sawfishes, but in Africa we just don't know where sawfish populations still exist. Without that very basic information, we can't develop sawfish conservation programmes or identify what the major threats to sawfishes are in various African countries. So right now, my work

sawfishes do indeed inhabit Malagasy waters and focuses on collecting baseline data – documenting important to them, either economically or culturally. where in Madagascar sawfish used to be found and This kind of work is slow and time-consuming. identify any critical habitats such as nursery areas whether they are still caught or seen in those areas. but doesn't require any specialised equipment. So the for young sawfishes. The Malagasy government funding provided by the SOSF covers the basic costs recognises the importance of protecting this unique I also document the links between communities and sawfishes. In the case of Madagascar, sawfishes of running the project: transport from one village and critically endangered species in national waters, are not culturally important (except in one small to the next (by bush taxi, bus or local canoe!), and I am looking forward to working closely with it area), but they do provide fishing communities with accommodation and hiring local translators and to develop a National Sawfish Conservation Strategy food and saleable commodities such as meat and guides to help with the interviews. A project of this in line with recommendations made by the IUCN's fins. If sawfishes are to be protected effectively, nature is generally good value for money, as it results Shark Specialist Group. I am optimistic that we can fishers must be provided with an alternative means of in really useful baseline information about where we protect one of Africa's last populations of sawfishes, providing for their families. need to focus future research conservation efforts for and in doing so raise awareness globally for these The project involves conducting interviews with sawfishes. fascinating 'sea monsters'!

fishermen and women, and other local people with long-term knowledge of fish catches, to find out whether they catch or observe sawfishes, or did in the past. We also ask whether they know of specific areas where sawfishes, which they call vahavaha or *vavana*, can be found and whether sawfishes are



The outlook for sawfishes in Madagascar is positive – they are certainly still present, at least in small numbers. The next essential steps are to conduct sampling in certain areas that interviewees have highlighted as being important sawfish habitats, so that we can get photographic proof that



### INCIDENTAL CATCH OF MANTA AND MOBULA **RAYS IN THE EASTERN PACIFIC OCEAN** INTER-AMERICAN TROPICAL TUNA COMMISSION 2015

#### EASTERN PACIFIC OCEAN

CONSERVATION

MOBULIDS (MANTA SPP & MOBULA SPP)



#### WHO I AM

During my childhood I was always close to the sea. I was born in Basque Country, a place where fishing has a huge impact in our culture and society. All activities, whether sporting or gastronomic, have always been traditionally tied to the sea. Until the age of nine I lived in Galicia, north-western Spain, and don't remember spending any weekend or special moment along that rugged coastline in a place that was not near the cliffs, the harbour or the wild beaches, watching the waves and feeling the salt-laden wind.

The first time I understood the meaning of conservation was when an oil tanker, the Aegean Sea, ran aground off the Galician coast and tons of fuel reached the shore, killing hundreds of animals. A biologist came to our school and showed us photographs and videos of the disaster. I was completely shocked, but already some ideas were beginning to form in my mind.

When I grew up I, like thousands of other people, fell in love with whales and dolphins because I saw them in movies and aquariums, and because of Jacques Cousteau. For many people they were no more than beautiful and charismatic animals, but for me studying them and trying to understand their behaviour and ecology became a way of life. Fortunately, during my studies for a degree

in biology, I had the opportunity to take up an internship in southern Spain, studying and working with marine mammals. This experience gave me the opportunity to work later as a research assistant in the Basque Country, studying the marine biodiversity of the Basque coast.

Now, as a PhD student, I'm working on by-catch data from the tropical tuna purse-seine fisheries in the Indian, Atlantic and Eastern Pacific oceans and I've become very aware of the plight of other pelagic species, such as manta and mobula rays. Last year I shared the rays' underwater habitat in La Paz in Baja California, Mexico, and knew that I wanted to learn more about them.

#### WHERE I WORK

The Eastern Pacific Ocean is a very large area and is regulated by numerous oceanographic processes that influence the distribution of most pelagic species. Although we know that manta and mobula rays are found in tropical and temperate waters around the globe, lack of data prevents us from defining their distribution in greater detail.

In general, large numbers of the rays are often seen aggregating in spring and summer to feed, mate or visit cleaning stations, where they are cleaned of parasites and dead skin by particular fish

'With its support and its confidence in our novel methods and flexible timetables, the SOSF has made our project possible. I hope you enjoy reading about our work and learning more about it, and that you will feel the same need to protect these amazing animals."

species, around the Gulf of California and Mexico's even days. Generally they are discarded, but they seldom survive the experience; because of their large size and weight, they need to be lifted from the deck using gaffs or large hooks inserted in the gill area. It is the aim of our project to understand and quantify the impacts of fishery by-catch on mobulid At present, manta and mobula rays are of populations – and find a way to solve this problem. The Inter-American Tropical Tuna Commission, an international body responsible for the conservation and management of tuna and other marine resources in the Eastern Pacific Ocean. created a database of by-catch records from observer programmes in order to provide information that can be used to benefit conservation. Collecting data has been a long process, and the database is the result of the observers' hard work since 1993. Today it is one of the most complete and accurate databases of this kind of fishery. With the aim of protecting manta and mobula

Pacific coast. The tropical sea surface temperature (higher than 26 °C) and the high abundance of phytoplankton along the coast of Central America make this region an ideal habitat for these species. increasing economic interest in global markets for food and medicine, and several subpopulations appear to have decreased in Mexico as a result of sustained pressure from different forms of fishing (such as trawling, long-line and purse-seine). The increase in catches of both genera in the Eastern Pacific Ocean is cause for concern because of their threatened status. These rays are very long-lived and reproduce infrequently, so they are vulnerable to impacts that increase their mortality. In addition, the lack of extensive scientific information about their biology and ecology is a major obstacle, limiting the effectiveness of conservation efforts.

## WHATIDO

The targeting of manta and mobula rays aside, many of these vulnerable animals are caught unintentionally. Sometimes they are caught in conjunction with tuna, sometimes with tuna and dolphins, and sometimes under fish aggregation devices (FADs) where they may remain for hours or ray populations, we will study the incidental catch of these species and will try to identify the areas, seasons and habitats in which they are most likely to be caught by the tropical purse-seine fishery. What we learn will help us to understand the biology and habitats of the rays and thus to achieve ecosystembased fishery management that takes into account all the components of the ecosystem.







#### **BIO-ACCUMULATION OF ORGANOCHLORINE CONTAMINANTS IN THREE SPECIES OF** PREDATORY SHARKS OCCUPYING MULTIPLE TROPHIC LEVELS

CALIFORNIA STATE UNIVERSITY LONG BEACH 2015

#### SOUTHERN CALIFORNIA, USA

Research

PRIONACE GLAUCA, ALOPIAS VULPINUS, SURUS OXYRHINCUS



## WHOIAM

Thanks to the movie and music industry, California has acquired a reputation as the land of endless summer. I grew up in one of the many cities in the county of Los Angeles and have lived in California for most of my life. I mention this fact because it has been integral in shaping who I am today and is perhaps why most of my research is based in California. When I was a child, my love for the ocean was fostered by my parents. One of my fondest memories is of my dad taking my sister and me to the beach every Monday night after he got home from work. Throughout my life, my parents have been supportive of my budding (and now realised) marine biologist endeavours. Whether it was after-school classes at local aquariums, day camps or taking me to visit colleges around the state that offered degrees in marine biology, my parents have been there every step of the way.

During my childhood, I became interested in shark research after reading the work of Dr Eugenie Clark. I was fascinated not only by her research on shark behaviour, but also because she was a woman in science who showed that shark research wasn't just for men. While working on my Master's at Cal State Long Beach, I forged my own path as a shark biologist. At college I became interested in environmental contaminants and since then I have been investigating patterns of accumulation and the implications they have for an animal's fitness. Elasmobranchs (sharks, skates and rays) represent a unique model system in contaminant research and are also understudied in this area compared to birds, reptiles or mammals.

#### WHERE I WORK

Up and down the coast of California, the Pacific Legacy contaminants are contaminants whose Ocean is more than just a body of water; it's a production ceased decades ago, but they still remain way of life. What most people don't realise is the in the environment because they do not degrade impact that humans have on the adjacent marine easily. Therefore, even though they are no longer areas. Think about it. More than 22 million people being produced, they are still problematic because live in southern California alone, which is a larger they persist in the environment. Contaminant population and higher density of humans than in research is a very exciting area and with respect to many countries around the world. Of course, many elasmobranchs is a relatively young field, so there is people are aware of the human impacts that they can much work to be done and a lot of questions to be see, such as litter or oil spills. However, the pollution answered. that people can't see lasts just as long – if not longer. One of these questions relates to patterns of I am interested in studying this unseen and accumulation among species of open-water sharks in southern California. So far, our research indicates often forgotten pollution. Many tons of organic contaminants were released into the southern that newborn sharks begin life with a 'starting California marine environment before they were amount' of legacy contaminants that is passed banned in the 1970s. In particular, DDT, the on to them by their mothers during gestation in a contaminant responsible for the thinning of bird process called maternal offloading. We have also eggshells made famous by Rachel Carson's Silent documented that as these young sharks grow, *Spring*, was released in high proportions there. the concentrations of their starting amount of Because of this, animals from southern California contaminants become diluted. We hypothesise that have a unique 'DDT signature'. While remediation this is due to the sharks' inability to acquire the efforts are ongoing, the high persistence of these same amounts of these contaminants from their food at this point in their life. However, we have contaminants in the environment is a concern. Since elasmobranchs are at the top of many food chains, also demonstrated that much older, adult sharks they have a tendency to accumulate high levels of have high levels of contaminants, such that the contaminants, which is where my interest in this field concentration curve of an animal over body size is predicted to look U-shaped. I am interested came into being. in examining the inflection point of this 'U' and investigating the factors that influence when there WHATIDO The short version of my research is that I study is a switch from contaminants being diluted to legacy contaminant concentrations in elasmobranchs. being accumulated. To do this, I will be examining However, that is not enough to describe all the contaminant concentrations for three species of interesting questions that come with the territory. shark: shortfin mako Isurus oxyrinchus, common

thresher Alopias vulpinus and blue Prionace glauca. With the funds provided by SOSF, I hope to offer more insights into the biology of these animals by approaching it from a contaminant point of view.

I would be lying to you if I said that legacy organic contaminants that were released decades ago were the only harmful compounds that the marine environment has to deal with. The reality is that everything that gets flushed down toilets and sinks or goes down storm drains has the potential to reach the ocean. However, there are many great researchers investigating these issues and I am grateful that my study has a place among theirs.

Some pessimists might say, 'Well, the damage has been done already.' I would respond that researching these legacy contaminants has several roles. Firstly, the signatures animals pick up when they utilise different areas with unique contaminant proportions offer another option in the scientists' toolbox to study the ecology of animals. Secondly, there is a need to study the potential physiological impacts of these contaminants because they are still in the environment. Thirdly, and perhaps most importantly, discussing legacy contaminants raises awareness about the impacts humans have on their environment. By starting the contaminant conversation, we can educate people about the influence that humans have had on the local marine environment and encourage them to think about how they want to leave the ocean and its inhabitants for future generations.



## **UNRAVELLING THE MYSTERY OF THE GENUS MUSTELUS IN SOUTHERN AFRICA** STELLENBOSCH UNIVERSITY 2015 SOUTH AFRICA Research MUSTELUS SSP

'I am really grateful to the SOSF for taking the initiative to support molecular genetics projects as they can provide valuable information about the genetic diversity of species. With its support there is now a chance to address the misidentification of species and this will prove useful in monitoring trade and assessing the catch rates of commercially important species."

#### WHOIAM

I'm a 'bench' conservation geneticist by trade. I admit it, I'm the kind who enjoys working in the safety of his lab bench and desktop, a nerd perhaps. Growing up on the warm east coast shores of Durban in KwaZulu-Natal, South Africa, meant that the ocean (nature) has been a huge part of my life. Back then I was so hung up on *what* I would be when I grew up. I was dead certain I was going to be a pilot, but unfortunately my eyesight was not in my favour. After denial, anger, bargaining and all that jazz, I moved on to molecular genetics. In newspapers and magazines I would come across devastating news about the ocean and its residents, and it was the role that we humans play in the destruction of marine ecosystems that troubled me the most by far.

The American journalist and author Maria Shriver posed a question in the title of one of her books: Just Who Will You Be? That is, who (not

*what*) will you be when you grow up? In 2012 I had an answer to her question: I was going to be a conservation geneticist and engage in the conservation of marine species whose survival is threatened by overexploitation, rampant poaching and the fragmentation of their habitat. I would thus help to maintain animal biodiversity for future generations.

My debut in marine conservation came in 2012, when I worked on Haliotis midae, commonly known as abalone or by its local name 'perlemoen', a commercially valued marine gastropod mollusc in South Africa. My research expanded to bioeconomically important shark species in South Africa, particularly the common smoothhound shark Mustelus mustelus. I am increasingly appreciating field work – persevering gloriously through seasickness – and researching various triakid shark species for my PhD has been a blast.

## WHERE I WORK

In Mzansi (South Africa) the coastline spans two oceans, the south-eastern Atlantic and southwestern Indian, making this seascape one of the marine biodiversity hotspots in the world. It also makes South Africa an ideal place to test a variety of ecological and phylogeographic hypotheses that prove useful for informing marine conservation management decisions. Portrayed by the media as 'the big bad wolf', sharks have long been feared by the public, but now we are seeing some progress in that same public's awareness of the need to protect sharks through educational outreach programmes. I, like many others, believe that sharks should be viewed as keystone species that are vital to the health of the ocean. A number of South African coastal ecosystems illustrate this better than any descriptive words could.

#### WHAT I DO

Conservation genetics. For my PhD I am using various molecular approaches to disentangle the evolutionary origin of the Mustelus genus in southern Africa and also resolve species identification issues within the genus. This work is driven by the high level of misidentification of Mustelus species in fisheries operations, not just in South Africa but also in other parts of the world, such as the Mediterranean Sea. Understanding the evolutionary history of species and resolving misidentification issues will enable us to understand the current levels of biodiversity and what we need to protect.

The Save Our Seas Foundation has afforded me the opportunity to explore and address various phylogenetic questions, such as where did the Mustelus genus in southern Africa originate? What is the evolutionary relationship among the species? And when did they diverge to become

different species? To answer these questions, we use molecular approaches such as the sequencing of mitochondrial genes (inherited from the mother) and nuclear genes (inherited from both parents) for phylogenetic reconstruction. Using sequence data generated from both mitochondrial and nuclear genes enables us to get a perspective from both sides of the coin and draw conclusions about the evolutionary history of the genus in question. This provides insight into speciation events and species delimitation.




'It is critical for us to understand the movements of this angel shark population around the Canary Islands so that appropriate management decisions can be made. We are very grateful to the Save Our Seas Foundation for giving us the funding to start with this tagging project.'

# DISTRIBUTION IN THE CANARY ISLANDS **BIODIVERSITY AND CONSERVATION RESEARCH**



### WHOIAM

When I was a kid my greatest nightmare was being the only survivor of a plane crash in the ocean and being eaten by a shark. What a crazy fear to have. I did not grow up near the ocean and I did not have much to do with marine life. In fact, I was born in Germany and grew up in Bolivia, in the middle of the Andes, far away from the sea. I never thought I would work as a marine scientist. I was more of an artist, a creative person, but I always loved nature. When we moved to Ecuador, I became even more fascinated by nature, especially marine life. There I was confronted by the most beautiful and sad things I had ever seen. The Amazon, the Andes, the Pacific and the Galápagos. I ended up studying marine ecology and swimming with sharks, the creatures I had feared for so long. I got involved in conservation projects, I studied their behaviour and I understood the importance of preserving them.

Today, my biggest nightmare is being the only survivor of a plane crash in the ocean and not seeing any sharks while I'm waiting to be rescued.

### WHERE I WORK

Our project is based in the Canary Islands, a beautiful archipelago of seven volcanic islands in the Atlantic and a popular destination of German and English tourists who come to escape the winter or to go diving. The diving community here is very large, with hundreds of divers visiting the same spots regularly throughout the year. One of the biggest attractions for them is seeing an angel shark. Many dive clubs use this shark as their logo and to promote adventure dives.

Angel sharks are easily spotted by a trained eye and can be found very close to shore at popular dive sites. Once one has been seen, the dive guide often



so that the divers can take better photographs and also appeal to recreational, artisanal and sport fishers, as they seem to be quite tasty and look good in a photograph when they have been caught from a charter boat.

The Angel Shark Project is trying to gather all removes its covering of sand or makes it swim away the information necessary to secure the future of observe the shark while it is swimming. Angel sharks the angel shark in the Canary Islands and the rest of Europe. To do so, we have developed different strategies that involve the recreational-diving and sport-fishing communities. We have engaged members of the diving community to register their encounters with angel sharks on our online I was surprised to find out that even though database, ePOSEIDON, where they can give us this shark is so popular and quite common in the Canary Islands, hardly anything is known about information about the exact locality of the shark, its biology and ecology. It has been extirpated from the environmental conditions at this locality, and the rest of Europe and is locally extinct in many the individual's size, sex and behaviour. Now citizen scientists are constantly helping us to gather areas. Considering the species' Critically Endangered status, the Canary Island population may be its information across the entire archipelago and we last stronghold worldwide. For the local people, are getting an idea about the current distribution however, the angel shark appears to be abundant and patterns and the structure of the population. At the same time, we are raising awareness of the critical everywhere. One of the main problems we have identified status of this shark and educating divers to avoid disturbing it.

is the lack of awareness of its conservation status and vulnerability. Fishing activity and increased disturbance to this shark may cause damage to the apparently healthy population. So before any management decisions can be made, we need to gather enough information about its current status.



### WHATIDO

Taking advantage of this participation, our next step in the project is a tagging element. We want to find out how many angel sharks are left in the Canary Islands and to understand their movements. At the moment we are unsure whether

they move between islands or even away from the Canary Islands. With funding from the Save Our Seas Foundation (SOSF), we will be able to tag angel sharks in the three main islands where divers are spotting them regularly, marking them with different colours depending on the island. Divers will be encouraged to submit encounters of tagged angel sharks into our database and report the colour and number of the tag. This will let us know which individual was seen at a specific locality and the island where it came from. We are very excited that so many people from different backgrounds are involved in our project and to have the SOSF helping us to achieve our goals.





THE EFFECTS OF WHITE SHARK CAGE-DIVING ON THE ECOLOGICAL IMPORTANCE OF RESIDING **AROUND SEAL COLONIES** 

FLINDERS UNIVERSITY OF SOUTH AUSTRALIA 2015

PORT LINCOLN. SOUTH AUSTRALIA

Research, Conservation White shark [CARCHARODON CARCHARIAS]

### WHOIAM

happening in the cold and chum-filled waters below In short, I am a young American marine scientist the boat, where the sharks glide past cages full of working with white sharks in South Australia. Although I grew up in the inland of north-western eager observers. USA, I became fascinated by the ocean and its Although it offers a mesmerising and awecreatures and, as I became older, would watch every inspiring experience, the cage-diving industry marine series on television and gawk at the alien remains controversial. White sharks naturally organisms in the aquarium, especially the sharks. aggregate in the marine reserve surrounding the I've been captivated by them ever since. Neptune Islands, feeding on the large colony of I spent several years studying general biology resident fur seals. They come to the islands naturally, in Los Angeles before I decided to dive in headfirst but they are drawn to the boat by tuna heads and berley, a chummy tuna fish mince that smells very and move across the world to Australia to pursue my life-long dream of being a marine scientist. Initially I unappetising – unless you're a marine predator. Although this attractant is too small to be eaten by worked as a field assistant, taking every opportunity available to work with the sharks that had sparked the white sharks, it does do two things. Firstly, it is my interest as a child. Later I was able to begin my instantly devoured by hoards of waiting fish, and own research as an eco-toxicologist, addressing how secondly, it brings the sharks in close to the boat to toxins accumulate in sharks and what this means for investigate the smelly, splashing centre of activity. managers and consumers. I have now begun my PhD, Cage-diving appears to be of little consequence to investigating the crossroads between the burgeoning the white sharks, yet changes in their behaviour and shark tourism industry and the structure of the local movements have been demonstrated. We don't vet ecosystem in South Australia's Neptune Islands. know whether these changes are detrimental, and if so, how? Furthermore, looking at the effect of the industry on the white sharks is just a small snapshot WHERE I WORK White sharks command a unique and of what could be happening in the local ecosystem.

indescribable fascination. Around the world, television, movies and magazines have elevated these predators into marine superstars, and people want to see them up close. It's this overwhelming curiosity that has built the cage-diving industry in South Australia's Neptune Islands. This group of rocky islands juts up out of the open ocean off the southern coast and is home to an array of seabirds and marine mammals. Here, we work alongside tourism operators to get an up-close view of what is

### WHATIDO

It is vital that we answer questions about the effects of cage-diving on white sharks and the local ecosystem, but there are also other challenging puzzles to solve. Fortunately, with support from the Save Our Seas Foundation, we are now able to apply state-of-the-art biochemical techniques to these long-standing questions. Our work begins out at the islands, where we partner with cage-diving operators

to get as close as possible to the sharks, enabling us to get a small biopsy from the animals as they swim by the cages. We then take the tissue back to the lab, where it undergoes lengthy chemical processing to remove and measure a range of fats and oils. This is where everything we can't see out at the islands comes to light, and it all comes back to the age-old saving 'you are what you eat'.

These biochemical results are able to tell us many things, starting with how much fat the sharks have stored for energy. The animals gather around the Neptune Islands to feed on the fatty fur seals, but instead they spend the day chasing bits of bait around the cage-diving boat without actually catching anything. We have effectively put these white sharks on a low-calorie, cardio-intensive exercise plan. Beyond assessing the energy costs, the oils are able to tell us what the sharks have been eating. These results provide us with vital information about whether the sharks are changing what they eat, especially if that change is from blubbery sea lions to the fish used for bait.

It's imperative that we assess what is happening directly to the white sharks everyone has come to see, but it is equally important to determine what is happening to the other creatures that make up the diverse ecosystem of the Neptune Islands. The white sharks may shun the berley mix, but a multitude of other organisms are eating it. Again, we are able to employ biochemical tools to find out whether, and how, the industry may be affecting the diets of the fish, rays and other marine animals.

# EMILY MOXHAM & PAUL COWLEY



### BEHAVIOURAL ECOLOGY OF BONEFISH AND PERMIT AT ST JOSEPH ATOLL, REPUBLIC OF SEYCHELLES SOUTH AFRICAN INSTITUTE FOR AQUATIC

BIODIVERSITY

### 2015

### ST JOSEPH ATOLL, SEYCHELLES

Research, Conservation, Education

Bonefish [*Albula oligolepis*] and permit [*Trachinotus blochii*]



### WHOIAM

I have always loved water. Growing up on a farm in the interior of South Africa means that swimming in dams and walking along the river formed a large part of my childhood memories. However, our location and the responsibilities of farming prevented my family from having much involvement with the ocean. This changed drastically one windy day in 2010 when I first sailed on the sea. The power of the wind immediately freed me from day-to-day concerns, while the infinity of the ocean opened my mind to the opportunities and experiences that lay ahead. As a young student I was hooked – and I hadn't even looked below the surface! Since then, I have become passionately involved in sailing and embarked on a degree in ichthyology. The ocean is now my sanctuary, learning about it has become an obsession and helping to preserve it is a lifelong goal.

### WHERE I WORK

I am registered for an MSc degree at Rhodes University in Grahamstown, South Africa, and will be working closely with my project supervisors Dr Paul Cowley (South African Institute for Aquatic Biodiversity), Dr Rainer von Brandis (SOSF D'Arros Research Centre) and Dr Jude Bijoux (Seychelles Fishing Authority). Although I am based in Grahamstown, the field work for my Master's research will take me to the pristine tropical paradise of St Joseph's Atoll in the Seychelles. Having just begun my Master's, I have yet to discover the environment in which I will conduct my research. However, from what I have read I know that a great deal of nature remains undisturbed by human activity at St Joseph's Atoll. Working in this environment will provide me with a perfect opportunity to investigate the behaviour of my study subject, bonefish of the genus *Albula*, in its natural habitat.

I have seen images of beautiful beaches and blue, crystal-clear water, and I have heard of storms and wind and rough seas. Postcard-pretty or not, it all sounds like paradise to me! I am prepared for long hours in the sun, wind and rain, and am excited and equipped to experience this environment. I also look forward to collecting and analysing data, as well as sharing ideas with my co-workers. Although this may sound boring, it is often the most exciting part of research, as findings become apparent and knowledge and creativity are tested. I am ecstatic about the opportunity to experience this life at first hand.

### WHATIDO

The Save Our Seas Foundation is enabling me to visit St Joseph Atoll and D'Arros Island to conduct research on the behavioural and trophic ecology of the bonefish, which is an important tourism fishery species in Seychelles and elsewhere in the world. It is abundant at tropical atolls such as St Joseph and forms a vital link in the food chain. This link between predator and prey connects and balances top predator species, such as sharks and barracuda, with invertebrates and crustaceans of the ocean floor.

By means of passive acoustic telemetry, we will be tracking the movements of bonefishes in space and time, thus gaining insight into how they use their habitat. We will investigate factors such as where they spend their day, where they forage and where they spawn, as well as how cycles such as those of the tides and moon may influence their movements. An array of acoustic receivers deployed in and around St Joseph Atoll is currently being used to track a number of other species, including sharks and stingrays.

In addition to the telemetry research, I will conduct gastric lavage on bonefishes to investigate their food habits and gain better insight into their trophic ecology. This study will be the first of its kind conducted on the bonefish in the Indian Ocean. The findings of this research will contribute towards a better understanding of multi-species interactions and ultimately the ecology of St Joseph Atoll, and will help fisheries managers to make informed decisions about laws and regulations that will protect bonefish and conserve stocks.



# LAUREN PEEL & GUY STEVENS

SPATIO-TEMPORAL MOVEMENTS OF MANTA RAYS IN THE SEYCHELLES **AUSTRALIAN INSTITUTE OF MARINE SCIENCE I** SOSF D'ARROS RESEARCH CENTRE I THE MANTA TRUST 2013 - 2015 D'ARROS ISLAND AND ST JOSEPH ATOLL, SEYCHELLES Research

REEF MANTA RAY (MANTA ALFRED





'Through the Seychelles Manta Ray Project (SMRP), we aim to investigate the movement patterns, feeding ecology and population dynamics of reef manta rays Manta alfredi within the waters of D'Arros Island and St Joseph Atoll. This research will enable us to gain a better understanding of the health and size of the local manta population, as well as where, how and why these animals move through the various habitats available to them.'

### WHOIAM

Having grown up in rural Western Australia, I have always been surrounded by wildlife and I cannot remember a time when I wasn't in awe of the natural world. My passion for the ocean and marine life was sparked when I was five years old and my family took the first of many trips to the Ningaloo Reef. I could not get enough of snorkelling the reefs and exploring the intertidal pools to see what new creatures I could discover. It wasn't long before everyone knew the response they would get when they asked me, 'What do you want to be when you grow up, Lauren?' 'A marine biologist!' I would say, with the biggest grin on my face.

My fascination with the world around me drove me to complete my Bachelor's degree in 2011 at the University of Western Australia, where I majored in zoology and chemistry. It was in 2012, while completing my Honours research into the visual

system of the Port Jackson shark, that I discovered my love for all things elasmobranch. I knew then that I wanted to make a career out of studying these incredible animals and promoting their conservation through education.

Since completing my undergraduate studies, I have been fortunate enough to work with a diverse array of marine life in Australia and South Africa alongside many incredible marine scientists. I have assisted with sea turtle research in the remote north-west of Australia and for two years I held the position of field specialist for a marine research organisation in South Africa, where I was able to contribute to research projects that focused on everything from intertidal invertebrate communities to dolphin, whale and white shark biology. These experiences have enabled me to refine my interests towards research projects that endeavour to expand our knowledge of the population dynamics, trophic role, movement patterns and ecology of sharks and rays in order to promote the development of scientifically informed management directives and the improved design of marine protected areas.

### WHERE I WORK

The stunning D'Arros Island and St Joseph Atoll belong to the Outer Islands group of the Republic of Seychelles in the Western Indian Ocean and their waters boast a diverse array of marine life. Depending on the season, you can observe turtles, stingrays, sharks and even manta rays in the turquoise blue waters of the lagoon or across the reefs and sea-grass beds surrounding the islands. The remote and sheltered nature of D'Arros Island and St Joseph Atoll contributes greatly to their beauty – and their importance as a research site. As human-driven impacts upon the marine ecosystems and native fauna in the area are greatly restricted because of the limited public access to the islands, studies of animal movement patterns and biology can be conducted with the knowledge that the animals' behaviour is completely natural and not being influenced by human activities in any way. This pristine

opportunity is rarely found in the modern age of global travel and is one of the many reasons why the Save Our Seas Foundation's D'Arros Research Centre is such an incredible place to work from.

### WHAT I DO

When people think of manta rays, they think of graceful and harmless giants that leave people in awe of their beauty and charisma. Diving with these animals is at the top of many people's bucketlists and global manta ray ecotourism ventures have been valued at more than US\$50-million. Despite this, manta ray populations around the world are currently in a state of decline. In the past 75 years, manta numbers have decreased globally by about 30% and losses of up to 80% have been witnessed in some areas. These population declines are driven largely by demand from the traditional Chinese medicine market for manta gill plates, as well as for food in smaller fishing villages. The rays are also taken as by-catch in fishing nets and on long lines. As the majority of the fisheries around the world that target these animals are artisanal and small-scale, it is difficult to decrease the mortality of manta rays using traditional approaches to

fisheries management, such as bag limits. In these circumstances we turn to marine protected areas as a means to manage and conserve manta ray populations.

Through the Seychelles Manta Ray Project (SMRP), we aim to investigate the movement patterns, feeding ecology and population dynamics of reef manta rays Manta alfredi within the waters of D'Arros Island and St Joseph Atoll. This research will enable us to gain a better understanding of the health and size of the local manta population, as well as where, how and why these animals move through the various habitats available to them. The information collected will not only provide us with a broader knowledge of manta ray biology, but also enable us to better understand the conservation needs of this species in terms of calculating homerange sizes and identifying areas of critical habitat. We also hope to use our findings to assess the effectiveness of using marine protected areas as a way to conserve manta ray populations both in the Seychelles and across the Indian Ocean, as well as to improve the design and implementation of such protective strategies in the future.







ASSESSING CONSERVATION STATUS AND **DEVELOPING AWARENESS OF SHARKS AND RAYS** IN NORTH MOZAMBIQUE

UNIVERSIDADE DO LURIO

### 2015

### NORTH MOZAMBIQUE

RESEARCH, EDUCATION SHARKS & RAYS



'The SOSF grant will enable us to build up a picture of what is happening in Cabo Delgado in terms of shark fishing and also raise awareness about the importance of sharks ecologically and for tourism. I'm sure it will make a difference in environmental conservation, but mainly I expect it to make a difference in people's lives and how they value their natural wealth."

### WHOIAM

I'm a *kerera*! That is the name given me by the people from the communities I work with. It means 'the snapper', 'the fish that never stops' - and it certainly fits me. I'm a fish! I started free-diving before I could swim properly. The north coast of Portugal, where I was born, is always swept by strong winds and my grandfather, who planted in the whole family a love for the sea, used to say, 'If you have a headache, there's no better medicine than the wind that blows by the sea.'

My mind is cleansed by the sea. I would be lost without the sea, so it was natural for me to become swirls of civilisation. Everything needs to be studied, but the logistics of working there are difficult and a marine biologist and a dive instructor. I love studving everything in the sea, but when I arrived in expensive. The coral reefs are absolutely stunning in Mozambique 10 years ago, I realised that I couldn't terms of diversity and conservation, but the threat of work in the sea without the people who live around unbridled development is arriving in the wake of the it. In one of the poorest countries in the world, you discovery of one of the biggest natural gas reserves cannot impose conservation on empty stomachs. You in the world. This being so, a huge effort is urgently needed to study and protect the beautiful reefs and simply cannot ask a starving man not to kill his next meal, even if it is an endangered species like a shark the livelihoods of the people who depend on them. or a turtle. Working to give better opportunities to the communities and educating them to understand WHATIDO that a living turtle or shark can create more jobs and I began with a turtle conservation project and money than a dead one became a very important then set up a monitoring programme for whales and part of my job. With time, it also became clear to dolphins before going on to develop, together with me that people only strive to protect what they love the fisheries department, one of the first marine and know: 'opening Mozambican eyes under the community sanctuaries in Mozambique. After giving water' became a priority. The people of Mozambique support to several alternative livelihood projects, I need to see the wonders hidden under their own ended up teaching at the university in Pemba, the sea. First came the swimming classes and then came capital of the province of Cabo Delgado.

the diving courses, but in between there were also small recreational courses aimed at key people in the government, fisheries environment, tourism, customs, and the like. Everyone needs to know the beauty of the sea in order to love and protect it in their daily lives.

### WHERE I WORK

I usually work in the remote islands of the Quirimbas Archipelago, an enchanted place where time stops and life seems to go on untouched by the

As soon as I arrived in the Quirimbas I realised that sharks were not as abundant as they had been before. Nevertheless, since most of my work was near an aggregation of grey reef sharks and promoting a marine sanctuary, I was quite happy with the ones I could see. It was only when I started noticing fewer sharks in the aggregation that I became worried about the grey reef sharks and discovered that no-one knew anything about the situation of the rest of the sharks in Cabo Delgado.

The aim of my new project is to assess the conservation status of sharks and rays by means of questionnaires distributed among fishing communities and by establishing a monitoring programme for fishermen to develop in them an awareness of the need to protect sharks. The questionnaires will be designed to determine the species composition and historical abundance trends of sharks caught in artisanal fisheries, with fishery characteristics (location, gear and seasonality) forming the baseline data. The monitoring programme, including photos of shark catches by key fishermen, will facilitate a more robust identification of species and current catch rates. By engaging fishermen in this study, I aim to raise awareness about the need to protect these species. A Facebook page created for the project will open a dialogue about the conservation and management of sharks.



### TRACKING TRANS-ATLANTIC MOVEMENTS. HABITAT PREFERENCES AND FISHERIES OVERLAP OF THE SHORTFIN MAKO SHARK

MARINE BIOLOGICAL ASSOCIATION OF THE UK 2015

### NORTH ATLANTIC OCEAN

Research



### WHOIAM

From the house on the south coast of England where I was born and grew up, it was only a few minutes on foot to the beach. It was a journey I made over and over again, every time I could. Countless days were spent in the cool waters of the English Channel, swimming, snorkelling, boating and exploring the pools in search of marine life, particularly sharks. Before that – and, according to my parents, from the age of about four – all I did was draw sharks and collect images of them. So all through those early years, the nearby sea and the creatures that lived in it were a central part of my world. It was only later, once I had started scuba diving at the age of 16, that I realised it was actually the other way around: what I really wanted was to be part of their world. Then a chance encounter with a giant, plankton-feeding basking shark that glided effortlessly past on its journey, disappearing as quickly as it had arrived, propelled me on my own journey to become a marine biologist and a shark scientist.

After studying for a degree in marine biology at university followed by a PhD in shark behavioural ecology, in 1994 I returned to a question I had posed many years before: where do basking sharks go and what do they do? I then spent the next 12 years in their world, studying them in many locations around the north-eastern Atlantic Ocean, spending hours, days and months on research vessels tracking their movements and sampling what they were feeding on. This way of learning about sharks and what we find out continue to fascinate and motivate me in equal measure.

Moving from Aberdeen University in Scotland to the superb laboratory of the Marine Biological

Association (MBA) in Plymouth, south-western UK, as a research fellow 15 years ago has enabled me over the ensuing years to build a research team of talented and enthusiastic scientists. The sole focus of the group is to study shark and ray behavioural ecology to inform conservation – what we do is who I am.

### WHERE I WORK

Our laboratory is the open sea. Depending on what species of shark or ray we are studying, it might be the Atlantic, Indian or Pacific Ocean. In this pelagic laboratory we search for sharks and rays, using our increasing knowledge of their behaviour and habitat preferences to lead us to the most likely places where they choose to hang out. When we find them we attach electronic tags to eavesdrop on their behaviour in their watery world, sometimes for as long as several years.

Over the past 20 years my research group has tagged hundreds of sharks and rays all over the globe, including shortfin mako, blue, porbeagle, bull and silvertip sharks, and common skate and thornback rays. But it is our research on the blue and mako sharks that takes us into the heart of the blue ocean. Finding the hotspots of adult makos, for instance, requires exploration of the remotest places, from the mid-Atlantic Ridge to tropical sea mounts, where in any direction the nearest land can be thousands of kilometres away. There's nothing boring about horizon after horizon of just sea – at least not for me. The ocean is never the same on any two days; nor are the incredible animals you see along the way, such as the strange-looking ocean sunfish (the world's heaviest bony fish), or migrating passing through.

### WHATIDO

protect them.

For the past eight years one of my team's principal projects has been on a highly vulnerable shark, the shortfin mako – the fastest shark in the sea, clocking speeds of 50 kilometres per hour (more than 30 miles per hour).

The shortfin make is threatened because it is the What surprised us, though, when we started and scale of, conservation measures. After all, you

second most exploited pelagic shark taken by longline fishing vessels - and there are no international limits on open-ocean catches. This, coupled with its late sexual maturity (18 years in females) and relatively low fecundity (4–18 pups every two or three years), makes it less resilient to fishing and more susceptible to the effects of overfishing. Indeed, studies where good quality data are available show declines in the abundance of Atlantic makos. the study was that very little was known about the species' movements and space use, its migrations and habitat selection, or its overlap with fishing vessels in space and time. Knowing where makos prefer to be, when they move on, and how much and for how long their space use overlaps with fishing effort is crucial information for assessing the likelihood of overexploitation and the need for, can't adequately conserve a species if you don't know where it is.

leatherback turtles or baleen whales that are just

My goal has always been to use our new tracking technologies not only to reveal the amazing lives of sharks, but also to use this knowledge to better

With this in mind, we aim to track large mako sharks in the blue ocean across the species' entire North Atlantic range. We have tagged large males and pregnant females in the mid-Atlantic with new satellite transmitters so that we can follow these ocean wanderers for a full annual cycle, with the objectives of determining their foraging grounds and breeding migrations and of highlighting the ocean areas critical for pupping. The shark tracks are analysed in relation to remote sensing data of the ocean, such as temperature, primary productivity and ocean weather, and then passed through mathematical models to identify which habitats the sharks prefer over others that are available. We have designed the tags to withstand immense pressure because in our previous SOSF-funded study we discovered that makes dive to a depth of more than 1,500 metres (about 5,000 feet) and often several times per day! Why they go that deep is another mystery we are aiming to solve.

A key target in this project to find out how much of the space used by makos is also exploited by long-line fishing vessels. Are makos essentially tracked by fishing effort all year round or are there periods or habitats in which sharks and boats don't cross paths? This aspect of the project will be made possible with a unique data set we have assembled: the satellite-tracked movements of the entire Spanish and Portuguese long-line fishing fleets for 10 years. Relating the satellite tracks of makos with those of the vessels will reveal if the sharks really do have no place to hide.





'Thanks to support from the Save Our Seas Foundation, however, we have been able to develop new technology in the form of two prototype programmable video stations that will be deployed at two well-known sea mount aggregation sites.'

### **AZORES SEA MOUNTS, FRINGING AGGREGATION** SITES FOR MOBULA TARAPACANA IN THE ATLANTIC

**INSTITUTE OF MARINE RESEARCH, DEPARTMENT** OF OCEANOGRAPHY AND FISHERIES AT THE UNIVERSITY OF THE AZORES

### 2015

RESEARCH, CONSERVATION

PORTUGAL, AZORES ARCHIPELAGO, ATLANTIC OCEAN



### WHOIAM

I grew up on the southern coast of Portugal, a small country with an immense coastline facing the Atlantic Ocean. My connection with nature, and the ocean in particular, was evident from a very early age. By the time I was five, I knew I wanted to be a marine biologist (although for a short time I did consider a career as an astronaut). My desire to become a marine biologist stemmed from wanting not only to learn more about the marine environment, but also to work towards its conservation.

As I grew, so did that passion and by 2010 I had graduated with a BSc in biology from the University of the Algarve. The will to work in marine conservation made me go abroad and travel to Mozambique to participate in a whale shark and manta ray conservation project. It was there that I had my first encounter with a manta ray,

an experience I'll never forget. The curiosity and penetrating eyes of these wonderful and mysterious animals immediately fascinated and intrigued me. In Mozambique I had the opportunity to learn a lot and be a part of the conservation work done in the field, thanks to the Marine Megafauna Foundation team.

### **WHERE I WORK**

I left Mozambique in 2011 to start my MSc, this time in the Azores Islands. The Azores is an archipelago 'lost' in the middle of the North Atlantic Ocean. These nine volcanic islands are the most isolated in the North Atlantic and are surrounded by many offshore underwater sea mounts. These unique characteristics make them an oasis for many marine species migrating across the Atlantic every year, from whales to sharks to devil rays.



has already proved of great importance and will be Once here, I realised that this was one of the few places in the world where mobula rays, the smaller crucial to learning more about these animals. cousins of manta rays, gather in large groups. One For the past three years I have been collecting species in particular, the Chilean devil ray Mobula data about the occurrence of the Chilean devil ray tarapacana, is barely known to science, yet it is one with the help of dive operators and citizen scientists of the species caught by target fisheries around the through the project Manta Catalog Azores, the world to satisfy the demand for mobula and manta first attempt to build a photo-ID database for a gill rakers used in Chinese traditional medicine. Mobula species. The fact that these rays are present Having large groups of these rays 'in our own only during the summer months (between July and backyard' makes this the perfect place to study them, October) gives us a short timeframe to study them. and that is what I have been doing. Moreover, the offshore location of their aggregations makes it difficult to carry out intensive field work.

### WHATIDO

The Chilean devil ray is listed as Data Deficient by the IUCN. The lack of information about this species hampers the implementation of management strategies and conservation measures. The use of new technologies and methodologies to study it Thanks to support from the Save Our Seas Foundation, however, we have been able to develop new technology in the form of two prototype programmable video stations that will be deployed at two well-known sea mount aggregation sites. Comprising GoPro cameras with external power sources, the video stations can be programmed to function independently for several days. This technology will enable us to watch for the presence of devil rays over a much longer time, which is crucial to filling gaps in our knowledge of the species and giving us a better understanding of these unique aggregations that occur in such specific systems as the sea mounts.



'The use of drones is increasing in many different areas of wildlife research and nature conservation, such as in the battle against rhino poaching, but applying the technique to cetacean research in South Africa is a novel approach.'

### **ID PHOTOS OF SOUTHERN RIGHT WHALES** COLLECTED FROM A REMOTE-CONTROLLED DRONE UNIVERSITY OF PRETORIA 2015 WALKER BAY AND PEARLY BEACH. WESTERN

CAPE. SOUTH AFRICA Research, Conservation, Education

Southern right whales [*Eubalaena Australis*]



### **WHOIAM**

Cetaceans have been my biggest passion since childhood. I have always been intrigued by the beauty and mystery of these animals. When I became a biologist, I decided to dedicate my research to the study of whales and dolphins, using different techniques and approaches to investigate how they live. Studying animals that are submerged for most of their life is like conducting research on elephants from the bottom of a waterhole, where you see only the tips of their trunks and sometimes the full body of an individual. We know so little about cetaceans and I want to change that, not only to increase our understanding of them, but also to ensure that conservation efforts for their benefit can be improved.

### WHERE I WORK

Known as 'the Cape Whale Coast', South Africa's south-western shoreline is considered to be among the 20 most important conservation areas for marine mammals worldwide, and it is here, in Walker Bay and the Greater Dyer Island Area, that I carry out my field work. This is one of the most extraordinary places in the world for observing southern right whales Eubalaena australis from land (or boat or plane) every year between June and the end of December. A number of other cetacean species also frequent the area, including the endemic Bryde's whale Balaenoptera brydei, migrating humpback whales Megaptera novaeangliae, the nearthreatened Indian Ocean humpback dolphin Sousa *plumbea* and the Indo-pacific bottlenose dolphin Tursiops aduncus.

In addition, the Cape Whale Coast is hugely significant for other marine wildlife species, such

# **KATJA VINDING PETERSEN**





as the endangered African penguin Spheniscus demersus, which breeds in a colony on Dyer Island; the Cape fur seal Arctocephalus pusillus, 60,000 of which live on Geyser Rock next to Dyer Island; and, not least, the vulnerable great white shark Carcharodon carcharias, for which the Greater Dyer Island Area is renowned.

Living here is like being on the other side of the camera in a National Geographic documentary. Furthermore, local support from the Overstrand municipality, professional divers and members of the public has been enormous.

### WHAT I DO

Our project is the first in-depth scientific investigation of the whales and dolphins here and its overall goal is to achieve a thorough understanding of how these cetaceans utilise the study area and why they depend on it. The project was initiated in 2011 and applies an innovative combination of several non-invasive monitoring methods to study the animals. I started off by analysing 13 years of sighting data from a local whale-watching vessel, which gave me a good basis for planning land-based visual theodolite tracking and passive acoustic monitoring.

There are, however, specific challenges to tracking groups of animals from the shore. It can be very difficult to judge the total number of animals in a group or even whether we are following the same animals on consecutive days. We also want to obtain more precise information about their behaviour.

As the whales and dolphins are not easy to observe from land, an 'eve in the sky' would be ideal. particularly as studying their behaviour is a priority. This is where I hope the drone donated by the Save Our Seas Foundation will enable us to collect a new type of information. Unlike behaviour observed from a vessel, behaviour observed by a drone is likely to be more natural as the drone can operate without disturbing the animals.

I am collaborating with Evan Austin from African Wings, who regularly flies along the coast with tourists and is a very experienced whale observer, and with local whale photographer Dave de Beer from Hermanus, who has kindly donated all the photographic material for the project. Based on the photos, I have established a photo-ID catalogue of local southern right whales. Individuals of the species can be identified by their unique callosity

pattern in the face region and in some cases by the interactions between cows and calves. In two white or grey markings on their backs. consecutive years we tracked how orphaned calves tried to find a new mother. It is believed that more The use of drones is increasing in many different frequent observations with the drone will enhance areas of wildlife research and nature conservation, such as in the battle against rhino poaching, but our knowledge of such behaviour. Local weather applying the technique to cetacean research in conditions make the use of a drone challenging, so South Africa is a novel approach. The aim of the I expect it will take some time to develop and fineproject is to test whether it is feasible, and if so to tune the method. Nevertheless, I am convinced that develop an efficient method of monitoring cetaceans if it is possible, it will open doors for new approaches and collecting ID photos by means of a drone. in science and conservation. The first step is to test the drone on southern right whales and find out whether we can determine the size and structure of the so-called surface active groups (SAGs). I am particularly interested in studying in detail the behaviour and social activity within an SAG and the relationship between cows and their calves. Observations from the air have already given us very interesting information about





TROPHIC POSITION AND ECOLOGICAL ROLES OF EURYHALINE ELASMOBRANCH PREDATORS SHARKS AND RAYS AUSTRALIA PTY LDT

### 2015

CAPE YORK PENINSULA, NORTH QUEENSLAND, AUSTRALIA

RESEARCH. EDUCATION Sawfish



### WHOIAM

I grew up in Austria, a land-locked country in the heart of Europe. My parents love travelling and whenever they could take time off, they would pack the Volkswagen Kombi and drive to the sea with my brother and me. We spent all my childhood summers on the Mediterranean coast and one of my first memories of the ocean – I was too young to remember my age – is from Turkey. My mom left an empty, but not clean, soup can overnight in shallow water. When we returned to it the next day there was an octopus inside. What a fascinating animal to discover at such young age. Of course we released it alive!

At the age of 14 I became an Open Water Diver at the Great Barrier Reef, Australia. When I saw my first shark in the wild. I realised that these animals were nothing like the media portraved them to be. After volunteering at Doc Gruber's Shark Lab in the Bahamas, I was completely hooked on sharks and rays.

My studies allowed me to return to Australia, where I now live. Here I started to work on the sensory biology of shovelnose rays. They always say that you are what you eat, but I think you also are what you perceive. Imagine you could see the UV patterns on flowers as bees do, or you could hear like an owl! We never think about how strongly our own sensory abilities influence our behaviour, thoughts and feelings. I believe that people fear sharks because our senses do not work as well underwater as they do on land, our natural habitat. The discomfort that people experience when, for example, they swim in the ocean and cannot fully perceive what is moving

underneath them is then projected onto predators that are perfectly adapted to their environment sharks.

I moved to Cairns more than six years ago while investigating the sensory abilities and feeding behaviour of sawfish for my PhD. I was collaborating with a local company that caught sawfishes in the remote regions of Cape York to be put on display in public aquaria around the world. This trade has since stopped, but the sawfishes I worked with continue to inspire people all over the globe.

### WHERE I WORK

The city of Cairns in Far North Queensland, Australia, is often called the gateway to the Great Barrier Reef, which well over 100,000 people flock to every year. Interestingly, when it comes to shark research or shark-based tourism, Cairns is not really on the map. It is, however, the last city you pass through en route northwards to the remote regions of Cape York.

As well as being ancient, the landscapes of Cape York are highly variable due to the alternating dry and wet seasons. Since Aboriginal settlement more than 40,000 years ago, fires have also had a major influence on the vegetation. Cape York country is wild and sparsely populated. When the monsoonal rains kick in, river crossings along the few roads become impassable and remain so for months. Field work in Cape York's remote rivers and along its coastline is carried out under the watchful eyes of saltwater crocodiles, an ancient predator that can easily reach five metres in length. Few people know

that these rivers and the coastline are also inhabited by some of the last remaining healthy populations of four species of sawfishes.

I will never forget the moment that I saw my first wild sawfish. We were in a very remote location close to the tip of Cape York in the north-eastern Gulf of Carpentaria. It was a 4.5-metre green sawfish that had become entangled in our gill net in knee-deep water. The animal was so massive that when we first caught sight of it from the shore we thought we had caught a dugong. We tagged and released it. But the question of how these animals live has mesmerised me ever since.

### WHATIDO

Working in the firm belief that long-term conservation goals can only be achieved if they are based on sound science and if local people understand and support them, I intend to bring research-based tourism to Cairns and Cape York. Sharks and Rays Australia (SARA) has been set up and a network of local volunteers, local tourism providers, NGOs and indigenous rangers has been created. A pilot study into the feasibility of the project, funded by the Save Our Seas Foundation, is ongoing. Its aims are to identify how local stakeholders can be involved in the project and how a tagging study of sharks, rays and sawfishes out of Cairns and in Cape York can be publicly funded in order to ensure its continued long-term existence.

# PROJECT LEADER PROJECT LEADER AN INTRODUCTION TO OUR PROJECT LEADERS WHOSE PROJECTS ARE A CONTINUATION FROM THE PREVIOUS YEARISI AND WERE FUNDED DURING 2015. THEIR COMPLETE PROFILES ARE AVAILABLE IN THE 2014 EDITION OF OUR ANNUAL REPORT AS WELL AS ON OUR WEBSITE.





### MOHAMMED ABUDAYA

Conservation is never an easy task, but it's even harder in a battleground. Mohammed works with fishing communities in Gaza to find out how to protect mobula rays during their visits to the east Mediterranean Sea.

Recent images and reports have revealed a targeted fishery for the giant devil ray, an endangered species, in Gaza. We need to collect data now before this ray is pushed to the point of collapse.

ASSESSMENT OF THE GAZA FISHERY OF THE GIANT DEVIL RAY

AL-AZHAR UNIVERSITY – INSTITUTE OF WATER AND ENVIRONMENT

2014, 2015

GAZA, PALESTINE

Research, Conservation Giant devil rays [Mobula spp]









### SHANNON ARNOLD

We know very little about manta and mobula rays in the Philippines. Shannon is working with fishers, divers, researchers and ordinary Filipinos to create a knowledge base that will help us to protect these vulnerable animals.

Country- and species-level data are desperately needed to deepen our understanding of the status of both manta and mobula rays, as well as the increasing pressures exerted upon these highly vulnerable species that by all indications are disappearing from the oceans at a concerning rate. Without this more specific data, it is very difficult to argue effectively for greater national and international protection and fisheries management.

THE STATE OF MOBULID RAYS IN THE PHILIPPINES
THE MANTA TRUST
2013, 2015
PHILIPPINES
Research, Conservation
Mobulids [Manta spp & Mobula spp]

### PAUL COWLEY

The Acoustic Tracking Array Platform (ATAP) covers thousands of kilometres of the southern African coast. Scientists are able to use this collaborative array to paint a picture of how fish and shark species behave along the coastline to better manage and protect them in the future. South Africa is a biodiversity hotspot boasting a high degree of endemic marine species that are biogeographically restricted by the presence of two contrasting boundary currents. The ATAP provides a fantastic opportunity to study multiple-year migration patterns and shed light on the possible effects of climate change.

### THE ACOUSTIC TRACKING ARRAY PLATFORM(ATAP) – A NATIONWIDE MARINE SCIENCE PLATFORM





### LAUREN DE VOS

fish life, but she has many more questions. Armed with more time and more underwater cameras, she is heading back to sea to discover how best to use and protect the bay.

If informed management decisions are to regulate fisheries in South Africa's False Bay, sound information across a wider species assemblage is needed. To date, no work has been done to sample the diversity and abundance of marine species and at the same time measure anthropogenic pressure.

**OPTIMISING THE EFFECTIVENESS OF MARINE BIODIVERSITY MONITORING AND CONSERVATION** PLANNING IN FALSE BAY, SOUTH AFRICA UNIVERSITY OF CAPE TOWN 2014, 2015 FALSE BAY, WESTERN CAPE PROVINCE, SOUTH AFRICA

Research, Conservation CHONDRICHTHYANS (SHARKS, RAYS & SKATES) AND TELEOSTS



### CHANTEL ELSTON

Lauren has already spent a year spying on False Bay's St Joseph Atoll is a special place in the remote Indian Ocean. It's home to numerous stingray species, including cowtail, mangrove whiptail and porcupine rays. Chantel is investigating how many of these animals there are, what they eat, where they live and how they move.

> Stingrays represent an important part of the food web by providing a link between apex predators and lower trophic levels. However, the lack of baseline data for these rays makes it difficult to manage their populations. St Joseph Atoll provides a unique opportunity to address this knowledge gap.

### THE ECOLOGY OF STINGRAYS IN ST JOSEPH ATOLL, SEYCHELLES SOSF D'ARROS RESEARCH CENTRE

2014, 2015

### ST JOSEPH ATOLL, SEYCHELLES

Research MANGROVE STINGRAY [HIMANTURA GRANULATA], COWTAIL STINGRAY [PASTINACHUS SEPHEN], PORCUPINE STINGRAY [UROGYMNUS ASPERRIMUS]





### DANIEL FERNANDO

Vulnerable mobulids include two manta and nine mobula species. Because they all look alike, it is difficult to identify different species. Daniel is compiling the world's first mobulid ID guidebook and genetic identification kit.

Species identification of mobulid rays has proven to be very problematic due to their similar external features. This has resulted in misidentification, even in current scientific literature, and highlights the necessity for a set of clear identification tools to help current and future researchers fill in the large knowledge gaps. The lack of available data for mobulid rays is currently severely impeding the conservation process.

## GLOBAL MOBULA RAY TAXONOMIC, MORPHOLOGICAL AND GENETIC IDENTIFICATION GUIDE

| THE MANTA TRUST                                  |  |
|--|--|
| 2013-2015  |  |
| WORLDWIDE  |  |
| Research, Conservation, Education                |  |
| Mobulids [ <i>Manta</i> spp & <i>Mobula</i> spp] |  |

### FRANCES HUMBER

Madagascar's sharks are in steep decline. Frances has trained members of the Vezo community to collect real-time information about local shark fishing using mobile phones.

A major stumbling block to establishing effective and broad-scale conservation of shark species is the paucity of information on their ecology, fisheries and socio-economic value. In the absence of any such understanding, diverse and unconnected stakeholders have no basis or motivation to enact meaningful conservation measures.

### SHARK ASSESSMENT AND CONSERVATION IN MADAGASCAR USING MOBILE PHONE TECHNOLOGY BLUE VENTURES CONSERVATION

2013-2015 WEST MADAGASCAR

CONSERVATION

SHARKS





### LUCY KEITH DIAGNE

Although they are found in 21 countries, West African manatees are rare and incredibly secretive. Lucy is creating a network of collaborators to help her learn more about this forgotten sirenian and how to conserve it.

The West African manatee is one of the least understood and least studied marine mammals in the world. Conservation efforts are hindered by a lack of basic information about the species and are also unsustainable without local capacity building.

### AFRICAN MANATEE RESEARCH AND CONSERVATION SEA TO SHORE ALLIANCE, AFRICAN AQUATIC CONSERVATION FUND

2009, 2011-2015

GABON AND SENEGAL Research, Conservation African manatee [*Trichechus senegalensis*]



### JULIANA LÓPEZ-ANGARITA & ALEX TILLEY

The rich mangrove systems of the Tropical Eastern Pacific provide a safe haven for juvenile sea creatures, including sharks and rays. Juliana and Alex are working with local fishing communities to find a way to sustain both people and biodiversity. This study will generate crucial data on a vulnerable and little-known group of elasmobranchs in an extremely understudied system, highlighting important priorities for marine conservation and fisheries management.

ASSESSMENT OF ELASMOBRANCH CRITICAL HABITAT IN THE TROPICAL EASTERN PACIFIC FUNDACIÓN TALKING OCEANS 2013, 2015 EASTERN TROPICAL PACIFIC RESEARCH, CONSERVATION SHARKS & RAYS









### LARA MARCUS ZAMORA

Every year, hundreds of whale sharks congregate at Ningaloo Reef in Western Australia. Lara wants to know why. She believes that the secret behind their annual visit is hidden in their stomachs. Although it's the largest fish in the world, the whale shark is also one of the least-studied shark species and its status is vulnerable. It is very important to gain new insights into the basic ecology of the whale shark in order to assist in the development of national and international management and conservation programmes.

ENVIRONMENTAL AND BIOLOGICAL FACTORS DRIVING WHALE SHARK DISTRIBUTION AND ABUNDANCE INSTITUTE FOR MARINE AND ANTARCTIC STUDIES 2013-2015

### NINGALOO REEF, WESTERN AUSTRALIA, INDIAN OCEAN

Research

WHALE SHARK [RHINCODON TYPUS]





### JEANNE MORTIMER

The beaches of D'Arros Island and St Joseph Atoll are very important places for mother sea turtles to come and lay their eggs. Jeanne is training Seychellois monitors to observe nesting turtles and collect data about them.

IUCN lists the hawksbill as Critically Endangered globally and the green turtle as Endangered. Green turtle populations are particularly endangered in the Inner Islands and the Amirantes Group of the Seychelles. The government of the Seychelles recognises the turtles' vulnerability and has passed legislation to protect them and implemented policies to encourage conservation efforts at the local level. More than 15 long-term sea turtle monitoring programmes have been implemented in the Seychelles since 1968 and most of them are ongoing.

COMMUNITY MONITORING OF NESTING SEA TURTLES AT D'ARROS AND ST JOSEPH, SEYCHELLES SOSF D'ARROS RESEARCH CENTRE 2013-2015 D'ARROS ISLAND AND ST JOSEPH ATOLL, SEYCHELLES RESEARCH, CONSERVATION, EDUCATION TURTLES







### NICOLAS PILCHER

Nick is on a mission to save Malaysia's turtles. By convincing policy-makers and fishermen to equip shrimp trawlers with Turtle Excluder Devices and studying the ecology of the turtles, he's tackling the problem head on.

Marine turtles are an integral component of the Sulu-Sulawesi marine ecosystems and provide tangible ecotourism services as well as support for cultural and traditional values. Marine turtles also possess, through their charismatic qualities, an ambassadorial value for wider conservation issues. The conservation of marine turtles is thus a critical step in promoting conservation of the wider marine ecosystem, enhancing marine stewardship and promoting more sustainable fishery practices.

### SEA TURTLE CONSERVATION IMPERATIVES IN MALAYSIA MARINE RESEARCH FOUNDATION 2009-2015

SABAH. MALAYSIA

Research, Conservation, Education Green turtle [*Chelonia mydas*]

### **ORNELLA WEIDELI**

Sharks don't look after their pups, but they do choose a safe place to give birth. Ornella studies young blacktip reef and sicklefin lemon sharks in St Joseph's lagoon to see how they get along while growing up together.

Global increases in fishing pressure, habitat loss and the biological vulnerability of sharks has resulted in steady population declines. Many shark populations lack baseline data, hampering their management and conservation. This research will add to our understanding of sharks in remote coastal ecosystems.

### HABITAT AND RESOURCE PARTITIONING OF JUVENILE SHARKS AND THEIR ROLES IN REMOTE COASTAL ECOSYSTEMS

SOSF D'ARROS RESEARCH CENTRE I CRIOBE I EPHE 2014, 2015

### ST JOSEPH ATOLL, SEYCHELLES

Research

BLACKTIP REEF SHARK [*CARCHARHINUS MELANOPTERUS*], SICKLEFIN LEMON SHARK [*NEGAPRION ACUTIDENS*]





## SCHOLL MICHAEL

Michael is the chief executive officer of the Save Our Seas Foundation, which allows him to merge decades of experience in science, conservation and education and his lifelong passion for conserving sharks and the oceans.

Born in land-locked Switzerland along the shores of Lake Geneva, Michael's love for the ocean transcended his personal geography. He attended the University of Lausanne in Switzerland and graduated from the University of Aberdeen in Scotland with a BSc in zoology.

His initial field experience with sharks began in 1995 at the Bimini Biological Field Station in the Bahamas. He then spent the next decade studying the population and ecology of white sharks around Dyer Island in South Africa. In 2002, he founded the White Shark Trust to support research, education and conservation projects focused on white sharks.

His genetic, tagging and fin-printing studies were integral to discovering a link between South African and Australian white shark populations. This work was a major factor in the decision to list white sharks on CITES in 2004.

Michael's research and conservation efforts have been featured in numerous television documentaries produced by the likes of BBC, National Geographic and Discovery Channel, as well as in publications such as *Science*, *Nature*, *BBC Wildlife* and *Africa Geographic*. In 2006, Michael co-authored *South Africa's Great White Sharks* (Struik Publishers) with photographer Thomas P. Peschak.

Michael taught bilingual high school and IB level biology, mathematics and physics classes in Lausanne, Switzerland, and worked for South African explorer Mike Horn on the Pangaea Expedition, assisting Young Explorers worldwide to establish environmental and social projects.



### PESCHAK THOMAS | DIRECTOR OF CONSERVATION

As well as being director of conservation for the Save Our Seas Foundation (SOSF), Thomas is an assignment photographer for *National Geographic* magazine. Also a senior fellow of the International League of Conservation Photographers, he is regarded as one of the 40 most influential nature photographers in the world. He leads a near-continuous nomadic existence, spending most of the year in the field on assignments around the globe.

Originally trained as a marine biologist, Thomas retired from science field work in 2004, choosing to become an environmental photojournalist when he realised that photographs could make a greater conservation impact than statistics do. As SOSF's director of conservation, he strives to merge photojournalism, documentary filmmaking and cutting-edge science to create powerful media projects that tackle some of the most critical marine conservation issues of our time.

Thomas has written and photographed five books: *Currents of Contrast, Great White Shark, Wild Seas Secret Shores* and *Lost World*. His latest publication, *Sharks and People*, was released in 2013 and chronicles the relationship between humans and sharks around the world. He is a multiple winner in the BBC Wildlife Photographer of the Year Awards and in 2011 and 2013 he received World Press Photo Awards for his work.



### FOWLER SARAH | PRINCIPAL SCIENTIST

Sarah has a first class joint honours degree in zoology and marine zoology from the University College of North Wales, an MSc in conservation from University College London and 30 years of professional experience as a marine biodiversity conservation expert. She has worked in various capacities for government departments, national and international NGOs and a biodiversity consultancy. Having been appointed to the IUCN Shark Specialist Group in 1991, she chaired it for many years and is now its vicechair for international treaties.

Sarah founded the European Elasmobranch Association and its UK member, the Shark Trust (and is a trustee of the latter). She was appointed Officer of the Order of the British Empire for services to marine conservation in 2004, and a Pew Fellow in Marine Conservation in 2005. She became principal scientist for the Save Our Seas Foundation in 2011.



### GRUBBS DEAN | SCIENTIFIC ADVISOR

Dr Dean Grubbs is a fish ecologist with interests in the biology of exploited and poorly studied estuarine and marine taxa. Much of his research addresses specific gaps in biological knowledge necessary for the management and conservation of coastal and deep-water sharks and rays. Dean specialises in the use of fishery-independent surveys to study population dynamics and the drivers of distribution patterns of fishes and to facilitate studies of life histories, reproductive biology, trophic ecology and systematics. Dean has also tagged and released more than 10,000 sharks representing over 40 species during the past 25 years. He employs a variety of tagging and telemetry techniques to examine movement, migration and patterns of habitat use and to delineate essential and vulnerable habitats for exploited, threatened or poorly studied species.

Dean is a native of Florida and his early years spent fishing and exploring the waters of the north-eastern Gulf of Mexico led to an early interest in marine biology. He received Bachelor's degrees in marine science and biology from the University of Miami and a doctoral degree in Fisheries Science from the College of William & Mary's Virginia Institute of Marine Science. Dean was a post-doctoral researcher and faculty member at the Hawaii Institute of Marine Biology before moving to Florida State University (FSU) in 2007. He is a member of the IUCN Shark Specialist Group, the National Oceanographic and Atmospheric Administration (NOAA) Office of Protected Resources' Smalltooth Sawfish Recovery Team and NOAA's SouthEast Data Assessment and Review Advisory Panel for Highly Migratory Species. Dean is currently the associate director of research at the FSU Coastal and Marine Lab, where he mentors graduate and undergraduate students and maintains an active research programme on the ecology of deep-water and coastal fishes. His research has been featured in many television documentaries, including National Geographic TV, National Geographic Wild, Discovery Channel and the US Public Broadcasting System.



### R

### BRUYNDONCKX NADIA | EXECUTIVE ASSISTANT AND SCIENTIFIC ADVISOR

Nadia is a doctor in biology who joined the team of the Save Our Seas Foundation in spring 2013. Based in Geneva, she works with Michael Scholl as an executive assistant and scientific advisor.

Animals and nature have fascinated Nadia since her childhood so it was a natural progression for her to study biology to better understand the wonders of the animal kingdom. For her PhD she researched the conservation and co-evolution of bats and parasites using several molecular tools. Bats, she established, are fascinating animals that can help to explain the role of scientists and make people sensitive to conservation and other environmental issues. Having completed her own PhD, Nadia became the coordinator of a doctoral programme, organising courses and workshops for PhD students in ecology and evolution. In 2012 she took over the administration of a biology department, dealing with finances and human resources.

A field biologist familiar with unpopular animals, Nadia also has solid expertise in administrative management. But it was while qualifying for her advanced diver certificate that she became sensitive to the vulnerability of the oceans and the importance of preserving them. After several years in science and administration, she decided to use her diverse skills to help to promote the conservation and protection of marine environments.



### STEVENS GUY | SPECIAL MOBULIDAE ADVISOR

Guy has always been fascinated by the natural world, especially life under the sea. He progressed through school and university with this in mind, graduating from the University of Plymouth in 2002 with a degree in marine biology and coastal ecology. After university he moved to the Maldives to work as a marine biologist and in 2005 he founded the Maldivian Manta Ray Project (MMRP) to help protect the country's manta population through active research and education. Guy's conservation efforts in the Maldives have led to the creation of several Marine Protected Areas (MPAs) at key manta aggregation sites. For six years his MMRP work in the region was funded and supported by the Save Our Seas Foundation (SOSF). In 2011 Guy went on to found the Manta Trust. The mission of this UK-registered charity is to advance the worldwide conservation of mobulid rays and their habitat through robust science and research and by raising awareness about them and providing education, influence and action. With a vision of a world in which manta and mobula rays thrive within a globally healthy marine ecosystem, the trust now has projects in 16 different countries.

The SOSF also supports various other mobulid ray research and conservation projects globally. As a leading expert on the science and conservation of mobulid rays, Guy has a role within the Foundation to advise it on such projects so that an effective conservation strategy for these increasingly vulnerable species is realised.

Guy is also working towards the completion of his PhD on his manta research at the University of York in the UK.



### KUBICKI STEFAN IT AND WEB OFFICER

Stefan grew up in North Dakota, about as far away as it's possible to get from the coast in the USA. He first developed a fascination with sharks and the underwater world thanks to nature documentaries and well-worn issues of National Geographic. He began his career as an analyst at a UN-based NGO in New York before moving to London, where he worked as a web developer and advisor to several startup companies. He joined the Save Our Seas Foundation in 2010. Aside from his work for the foundation, Stefan is an award-winning filmmaker whose films have screened at festivals around the world.



### BOONZAIER LISA CONTENT MANAGER AND SCIENCE EDITOR

Growing up in Cape Town with weekends spent at the coast, roaming freely along the shoreline, exploring rock pools and falling asleep to the sound of the waves led Lisa, not unexpectedly, to fall in love with the ocean. She completed her undergraduate and Honours degrees in biological sciences at the University of Cape Town in 2007 before entering the world of digital magazines and publishing at BigFig Digital Media a few years later. There she learned her first lessons in science communication and magazine production and worked her way up to become the editor of *PLANET* digimag, produced in association with WWF.

After some time in the publishing world, Lisa decided to turn her focus back to science and embarked on the pursuit of her Master's degree at the University of British Columbia (UBC) in Vancouver, Canada. Under the supervision of Daniel Pauly, she conducted a global assessment of the effectiveness of marine protected area management, which she completed in 2014. While working on her degree, she kept one foot in the world of science communication by also coordinating outreach for her research group and editing newsletters for the UBC Fisheries Centre.

Lisa is now back in her home city, where she's very happy to have settled and joined the Save Our Seas Foundation's (SOSF) Conservation Media Unit. Here she is able to put her communication and science skills to good use as she works on compelling projects to convey the importance of marine conservation and the SOSF's work.



Pippa first fell in love with conservation media after reading the story of the Knysna elephant; she was mesmerised by the animal and the characters and mysteries that surrounded it. After graduating with a Bachelor of Journalism, she spent a year in Thailand and the USA, where she came to appreciate fully the rarity of healthy ecosystems. On her return to South Africa she was inspired by the rich underwater worlds of False Bay and southern Mozambique.

After two years as an investigative journalist for the television programme Carte Blanche, Pippa decided that the only stories she really wanted to engage with were those that explored nature and our relationships with it. This was unfortunate because next she found herself in the world of corporate campaigns and commercial media production. Luckily nature won out and she was appointed conservation journalist for the Save Our Seas Foundation (SOSF).

Now, armed with a deep connection to the ocean and a 'colourful CV', Pippa aims to find the balance between traditional journalistic storytelling and a more popular, creative and emotive approach. She is increasingly amazed by the SOSF scientists she speaks to and is excited to help them share their stories.



## SCHULTZ JADE

From a young age when she and her family would go on holiday to nature reserves and the seaside, Jade has felt a very strong connection to the natural world and a great appreciation for its overwhelming beauty. With time however, she realised that this was a view few others shared. Having experienced in particular how little other people know about the wonders of the ocean, she became acutely aware that they know even less about the dangers that the marine realm faces. With a background in marketing and media experience, Iade understands that the media is extremely powerful when it comes to spreading a message and raising awareness- and, in fact,





### CONTENT MARKETER AND SOCIAL MEDIA MANAGER

in today's digital world it is an invaluable conservation tool. She believes that the knowledge and experience that she is able to bring to the Save Our Seas Foundation's Conservation Media Unit, together with the passion and dedication of the other team members, can and will make a positive difference in the mindset of the public - and, ultimately, the health of our oceans.

### OLIVEIRA MIGUEL VISUAL CONTENT DESIGNER

As an artist, Miguel realised long ago how much he loves to collaborate on projects that make a positive difference to the planet, especially when it comes to protecting wildlife.

He grew up in Cascais, Portugal, a fishing village that lies very close to Lisbon and has a long history with the sea. From an early age he was close to the ocean all year, cycling and skating along the promenade. In summer he would spend most days at the beach, which inevitably meant that he saw at first hand how human actions have changed things along that coastline for the worse.

Miguel studied communication design at the Fine Art School of Lisbon because he believes in change for the better, and that art and design are great tools for making people aware that that we are not alone on this amazing planet – we share it with other beautiful creatures that are as important as humans. These creatures need to be respected and be given space to play their roles in this bigger system called nature so that some day, with our help, balance can be restored.

Miguel is very passionate about what he does and what he can bring to the foundation. He finds great pleasure in working closely on the conservation and protection of our oceans and helping to give a visual shape to the projects that our foundation supports.



### VON BRANDIS RAINER SCIENTIFIC DIRECTOR

After completing a degree in nature conservation in Pretoria, South Africa, Rainer spent the first part of his career in the African bushveld, where he studied white rhino movements, conducted anti-poaching patrols and guided safaris. Several years later he took a temporary job as a botanical guide at Rocktail Bay on the northern coast of South Africa. During his first encounter with a nesting turtle on the beach, he was so inspired by these vulnerable creatures that he sensed a major fork in his career path. He soon became hopelessly addicted to the ocean and spent all his spare time getting to know it. After hastily completing his Honours degree, he returned to Rocktail as a turtle researcher and staved there for nearly two years.

Rainer's persistent hunger for adventure eventually led him to a four-month voluntary position at Aldabra, a remote, untouched coral atoll teeming with turtles and other marine life. He loved it so much out there that he ended up staying for five years, employed as the chief scientific officer. In 2006 he was offered an opportunity to conduct his PhD on the foraging ecology of the critically endangered hawksbill turtle at D'Arros Island and St Joseph Atoll in the Amirantes group of the Seychelles. He spent the next five years following turtles around underwater and gaining an intimate understanding of the area and its surroundings. Having completed his PhD in 2011, he took up the position of scientific director of the D'Arros Research Centre.



### BOYES CHRISTOPHER ALAN | LAB MANAGER

For Chris Boyes, being the lab manager at the research centre on D'Arros Island in the Seychelles means that he is the fulltime person on the ground who maintains a world-class facility for research and education. At the same time, he manages the longterm studies and rehabilitation projects on and around the island and neighbouring St Joseph's Atoll.

Since gaining a BSc in forestry (nature conservation) from the University of Stellenbosch in 2004, Chris has worked on many diverse research projects, from nesting sea turtles in Costa Rica and Maputaland, South Africa, to wetland birds in Botswana's Okavango Delta. He specialises in working with nesting sea turtles and is currently completing his MSc thesis on leatherback sea turtles in Maputaland with the University of Stellenbosch.



### BULLOCK KERRYN I RESEARCH ASSISTANT

Kerryn started her career in nature conservation in 2007 in the Kalahari Desert. Since then, her research has focused on small mammals in the savanna and most recently, for her Master's degree, on samango monkeys in the forests of Magoebaskloof, South Africa. Kerryn came to D'Arros as a forest-rehabilitation volunteer and now, after four trips to the island, she has gained valuable knowledge not only about rehabilitating its forest, but also about its ecosystems and marine life. As assistant lab manager of the D'Arros Research Centre, Kerryn is keen to continue in her chosen field of nature conservation.



### YELD HUTCHINGS ELEANOR | EDUCATION CENTRE MANAGER

Dr Eleanor Yeld Hutchings currently works for the Save Our Seas Foundation, managing the Shark Education Centre in Kalk Bay, South Africa. She is also the specialist marine biologist presenter for the award-winning South African television documentary series *Shoreline*, which recently completed its second season exploring the coast of South Africa.

Eleanor gained her PhD from the Marine Biology Research Centre, University of Cape Town. Her research was on the parasites of a number of endemic South African shark species, focusing on the discovery and description of several species new to science, the transmission of blood parasites and the ecology of parasite communities with potential for application in the assessment of fisheries stock.

Demonstrating a special affinity for connecting civil society with the marine environment, Eleanor in the past has managed WWF-South Africa's People and the Coast programme and, with a tourist guide certificate for marine and coastal tourism, has run a specialist company guiding tours of the marine environment. She is a qualified scuba diver (both commercial and PADI Rescue level) and dive/boat skipper, and she is kept level-headed by trail-running in the Table Mountain National Park. She lives with her husband and son in the seaside village of Kommetjie.



### MILLAR PAUL JAMES EDUCATION OFFICER

As an educator and conservationist whose own fascination with the marine world began with surfing and diving around Cape Town, Paul believes that initiating or growing people's experience, knowledge and appreciation of our oceans has a vital role to play in protecting our natural world. In between chasing swells up and down the coast of South Africa and enjoying the icy waves of local surf spots, he squeezed in some terrestrial time at the University of Cape Town, studying environmental and geographical science and education. Paul draws on his significant experience in schools and environmental education when running the SOSF Shark Centre's programmes. His classes welcome the range of strong opinions inevitably encountered when educating people about sharks.



### 5 | R

### THORMÄHLEN HEIDI | FACILITIES ADMINISTRATOR

Heidi joined the Save Our Seas Shark Education Centre team in December 2011. Moving home from the Sevchelles marked a welcome return to South Africa – and an exciting opportunity to support the foundation's education work in the region. With more than 19 years' experience in the hospitality, office and property management industry, Heidi loves interacting with people. The Shark Education Centre's situation in the vibrant hub of False Bay makes this an interesting – and a rewarding – task! With diplomas in Travel & Tourism Management, Business Economics and a Swiss post-graduate degree in Hospitality/Property Management, she brings a strong administrative background to the centre. On a philosophical note, the arrival of her baby girl Maya highlighted something very close to Heidi's heart: the need for her to use her skills to support a cause that extends beyond tourism – to leave our planet a better one for our children. If anything, motherhood represents the strongest confirmation for Heidi of our role as custodians. And if the Shark Education Centre's work contributes to the sustainability of the oceans when baby Maya and her generation have grown up, then Heidi is in the right place!



### MAYIYA ZANELE | ASSISTANT EDUCATOR

Zanele was born in the northern part of South Africa's Eastern Cape. As a young girl she enjoyed cooking very much, so when she completed her matric she decided to make hotel and catering management her career. In March 2008 she started working for the Save Our Seas Foundation (SOSF) as a housekeeper at the Shark Education Centre. As well as carrying out her housekeeping duties, she assisted with the bookshop and showed the public around the centre. In June 2009 she joined Alison Kock on the research boat to Seal Island in False Bay and there she saw a great white shark for the first time in her life. By the end of that trip she had fallen in love with the sea and decided to become an educator so that she can pass on her enthusiasm to the upcoming generations of South Africans.

Although she enjoyed her job during those years, she told herself that one day she would fulfil her dreams. Her previous duties at the centre were the steps of the ladder that enabled her to get where she is today. The experience that she gained by showing the public around the centre, reading marine books and helping with school groups helped her a lot. Getting an opportunity to teach young people about marine life makes her very proud, in particular because most South African children, especially those who grow up in townships and rural areas, do not have a direct connection to nature or the ocean. After the training that she did during the probation period in her new role as assistant educator, Zanele explained, 'I can truly say that to achieve success you have to believe in yourself, have a vision and work hard because there were so many challenges during the training, like presenting in front of big school groups.' But through hard work she's made it.



### SOSF ISLAND SCHOOL SEYCHELLES MAHÉ. SEYCHELLES

### SHIVJI MAHMOOD DIRECTOR

Mahmood is professor of marine science at Nova Southeastern University's (NSU) Oceanographic Center in Florida and a director of the SOSF Shark Research Center. He received his undergraduate degree in biological sciences at Simon Fraser University in Canada, his masters from the University of California, Santa Barbara, and his PhD from the University of Washington. He has been a faculty member at NSU since 1993 and a director of the SOSF Shark Research Center since 2010.

Mahmood credits his life-long fascination with biology to growing up in Kenya, where he was routinely exposed to African wildlife and undersea environments as a child and teenager. His interests in marine science in particular were boosted when as an undergraduate student he assisted one of his professors with kelp-bed ecology research in a pristine part of British Columbia. That experience proved transformative, leading to a career in marine and conservation science and education.

In addition to leading the research and education programmes of the shark research centre, Mahmood directs the Guy Harvey Research Institute, emphasising collaborative projects between the two entities to achieve larger and more impactful research and conservation outcomes. He specialises in integrating laboratory genetics-based and field-work approaches to study and solve problems pertaining to the management and conservation of sharks and rays, billfishes and coral reef ecosystems.

Mahmood's work consistently receives worldwide attention. His research developing rapid DNA forensic methods to identify shark body parts is being used by US and other national fisheries management agencies to reduce the illegal fishing of threatened species. This work is also on exhibit at the Smithsonian Museum's Sant Ocean Hall in Washington, D.C. and his team's research discoveries have been widely reported in the national and international media.



### DODGE RICHARD DIRECTOR

Having conducted research on coral reefs worldwide, Dr Richard E. Dodge is a recognised authority on reef ecosystems With expertise involving reef ecology and ecology, he is also the author of many publications in scientific literature. His interests include the study of natural and man-induced impacts on coral reefs from factors including climate change, ship groundings and oil spills with their related mitigation, pollution and sedimentation; coral skeletal growth and sclerochronology; coral reef restoration; reef mapping and assessment; and Habitat Equivalency Analysis.

Richard gained a BA degree from the University of Maine in 1969 and an MPhil and PhD in geology and geophysics from Yale University in 1973 and 1978. He is dean of the Nova Southeastern University Oceanographic Center as well as executive director of the center's National Coral Reef Institute, which is dedicated to providing management research outcomes on reef monitoring, assessment and restoration.



### MARCH ABIGAIL (ABI) **PROJECT MANAGER AND EDUCATOR**

It could be said that Abi came to the Sevchelles via Australia, for it was on Ningaloo Reef that she first encountered a whale shark, 'the best thing in the ocean'. She was in Australia between completing her BA in art and studying to be a secondary school teacher, and while learning to scuba dive she developed a love for the ocean. During the following years as a teacher she spent her evenings poring over marine-related books and documentaries and her holidays diving – and looking for whale sharks.

It was Abi's enthusiasm for these giant, spotted sea creatures that first brought her to the Sevchelles, as an intern on a whale shark-monitoring programme with the Marine Conservation Society Sevchelles (MCSS). She worked another two seasons on the programme and then led three whale shark-monitoring expeditions in Djibouti before returning to university to study for an MSc. For her placement she set up the 'Academy by the Sea' in the Seychelles and developed this marine education programme over the next 18 months.

Five years after first setting foot in paradise, Abi feels very lucky to call the Seychelles home. Comprising approximately 115 islands in the Indian Ocean, the country relies heavily on marine resources – and they are at risk of serious depletion because they are not used sustainably and because the general public is not sufficiently aware of their importance. As Abi sees it, education is an essential tool in efforts to conserve the Seychelles' marine environment and resources, and her skills as an educator and her knowledge of the ocean can help to make a difference in the country.

She now manages the SOSF Lekol Zil Sesel - Island School Seychelles marine education project. In the close-knit family community of the Seychelles, young people play an influential role on their parents and extended family members, and as their knowledge and interest develop they become the voice of marine conservation within their community.



### HINE ABBIE PROJECT ADVISOR AND EDUCATOR

A marine educator and coral researcher, Abbie has more than 12 years' experience of educating people of all ages and abilities - and many more years submerged and passionately embracing everything marine related. She worked in various countries on coral reef research expeditions, coordinating volunteers and training them to identify and survey vulnerable reefs, liaising with in-country partners and providing advice on coastal management issues. She subsequently undertook an MSc in tropical coastal management. Her final research paper, on marine education being used as a form of management to reduce damage to coral reefs, was presented at the 2007 International Pacific Marine Educators Conference (IPMEC) in Hawaii.

As the resident marine biologist and environmental advisor for luxury resorts in the Maldives for three years, Abbie learned about putting into practice an educational programme for resort guests. She simultaneously worked on a coral propagation project and started another initiative for the Save Our Seas Foundation (SOSF) that not only demonstrated an improvement in the health of the reef, but also acted as an educational tool for resort guests and local schools, and a means of spreading awareness about coral reefs.

Abbie subsequently worked in the Kingdom of Saudi Arabia on a reef restoration and education project for the SOSF, expanding its education element and moving it to the Seychelles in 2010. There she set up, developed and ran an extensive marine-awareness project that has now been integrated into the SOSF Island School Seychelles, with Abbie as project advisor. In 2011 Abbie founded WiseOceans, a concept she'd been mulling over for many years. It's based on a culmination of her experiences in coral recruitment, reef monitoring and rehabilitation, turtle nesting surveys, research into manta rays, whale sharks and plankton, and studies into fish identification, abun-

dance and diversity.



### HYPOLITE FRED PROJECT ASSISTANT AND EDUCATOR

Fred has a great passion for the environment and is fascinated by the natural world. Born in the Seychelles, he was inspired by his father, who worked as a gear technician at the Seychelles Fishing Authority. His dad was his role model and taught him the names of different fish species, as well as how to tie knots and make nets. Fred also assisted his dad during fishing expeditions. As Fred grew up, so his love for nature and his curiosity about the environment around him developed.

Before joining the Save Our Seas Foundation Island School Seychelles, Fred taught physical education at a primary school. As a teacher he has always shared his love for and knowledge of the environment with the younger generation. believing that children are tomorrow's conservationists. He joined a community-based organisation called Bel Ombre Action Team and has been an active member for the past four years, involved in designing the logo, doing community work and taking part in environmental awareness campaigns. In 2014 he was elected to the committee as the assistant chairperson.

Fred's inspiration, motivation and willingness to learn and develop his knowledge of the marine realm grew after helping Abi with the Marine Explorers' Programme in 2014. His enthusiasm and willingness to be immersed in the programme led to him being offered a full-time position with the team.

As project assistant for the Island School Sevchelles, Fred believes he's transforming the lives of many people, especially the young. He thinks that the Sevchellois, being surrounded by the sea, should always protect and conserve what they have for future generations and that they should, most of all, nurture a love of the sea.



### SOSF CENTRES

SOSF Headquarters Geneva, Switzerland | Scholl Michael

SOSF Shark Education Centre -Kalk Bay, Western Cape, South Africa (105) | Yeld Hutchings Eleanor

SOSF Shark Research Center – Nova Southeastern University (NSU), Oceanographic Center (OC), Dania Beach, Florida, USA (157) | Shivji Mahmood

SOSF Conservation Media Unit – Kalk Bay, Western Cape, South Africa (284) Boonzaier Lisa

SOSF D'Arros Research Centre - D'Arros Island and St Joseph Atoll, Les Amirantes, Seychelles (285) | von Brandis Rainer

SOSF Island School Sevchelles SOSF D'Arros Experience - Mahé, Sevchelles (286) | March Abi & Hine Abigail

### SOSF PARTNERS

Cetacea Lab – Identifying critical habitat for killer whales in northern British Columbia (217) Wray Janie & Meuter Hermann

Bimini Biological Field Station Foundation – Elasmobranch research, education and conservation in Bimini, Bahamas (260) Gruber Samuel & Guttridge Tristan

The Manta Trust – A global strategy and action plan for the long-term conservation of mobulid rays (291) | Stevens Guy

Shark Spotters – Finding a balance between recreational water-user safety and white shark conservation (149) | Waries Sarah, Kock Alison & Sikweyiya Monwabisi

### SOSF SPONSORSHIPS

SOSF Marine Photography Grant 2016 (339) Peschak Thomas

Award – Eugénie Clark Award at the American Elasmobranch Society (AES) Scientific Conference, July 2015 | Reno, Nevada USA (335) | Lowe Christopher

Conference – Third Southern African Shark and Rav Symposium. September 2015 | Simon's Town, South Africa (333) | Waries Sarah

International League of Conservation Photographers (iLPC) (329)

Museum Exhibit - Permanent Shark Exhibit at the Museum of Natural History | Lausanne, Switzerland (330)

National Geographic magazine NGM | Baja California, Mexico & Sevchelles (368)

Social Network Blogging, July 2015 | Reno, Nevada USA (266) | Shiffman David

Student Travel Grant – Oceania Chondrichthyan Society (OCS) Scientific Conference 2015, July 2015 | Auckland, New Zealand (255) | Chin Andrew

Student Travel Grant - American Elasmobranch Society (AES) Scientific Conference, July 2015 Reno, Nevada USA (229) | Lowe Christopher

Student Travel Grant - FSBI 2015. The Biology, Ecology and Conservation of Elasmobranchs: Recent Advances and New Frontiers, July 2015 Plymouth, UK (331) | Sims David

Student Travel Grant and Keynote Speakers - European Elasmobranch Association (EEA) Scientific Conference, October 2015 | Peniche, Portugal (228) | João Correia

Training laboratory equipment at the University of the Sevchelles | Sevchelles (338) | Fleischmann Karl

WaveScape 2015, December 2015 | Clifton Beach, Cape Town, Western Cape, South Africa (334) | Frylinck Ross

Workshop - Mobulid Ray Biology, Ecology and Conservation Workshop at FSBI 2015, July 2015 | Plymouth, UK (332) | Stevens Guy

### A: ALL SOSF PROJECTS FUNDED IN 2015.

IN ALPHABETICAL ORDER OF THE PROJECT TITLE

Assessing conservation status and developing awareness of sharks and rays in North Mozambique (318) da Silva Isabel

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Assessment of elasmobranch critical habitat in the Tropical Eastern Pacific (251) López-Angarita Juliana & Tilley Alex

ray (265) Abudaya Mohammed

Automated fin identification system: (310) Scholl Michael

*Mobula tarapacana* in the Atlantic (327) Sobral Ana

Cowley & Moxham Emily

Bio-accumulation of organochlorine contaminants in three species of predatory Lvons Kadv

Characterising the emerging deep-water shark fisheries in Belize (299) Baremore Ivy

at D'Arros and St Joseph, Seychelles (256) Mortimer Jeanne

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Behavioural ecology of bonefish and permit at St Joseph Atoll, Republic of Sevchelles (312) Paul

sharks occupying multiple trophic levels (324)

Community monitoring of nesting sea turtles

Environmental and biological factors driving whale shark distribution and abundance (241) Marcus Zamora Lara

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Global mobula ray taxonomic, morphological and genetic identification guide (242) Fernando Daniel

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Habitat use, residency and population genetics of the endangered smalltooth sawfish off Andros Island (302) Grubbs R. Dean

High-resolution drone survey of St Joseph Atoll (337) Drone Adventures, senseFly

Incidental catch of manta and mobula rays in the Eastern Pacific Ocean (323) Lezama Ochoa Nerea

Manta ray genetics project (249) Hosegood Jane

Marine protected areas training project (317) Cruz Daniela

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Return to the unknown: exploring the southern Indian Ocean's mysterious 90 East Ridge (301) Clerkin Paul

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Shark research component of the Shark Spotters programme. (306) Kock Alison

Spatio-temporal movements of manta rays in the Seychelles (230) Peel Lauren

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The ecology of stingrays in St Joseph Atoll, Sevchelles (288) Elston Chantel

The effects of white shark cage-diving on the ecological importance of residing around seal colonies (313) Meyer Lauren

The establishment of Shark Share Global, an online elasmobranch tissue database (322) Green Madeline

The Galapagos Marine Reserve: providing a model for a sustainable coexistence between humans and sharks (304) Harvey Euan

The old men and the sea: using fishermen's knowledge for shark conservation (321) Dornhege Mareike

The state of mobulid rays in the Philippines (247) Arnold Shannon

Tracking trans-atlantic movements, habitat preferences and fisheries overlap of the shortfin mako shark (308) Sims David

Trophic position and ecological roles of euryhaline elasmobranch predators (309) Wueringer Barbara

Unravelling the mystery of the genus Mustelus in southern Africa (325) Maduna Simo

Urban shark: the effects of human-induced stressors on the ecology of sharks occupying urbanised landscapes (303) Hammerschlag Neil B: ALL SOSF PROJECTS FUNDED IN 2015, SORTED BY CATEGORY AND IN ALPHABETICAL ORDER OF THE PROJECT TITLE

### **KEYSTONE GRANTS – CONTINUATION**

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SOSF staff – Introduction: A lemon shark on patrol below the surface at dusk in The Bahamas, a shark sanctuary. David Doubilet | National Geographic Creative



In Zermatt, Switzerland, the 4,478-metre-high Matterhorn rises behind the SOSF team at the annual meeting of the scientific advisors in September 2015. From left to right: Nadia Bruyndonckx, Sarah Fowler, Michael Scholl, Dean Grubbs and Thomas Peschak. Published by the Save Our Seas Foundation (SOSF)

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