# SAVE OUR SEAS FOUNDATION

## ANNUAL REPORT 2016

save our seas
foundation

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# “AS LONG AS THERE ARE PEOPLE WHO CARE, WE CAN AND WILL MAKE A DIFFERENCE.”

THE FOUNDER | SAVE OUR SEAS FOUNDATION


Photo by Michael Scholl

# CEO'S NOTE

In 2016, the Save Our Seas Foundation maintained its dedicated support for the three centres it manages directly – the Shark Education Centre in South Africa, the Shark Research Center in the USA and the D'Arros Research Centre in the Seychelles – as well as for 56 projects. Of these, 10 were new, five were long-term (referred to as Partnerships), 17 were continuations of Keystone Grants, 14 were new Small Grants and 10 were Sponsorships. In addition, the Foundation was represented at the regional scientific conferences of the American Elasmobranch Society (AES) in New Orleans, USA, and the European Elasmobranch Association (EEA) in Bristol, United Kingdom.

For the past four years (2012–2016) the Save Our Seas Foundation has focused its funding strategy on Mobulidae and by supporting more than 30 projects worldwide it has played an important role in the dramatic increase in knowledge about the various species of this family. They featured strongly at the 17th meeting of the Conference of the Parties (CoP17) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), held in Johannesburg, South Africa, in October 2016, when no fewer than nine mobula ray species were among the 13 elasmobranchs added to the CITES listings. Three thresher shark species and the silky shark were the other additions.

This brings the total number of shark and ray species listed in the CITES Appendices to 30. Following the listing of manta rays on Appendix II in 2014, the addition of the nine devil rays in 2016 means that trade in all Mobulidae species is now effectively limited. The message is clear: member countries want mobulid fisheries to be sustainably managed. They also expect the managers of the fisheries and of the trade worldwide to work together to achieve that end.

In 2016, the Foundation continued its engagement with rare species by making a special call for research applications on some of the most threatened Chondrichthyes: sawfishes. Characterised by their long, toothed snouts, these warm-water, shark-like creatures are the largest of the rays, reaching a length of more than seven metres (23 feet). Once found in the coastal waters and rivers of more than 90 tropical and subtropical countries, all five species are today classified as Endangered or Critically Endangered. This sawfish effort comes on the heels of our Mobulidae strategy and will run from 2017 until 2020.

Our Marine Conservation Photography Grant was awarded in 2016 and the two winners selected were Justin Gilligan from Australia and Sirachai Arunrugstichai from Thailand. Their assignment for the Save Our Seas Foundation was to investigate how two fragile ecosystems on opposite sides of the Gulf Stream have been encroached upon by human developments and what the impacts have been. In Miami, South Florida, the ever-increasing human need for habitable space is taking over what used to be a wild and unfriendly environment, while in Bimini, The Bahamas, the development of a leisure resort is continuing unchecked, despite a marine protected area having been declared there nearly 20 years ago.

We published two new issues of our flagship *Save Our Seas* magazine in three editions (print, digital and web) and are distributing them worldwide for free. These issues featured a variety of articles and opinion pieces, including the different types of management for marine protected areas and the impacts they have; the mysterious realms of sawfishes and manatees in West Africa; the pioneering use of unmanned aerial vehicles to map a marine ecosystem; the challenges – and passion – involved in conserving mobulas in an unlikely region; the elusive Greenland shark, one of the oldest creatures on earth; and by-catch and its effects on elasmobranch populations.

Inspired by the unparalleled and unequivocal pledge from our Founder, we continue our collaboration and work with passionate and dedicated project leaders around the world. For all of us, our responsibility for elasmobranchs and other important marine animals, and for their habitats, is clearly defined.

Michael Scholl | Chief Executive Officer

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53 Biology and Ecology of Sawfishes Symposium (AES) | New Orleans, USA
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58 WaveScape 2016 | Cape Town, ZA | Frylinck Ross





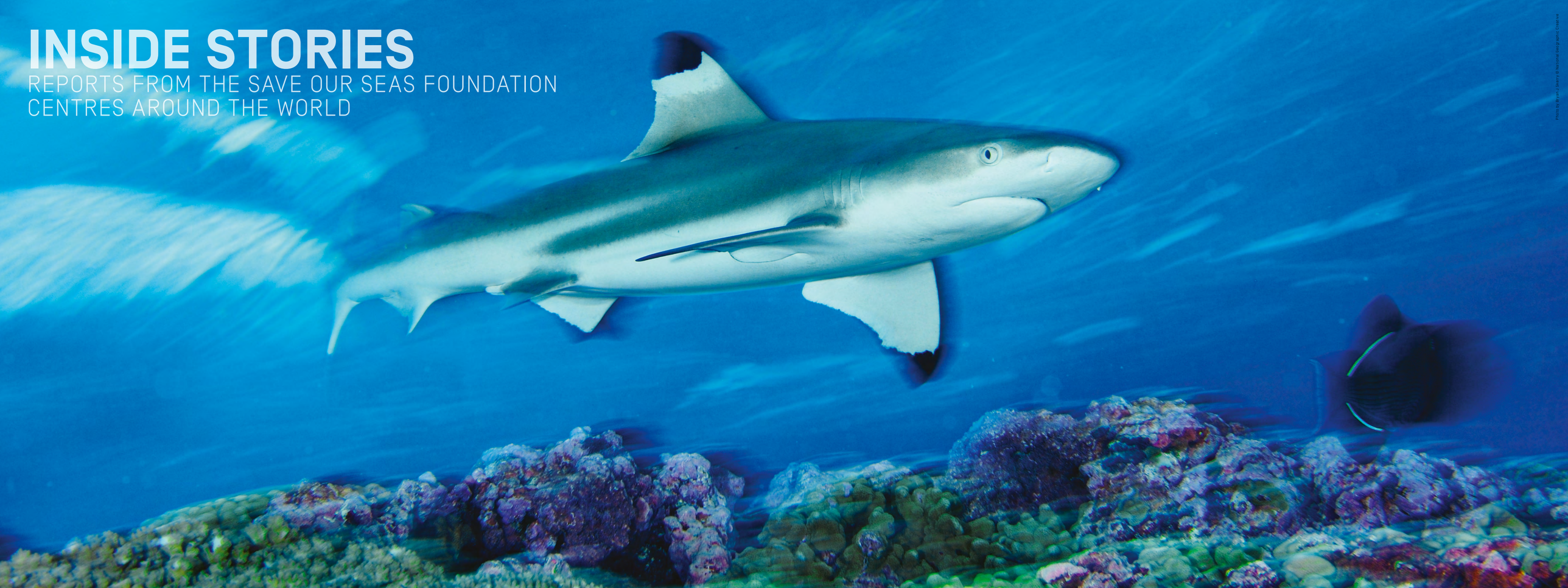

# WHERE WE WORK 2016

The Save Our Seas Foundation was established in 2003 with a mission to protect our oceans by funding and supporting research, conservation and education projects around the world, focusing primarily on charismatic threatened wildlife and their habitats.
In that time, the foundation has sponsored over 300 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*

# INSIDE STORIES

REPORTS FROM THE SAVE OUR SEAS FOUNDATION
CENTRES AROUND THE WORLD



# SOSF D'ARROS RESEARCH CENTRE

CLARE KEATING DALY & RYAN DALY

save our seas
d'arros research centre

For over a decade, the D'Arros Research Centre (DRC) has thrived as a regional centre of excellence for marine and tropical conservation in the Amirantes Island Group of the Seychelles. Together with the biological diversity and abundance of its sister atoll St Joseph, D'Arros Island provides an outstanding ocean observatory for scientific research and discovery. Since its establishment in 2004, the DRC's core research has focused on long-term data collection and monitoring, such as the coral reef and turtle monitoring programmes, as well as targeted research projects.

In August 2012, new ownership of D'Arros Island put the DRC under the umbrella of the Save Our Seas Foundation (SOSF), thus creating the SOSF-DRC. This enabled the research facility to further its goals and extend its reach. Recognising the importance of round-the-clock access to tide-restricted St Joseph Atoll, in 2014 the SOSF-DRC established a biological field station on the largest island in the atoll, St Joseph.

The DRC's infrastructure, comprising a wet and dry laboratory, digital microscopes, a -20 °C (-4 °F) freezer, a drying oven, dive equipment and, of course, running water, Internet and electricity, provides the ideal base for analytical and logistical support to the field station. The establishment of the basic field station has enabled the SOSF-DRC to define and maximise opportunities for research in St Joseph Atoll, strengthening the link between the island and atoll systems.

In addition to its core research programmes, in 2016 the SOSF-DRC supported eight targeted research projects, which include studies of 12 species, such as the manta ray *Manta alfredi* (which is categorised as Vulnerable on the IUCN List of Threatened Species), the hawksbill turtle *Eretmochelys imbricata* (Critically Endangered) and the green turtle *Chelonia mydas* (Endangered). Together with Danah Divers, the SOSF-DRC maintains the largest acoustic receiver network in the Western Indian Ocean, consisting of 88 receivers that track marine life over the entire Amirantes Bank.

The comprehensive research projects based at the SOSF-DRC focus on larger conservation issues that involve both ecosystems and species and have future generations of the Seychellois people in mind. The SOSF-DRC has contributed to research over the past five years and 2017 is shaping up to be an even larger chapter of growth and success.

# CORE RESEARCH PROGRAMMES

> Near-pristine coral reefs of D'Arros Island photographed prior to the bleaching event that peaked in April and May 2016.

⌄ DRC staff conduct the annual reef monitoring survey off D'Arros Island. 2016 marks the fifth year of data collection for this programme.

Photos by Ryan Daly

## CORAL REEFS

**AUTHORS:** DR RYAN DALY & CLARE KEATING DALY
**PRINCIPAL INVESTIGATOR:** SOSF-DRC
**FIELD PERSONNEL:** SOSF-DRC STAFF

The effects of the third global coral bleaching event reached the reefs of D'Arros and St Joseph Atoll in 2016. The mass bleaching of coral began in earnest in 2015 and, driven by a strong El Niño, persisted throughout 2016 to become what is now the longest and most widespread bleaching event in recorded history. All three global coral bleaching events have occurred in the past 20 years, caused largely by changing trends in sea temperature and heightened by strong El Niño weather patterns. Although coral reefs can recover from bleaching events, they require time between events or sustained normal sea temperatures to do so, but this has not occurred during the latest event. Coral reefs make up only a small proportion of ocean but support approximately 25% of all marine species, which makes their health critically important for the marine environment.

As coral reefs take hundreds of years to form, long-term data are necessary for meaningful study. Thus, the DRC core research includes an annual coral reef monitoring programme that aims to assess trends in the structure and health of local coral reef communities. This core research is particularly relevant in light of the increasing impacts of climate change. 2016 marked the fifth year of consecutive data collection on long-term physical and biological changes to the reefs around D'Arros Island and St Joseph Atoll.

Sea temperatures recorded at D'Arros and St Joseph in 2016 peaked at 31 °C (88 °F), with sustained sea temperatures above 30 °C (86 °F) between April and May. The maximum sea temperatures recorded in 2016 were not significantly different from those of previous years, but the persistently high sea temperatures recorded (>30 °C) were abnormal, which ultimately resulted in the observed coral reef bleaching event (figure 1). Fine-scale coral reef surveys conducted by DRC staff in May focused on monitoring the progression, distribution and severity of the bleaching event. Results suggested that an average of 54% of monitored corals exhibited bleaching during the peak in sea temperature. Although some corals did recover after the sea temperature had eventually dropped, the bleaching event resulted in a widespread hard coral mortality of between 35 and 50%.



Figure 1. Sea temperature as recorded at D'Arros Island between the years 2012 and 2016, showing the 30 °C (86 °F) temperature threshold (red band) at which corals may start to bleach. Elevated sea temperatures in 2016 were notably higher for longer than in previous years.

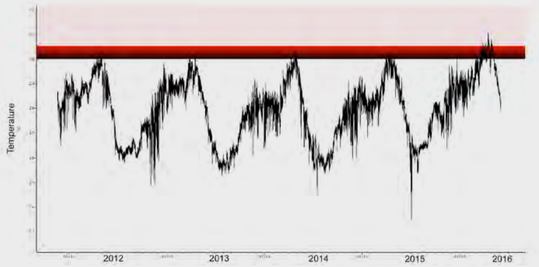
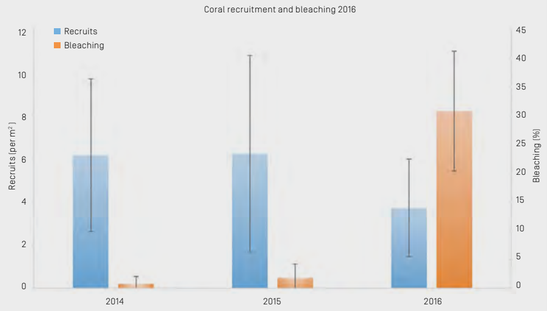



Figure 2. The results of coral recruitment and bleaching surveys from the years 2014 to 2016. The most recent year shows less coral recruitment and significantly increased coral bleaching.




Coral reef recruitment surveys in 2016 sampled and analysed 864 square metres (9,300 square feet) of reef and assessed 5,382 *Acropora* and *Pocillopora* coral recruits. The bleaching event appeared to negatively impact coral recruitment in 2016, with an average of 30% of all recruits surveyed exhibiting bleaching and the number of recruits in 2016 significantly lower than in previous years (figure 2).

Based on early analysis of data collected in 2016, coral reefs at D'Arros and St Joseph were severely impacted by the global bleaching event. In order to understand its long-term consequences, the SOSF-DRC will continue to monitor various indicators of reef health in 2017 and beyond.

Photo by Ryan Daly

Photo by Olivier Born

‹ St Joseph Atoll as seen from the air. Shallow sea-grass flats provide ideal foraging habitat for both green and hawksbill turtles.

› SOSF-DRC staff take a straight-line measurement of a juvenile green turtle in St Joseph Atoll.

## GROWTH RATES AND POPULATION SIZE OF RESIDENT JUVENILE HAWKSBILL AND GREEN TURTLES

**AUTHOR:** DR RYAN DALY
**PRINCIPAL INVESTIGATOR:** SOSF-DRC
**FIELD PERSONNEL:** SOSF-DRC STAFF

The combination of sea-grass flats and sheltered habitat at D'Arros Island and St Joseph Atoll provides critical habitat for juvenile green and hawksbill turtles. This, combined with the significant nesting habitat for these same species, sets D'Arros and St Joseph apart as one of the most important areas for these turtles in the Seychelles and the broader Western Indian Ocean. As hawksbill and green turtles are listed by the IUCN as Critically Endangered and Endangered respectively, the monitoring and conservation of their populations is a priority. Part of this conservation effort includes improving the understanding of population numbers and demographics and the growth rates and movements of juvenile foraging turtles. This is the aim of this core research programme.

In the 11 years of this core research programme, the DRC has caught 384 turtles, the majority of which were hawksbill turtles (n=307). In 2016, the programme recorded a number of long-term hawksbill turtle recaptures. The recaptures were tagged between three and four years ago and grew between 5.2 and 8.5 centimetres (2.05 and 3.35 inches), highlighting their slow growth rate. The recapture data suggest that the juvenile hawksbill population consists of at least 600 individuals that rely on St Joseph Atoll as a critical foraging habitat. Multiple recaptures of the same individual turtles throughout the duration of the monitoring programme highlights the residency and inherent susceptibility of this population and emphasises the need for prioritised conservation.

Green turtles have proved more challenging to monitor, as juveniles of this species require more effort to catch than hawksbills of the same size class. Since 2006 this programme has tagged 77 green turtles, but in 10 years has only one recapture on record. Observational data suggest that the population of green turtles appears to be much larger (more than 2,000 individuals) than the hawksbill turtle population. However, further research is required to record accurately the distribution and abundance of green turtles at D'Arros and St Joseph.


Photo by Michael Scholl

The D'Arros Research Centre boat conducting a manta survey around D'Arros Island.

Photo by Olivier Born

## POPULATION STRUCTURE, RESIDENCY AND BEHAVIOUR OF REEF MANTAS

**AUTHOR:** DR RYAN DALY
**PRINCIPAL INVESTIGATOR:** SOSF-DRC
**FIELD PERSONNEL:** SOSF-DRC STAFF

Since 2009, the DRC has been monitoring the population of reef mantas *Manta alfredi* that frequents D'Arros Island and St Joseph Atoll to improve the understanding of this iconic and vulnerable species. This programme has relied primarily on photo identification to catalogue individual mantas over time in order to investigate the population's structure, size, residency patterns and site fidelity. SOSF-DRC staff conduct regular dives and surveys to record the presence and location of mantas and take photographs to identify individual manta rays. This ongoing research was complemented in 2016 by the start of a broader manta ray project led by PhD candidate Lauren Peel. In 2016, 197 mantas were recorded at D'Arros and St Joseph, bringing the total number on record to 764. A total of 159 individual mantas have been identified within the Seychelles population, of which 56% have been re-sighted, particularly at D'Arros Island. Additionally, many manta rays recorded at D'Arros Island have been re-sighted multiple times over the past eight years, highlighting the importance of D'Arros as a critical habitat for this species.

**COMMUNITY MONITORING OF NESTING SEA TURTLES**
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Sea turtles have long been of economic importance to the people of the 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 Seychelles cuisine.

In 1994 the Seychelles 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. However, some human customs and habits die hard and many Seychellois, especially the more traditional people living and working 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 those who live at the coast to take ownership of conservation programmes involving sea turtles. The D'Arros Research Centre achieved this through the Community Monitoring of Nesting Sea Turtles Programme, which enlists Seychellois labourers who work on D'Arros Island to conduct daily monitoring walks along its nesting beaches at the end of their work day, on a paid overtime basis. Once a week they also go across to the more remote St Joseph Atoll and monitor nesting activity on the beaches there.



Photos by Olivier Born

# PROGRAMME OUTPUTS

**CONSERVATION BENEFITS**

The part-time turtle monitors 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 be involved in conservation.

**SOCIAL BENEFITS**

Usually the part-time turtle monitors enjoy the work and they appreciate the opportunity to do something meaningful outside normal working hours, while also making a bit of extra money. Most of the turtle monitors 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 stayed with the turtle programme for extended periods (up to seven years in one case) and two of them have gone on to become full-time conservation rangers on other islands in the Seychelles.

**SCIENTIFIC BENEFITS**

Initiated in 2004, the D'Arros/St Joseph turtle monitoring programme is the first such study to be implemented anywhere in the Amirantes Island Group of the Seychelles. 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:

- ***What species of turtles occur?***
  - Nesting sea turtles: the hawksbill turtle *Eretmochelys imbricata* and the green turtle *Chelonia mydas*
  - Foraging sea turtles: large numbers of hawksbill and green turtles; and evidence of small numbers of loggerhead turtle *Caretta caretta* [a dead juvenile loggerhead that washed ashore was recovered by some of the turtle monitors]
- ***How many turtles nest each year?*** Based on the data collected during the past five seasons, we estimate the numbers of females of each species that nest annually to be approximately the following:

| | Hawksbills | Green turtles |
|---|---|---|
| D'ARROS ISLAND | ~115 | ~35 |
| ST JOSEPH ATOLL | ~175 | ~145 |
| TOTAL | ~290 | ~180 |

Considered together as a single site, D'Arros Island and St Joseph Atoll host the largest nesting population of hawksbill turtles not only anywhere in the Seychelles, but also in the entire Western Indian Ocean region. This is important given that the IUCN lists the hawksbill turtle as Critically Endangered and that the Seychelles hosts one of the four largest national populations of nesting hawksbills anywhere in the world.

- ***What are the population trends?*** In the early years of the D'Arros and St Joseph Atoll turtle monitoring programme, numbers of nesting turtles remained relatively constant from year to year. In recent years, however, the numbers have increased – evidence that conservation efforts are paying off.
- ***What is the nesting seasonality?*** Hawksbill turtles everywhere in the Seychelles, including at D'Arros Island and St Joseph Atoll, have a nesting season that peaks between mid-October and mid-January (figure 3a).
  Green turtles are more variable, with nesting 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

Photo by Clare Keating Daly

The four-man turtle monitoring team of late 2016 measures the track of a nesting hawksbill turtle on the beach of D'Arros Island.

Figure 3 (a)
**NESTING HAWKSBILLS**

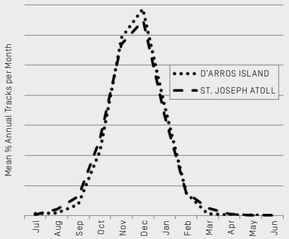


Figure 3 (b)
**NESTING GREEN TURTLES**

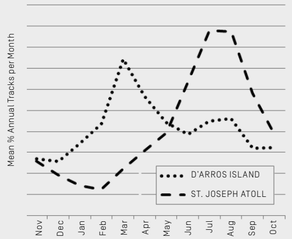


Figure 3. Graphs showing the peaks in hawksbill (a) and green turtle (b) nesting at D'Arros Island and St Joseph Atoll.

winter and more southerly sites (away from the equator) during the austral summer. So we were surprised to find that the nesting season of green turtles at D'Arros Island (February to April) was consistently different from those nesting at St Joseph Atoll (June to October) located only two kilometres (1.24 miles) away (figure 3b). The reason for this difference remains a mystery, but it may be related to water temperature.

- ***What are the turtles' genetic characteristics?*** The genetic characteristics of nesting hawksbills appear to be relatively consistent at most nesting sites in the Seychelles. In fact, genetic studies indicate that hawksbill nesting populations here and those 2,000 kilometres (1,243 miles) to the east in the Chagos Islands belong to the same regional management unit (RMU). In contrast, 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.

D'Arros and St Joseph has been recognised to be one of the most important and unique sites for sea turtles in the Western Indian Ocean, given the relatively high numbers of both hawksbill and green turtles sharing the same breeding beaches. With continued protection, we can expect their numbers to increase.

# TARGETED RESEARCH PROJECTS

**POPULATION DYNAMICS, MOVEMENT PATTERNS, TROPHIC ECOLOGY AND GENETICS OF REEF MANTA RAYS AT D'ARROS ISLAND**
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**FIELD PERSONNEL:** SOSF-DRC STAFF & PRINCIPAL INVESTIGATORS

The SOSF-DRC and Manta Trust's Seychelles Manta Ray Project aims to investigate the population size, movement patterns, feeding ecology and genetics of the reef manta ray population of the Seychelles in order to further our understanding of the biology and conservation needs of this species in the Western Indian Ocean.

Using photographs of the unique pattern of spots on the bellies of reef manta rays, the research team has so far been able to identify 159 individuals throughout the Seychelles, of which 114 were recorded at D'Arros Island. Both sexes are equally represented within the population, and the maturity status of individuals ranges from immature (36%), to sub-adult (8%), to mature (42%). An assessment of maturity status was unable to be made for 21 individuals.

To determine how reef manta rays are moving through the Amirantes Island Group and how they are using the various habitats available to them, 22 acoustic tags were deployed in 2016 to build upon previous tagging efforts in the region. Preliminary data are revealing that D'Arros Island plays an important role in the life cycles of reef manta rays in the Amirantes, and that the eastern Amirantes Bank ridge may be important to their navigation.

To investigate reef manta ray movement on a larger scale, two satellite tags were also deployed in 2016. Data retrieved from one of these tags are already highlighting the extent to which reef manta rays move between the different island groups of the Seychelles and how they utilise offshore habitats.

Lastly, reef manta ray tissue samples have been collected in order to assess the genetic relatedness of individuals sighted around D'Arros Island. These samples will also be used to investigate the feeding preferences of reef manta rays in this location by analysing them alongside zooplankton samples that were collected during manta feeding events.

Photos by Ryan Daly

^ A manta ray at a reef cleaning station at D'Arros Island.

> A reef manta ray swims in the clean water just off the reef crest of D'Arros Island.

## HABITAT USE PATTERNS AND MOVEMENT BEHAVIOUR OF BONEFISH *ALBULA GLOSSODONTA* IN ST JOSEPH ATOLL

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**FIELD PERSONNEL:** SOSF-DRC STAFF, PRINCIPAL INVESTIGATORS & DR RHETT BENNETT (SAIAB)

Bonefish *Albula* spp. support valuable recreational and artisanal fisheries worldwide, yet nothing is known about *A. glossodonta* in the South-western Indian Ocean. The fly-fishing industry in the Seychelles is a growing economic sector and much-needed research on highly sought-after species such as bonefish will aid the management of this fishery and the sustainability of localised stocks at prominent islands and atolls, such as the D'Arros and St Joseph complex. Specific objectives of this study were to investigate the habitat use patterns and movement behaviour of *A. glossodonta* in St Joseph Atoll.

A total of 30 bonefish were surgically equipped with acoustic transmitters to study their movements and habitat use patterns in St Joseph Atoll. Although extreme care was taken while handling and tagging these fish, only three (10%) survived for more than two weeks. The losses were ascribed to post-release predation by sharks. Information from the surviving individuals revealed that they utilised both sand-flat and lagoon habitats. Water temperature, time of day and tidal phase influenced the presence of bonefish in the lagoon, as they spent more time in the deeper, cooler lagoon during the day and frequented the shallow flats more at high tide. The high mortality rate due to post-release shark predation has important management implications, suggesting that catch-and-release angling is not benign and may negatively impact on locally resident bonefish populations at remote areas with healthy shark populations.



Photo by Rainer von Brandis

Project leader Dr Paul Cowley observes a bonefish in a saltwater isolation keep-pen prior to the fish being implanted with an acoustic transmitter.

## MOVEMENT ECOLOGY OF TWO TREVALLY SPECIES *CARANX IGNOBILIS* AND *C. MELAMPYGUS* IN THE SEYCHELLES

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**PRINCIPAL INVESTIGATORS:** DR PAUL COWLEY (SAIAB), DR RYAN DALY & DR JOHN FILMALTER (SAIAB)
**FIELD PERSONNEL:** SOSF-DRC STAFF & PRINCIPAL INVESTIGATORS

The giant trevally *Caranx ignobilis* and the bluefin trevally *C. melampygus* (family Carangidae) represent iconic recreational angling species throughout their tropical distribution. Both species are important targets of the growing fly-fishing industry in the Seychelles, yet little information exists on these species in the South-western Indian Ocean. This study aims to contribute to the understanding of the movement ecology of these species around the near-pristine environments of D'Arros Island and St Joseph Atoll. Specific objectives include investigations into their habitat use patterns and movement behaviour and the identification of spawning aggregation sites. The findings of this study will aid the management of these species and the sustainability of localised stocks.

Thirteen adult giant trevally, ranging from 725 to 1,200-millimetre (28.5 to 47.2-inch) fork length, were tagged with acoustic transmitters in the coastal waters of D'Arros Island, while four juveniles, ranging from 405 to 470-millimetre (15.9 to 18.5-inch) fork length, were tagged in St Joseph Atoll. Additionally, 17 bluefin trevally were tagged with acoustic transmitters in April/May 2016. The fish were captured using conventional fishing gear and artificial lures from a small vessel or from shore. They were handled with care and during the surgical procedure were maintained in a large tub filled with fresh seawater. After the transmitters had been implanted, each fish was measured and a small fin clip sample was taken for genetic analysis. Following the surgical procedure, the tagged fish were released at their site of capture. The tagged fish were monitored by a permanent array of 88 acoustic receivers in and around D'Arros Island and St Joseph Atoll. The data obtained from the first six-month period were analysed and are highlighted in this report.

A total of 39,379 and 12,351 detections were obtained for the giant trevally and bluefin trevally, respectively. The large difference in the average number of detections per individual (2,461 versus 950) suggests that the giant trevally occurs in deeper waters off the reef crest where the receivers are moored (at a depth of about 15 metres; 50 feet), whereas the bluefin trevally probably prefers the shallower waters on and around the reef flats.

Photos by Ryan Daly

< Bluefin trevally prey on baitfish in the shallows of D'Arros Island. These predatory fish play an important role in shaping their marine communities.

Photo by Ryan Daly

Photo by Claire Keasling Daly

< Project investigators use traditional rod and reel to catch bluefin trevally and giant trevally off St Joseph Atoll and D'Arros Island. Each fish is tagged and fin clips are taken before it is released.

> Figure 4. Circle sizes show proportional detections of tagged adult (red circles; n=13) and juvenile (blue circles; n=3) giant trevally on the receivers within the D'Arros Island and St Joseph Atoll array.

The giant trevally juveniles tagged in the atoll showed extensive movements and were recorded on 10 different receivers in the lagoon and atoll sand flats. However, a common high-use area adjacent to Foquet Island was observed. It appears that the sheltered atoll environment represents a nursery refuge for juveniles, as the tagged individuals were never recorded on any of the marine receivers outside the atoll (figure 4).

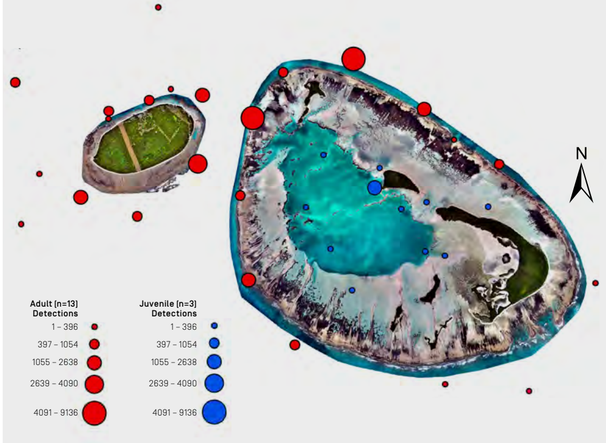
The giant trevally adults were recorded on multiple receivers in coastal waters around the atoll and island, but no detections were logged on receivers inside the atoll, suggesting that the fish lose their juvenile dependence on the sheltered waters of the atoll (figure 4). An average of 2,461 detections were recorded for each tagged fish between May and November 2016, with the highest number of detections recorded on the north-western side of St Joseph and the eastern side of D'Arros. Importantly, fish tagged on D'Arros were detected at St Joseph Atoll and vice versa, highlighting the connectivity between these islands.

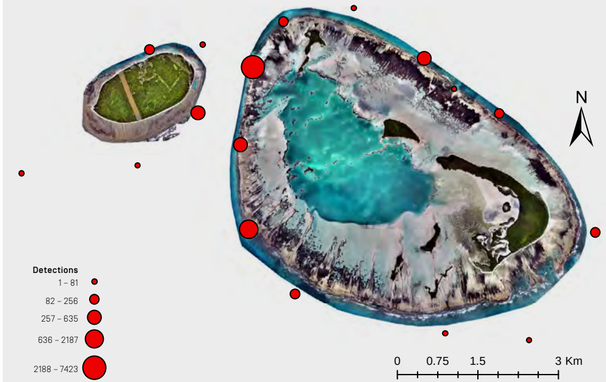
The tagged samples of bluefin trevally were recorded on fewer receivers compared to giant trevally. It is possible that this species exhibits residency behaviour and it may inhabit shallower waters near the reef crest (figure 5). An average of 950 detections were recorded for each tagged fish between May and November 2016.

As well as the telemetry work, genetic samples (fin clips) collected during this study will be used in a broader investigation of the connectivity and population genetics of both species. In addition, an amino acid-specific stable isotope analysis will be conducted to compare the trophic niche space of giant trevally from sites in the South-western Indian Ocean that constitute three habitat types: coastal continental reef, island reef and coral atoll.

> Figure 5. Circle sizes show proportional detections of tagged bluefin trevally (n=13) on the acoustic receivers within the D'Arros Island and St Joseph Atoll array.






A lemon shark with an activity tag attached to its dorsal fin. These tags record data on the shark's fine-scale habitat use, behaviour and environment.

**BEHAVIOURAL PATTERNS OF LEMON SHARKS *NEGAPRION ACUTIDENS* AT ST JOSEPH ATOLL**
**AUTHORS:** DR RYAN DALY & CLARE KEATING DALY
**PRINCIPAL INVESTIGATOR:** SOSF-DRC
**FIELD PERSONNEL:** SOSF-DRC STAFF

Historically, the study of habitat use by animals has relied primarily on telemetry equipment that transmits geographical location but provides little information about the animal's behaviour. Thus, in many studies investigating the conservation challenges faced by species there is a gap in the understanding of the biological and physiological behavioural responses of species to their environment. As new research begins to shed light on the habitat use, diet and ecology of lemon sharks at St Joseph Atoll from ongoing SOSF-DRC projects, a gap with regard to the behaviour of these sharks remains.

This study uses activity tags to address this gap and investigate the behavioural patterns of the sicklefin lemon shark *Negaprion acutidens* at St Joseph Atoll. It aims to investigate how lemon shark behaviour and energetic dynamics relate to the sharks' physical environment, and the data it produces will contribute to the understanding of the ecological role and conservation of lemon sharks in St Joseph Atoll.

In 2016, SOSF-DRC staff tagged four lemon sharks, with total length ranging from 130 to 203 centimetres (51 to 80 inches) and mean total length 178 centimetres (70 inches), for observation. Each shark was observed for an average of two hours 39 minutes and video recordings were made of its behavioural patterns. These patterns were categorised and will be used to interpret the data from the tags. In addition, the SOSF-DRC team tagged four lemon sharks for free-range deployments. These sharks ranged between 156 and 211 centimetres (61 and 83 inches) total length, with a mean total length of 181 centimetres (71 inches), and the ratio of male to female was 1:3. The first tag was lost and the remaining three deployments lasted between 26 and 49 hours, resulting in more than five million rows of data that help to provide new insights into the daily lives of these sharks.

SOSF-DRC staff watch the behaviour of a lemon shark fitted with an activity tag at St Joseph Atoll. The shark is observed before being released to facilitate interpretation of the data collected by the tag.

Photos by Ryan Daly

By using recently available technology, this project will enable us to improve our understanding of the spatial and temporal behavioural dynamics of lemon sharks relative to current conservation management plans and a changing marine environment. This knowledge can be applied locally to monitor lemon shark population dynamics and regionally to investigate ways to improve current conservation measures for this vulnerable species in light of increasing threats from habitat loss and fishing.

Photo by Ryan Daly

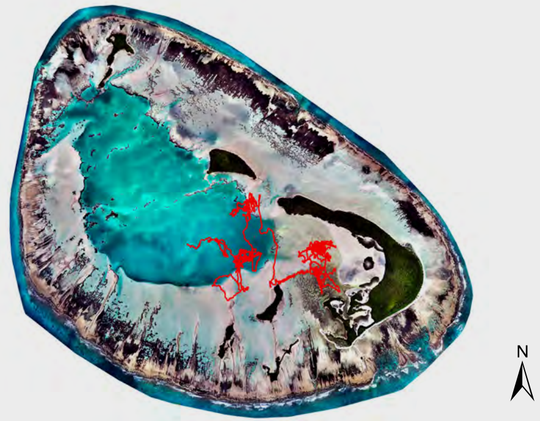



Figure 6. The red line represents the fine-scale movement patterns of a tagged lemon shark over a 12-hour period at St Joseph Atoll. The tracks are calculated from a combination of the compass and accelerometer in the tag package, providing an exceptionally detailed record.



> Juvenile mangrove whiptail and feathertail stingrays at St Joseph Atoll take refuge on the shallow sand flats that surround the deep lagoon.

> An adult mangrove whiptail ray at D'Arros Island.

Photos by Ryan Daly

**THE ECOLOGY OF STINGRAYS AT ST JOSEPH ATOLL**
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**FIELD PERSONNEL:** SOSF-DRC STAFF, PRINCIPAL INVESTIGATOR & DR PAUL COWLEY (SAIAB)

There are three species of stingray that are ubiquitous in St Joseph Atoll: the feathertail ray *Pastinachus sephen*, the porcupine ray *Urogymnus asperrimus* and the mangrove whiptail ray *U. granulata*. Given its remote location, St Joseph 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. This study focused on improving the understanding of the dietary ecology and habitat use of these stingray species.

Throughout 2014 and 2015, 121 stomach content samples were collected from stingrays using the non-lethal technique of gastric lavage. These samples were visually assessed in 2016 to determine what prey constituted the diets of the stingrays. Data for the porcupine rays have been analysed and two phyla (Sipuncula and Nemertea) and 11 polychaete and crustacean families were recorded in their stomach contents. Polychaetes of the family Capitellidae were the most important prey item, as they made up the bulk of the stomach contents in most of the individuals, and juvenile porcupine rays appeared to specialise on this family. Other prey items were eaten infrequently and in low proportions. Porcupine rays were found to be opportunistic feeders, as Capitellidae displayed the highest environmental abundance. There was evidence of a size-related shift in the crustacean families consumed by juvenile porcupine rays, with larger crustaceans possibly providing the necessary energy increases for more mature rays. 2017 will see the data analysis of stomach contents from the other two stingray species so that dietary overlap can be assessed.

Data collected from tagged stingrays (20 individuals for each of the three species) in 2016 showed that all the stingrays appear to be resident at the atoll, as the vast majority of detections occurred within it. Only three feathertail rays, two mangrove whiptail rays and three porcupine rays were detected on the Amirantes Bank outside the atoll, and only for five, two and five days respectively. Most detections (87.6%) occurred on the sand flats of the atoll, whereas there were few detections (12.3%) from the lagoon and very few (0.07%) from the outer reef surrounding the atoll. Feathertail rays, mangrove whiptails and porcupine rays were detected for an average of 61%, 70% and 35% of days within the atoll (expressed as a percentage of total monitoring days). The environmental drivers behind movement patterns still need to be determined, but initial analyses suggest that temperature and water depth play important roles in regulating the patterns.

Protecting these species is vitally important; the porcupine ray and mangrove ray are categorised as Vulnerable and the feathertail ray as Data Deficient on the IUCN Red List. Not only will the information gathered by this project benefit management plans for the stingray population of St Joseph Atoll, but it will also help us to understand and conserve these species as a whole throughout their wide-ranging distributions.

An adult Wedge-tailed Shearwater with its egg at St Joseph Atoll.

## THE FORAGING ECOLOGY OF WEDGE-TAILED SHEARWATERS *ARDENNA PACIFICA* ON D'ARROS ISLAND AND ST JOSEPH ATOLL

**AUTHOR:** DANIELLE Z VAN DEN HEEVER
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**FIELD PERSONNEL:** SOSF-DRC STAFF, PRINCIPAL INVESTIGATOR & JONATHAN BOTHA

Very few studies have been conducted on the Wedge-tailed Shearwater *Ardenna pacifica* in the Western Indian Ocean and only one other study has utilised GPS devices to track the foraging distribution of this species at a fine scale during its breeding season. A large portion of the Western Indian Ocean is impacted by tuna fisheries. This may severely impact seabird species, including the Wedge-tailed Shearwater, that take tuna as prey. The population of Wedge-tailed Shearwaters is said to be declining, but by tracking the birds at sea we may be able to determine foraging hotspots that could be important for future conservation.

Miniature Global Positioning Systems (GPS) and Temperature, Depth Recorders (TDRs) were taped to the shearwaters, but unfortunately all the devices fell off and no data could be retrieved. However, blood and feather samples were collected for stable isotope analysis to determine the trophic relationships among individuals and between sexes. These samples are being processed. Some diet samples were collected opportunistically and it was found that the shearwaters feed on Exocoetidae (flying fish), Teuthida (squid), crustaceans and small fish species. Thirty female and 12 male shearwaters were identified and once we have the results from the stable isotopes we will be able to assess differences in the trophic ecology of males and females.

The SOSF-DRC team also carried out a census of Wedge-tailed Shearwaters on D'Arros to determine how many breeding pairs were on the island. This information will enable us to assess potential changes in the population status. A combination of direct counts and area-based estimates was used to calculate the breeding population, and activity in the birds' burrows was inspected by means of an endoscope and call-back.

From the direct counts it was found that by early November most of the active nests contained incubating parents (56.73%), with some chicks starting to hatch (1.04%). Only 39.1% of the burrows were empty. Taking into account the area-based estimates, we determined that the population had increased twelvefold since the previous census in 2009 and assessed that it had grown to approximately 3,045–3,228 breeding pairs, despite the current decline in many other populations.


Figure 7. Wedge-tailed Shearwater colony areas on D'Arros Island in November 2016. Yellow areas indicate direct count plots and red areas indicate high burrow density plots, where area-based estimates were conducted. Plot numbers are indicated in the white squares.



Photos by Ryan Daly

A Girth measurements are now also taken when collecting baseline data at St Joseph Atoll. The dorsal girth measurement is one of three that will shed new light on the condition of these atoll-bound juvenile sharks.

A juvenile blacktip reef shark equipped with a small GPS/VHF device, which records the shark's position every 10 minutes over 24 hours. After that period, a small galvanic timed release (GTR) triggers the plastic clip to pop off and the device is retrieved.

## HABITAT AND RESOURCE PARTITIONING OF JUVENILE SHARKS AT ST JOSEPH ATOLL

**AUTHOR:** ORNELLA WEIDELI
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**FIELD PERSONNEL:** SOSF-DRC STAFF & PRINCIPAL INVESTIGATOR

The main objective of this three-year study is to gain better insight into how ecologically similar species can co-occur at the same habitat without outcompeting each other. According to niche theory, ecologically and morphologically similar species that co-occur at the same habitat have to segregate into different ecological niches in order to avoid competition. Segregation between sympatric species can therefore be found at spatial and temporal scales and/or in differently used resources (differences among prey species, prey sizes, contribution of prey).

At St Joseph Atoll, the blacktip reef shark *Carcharhinus melanopterus* and the ecologically similar sicklefin lemon shark *Negaprion acutidens* utilise the shallow waters as their nursery ground. Every year between September and March, female blacktip reef and sicklefin lemon sharks seek the shallow flats of St Joseph Atoll to give birth. During the juveniles' first year of life, their movements are restricted to the shallow and easily accessible waters, which gives us a great opportunity to study how mutually used nursery resources are partitioned among species and to find out whether competition occurs between these two species. A diverse set of methods, including tracking by different means, dietary investigations, stable isotope analysis, genetic analysis and behavioural experiments, have been applied to understand whether and how these two species are partitioning or overlapping in their habitat and resource use.

In 2016 the SOSF-DRC caught 172 juvenile sharks, of which 128 were new and 44 were recaptures from earlier sampling seasons. In total, since the initiation of this project in November 2014, 557 sharks have been caught and 183 recaptured. Some of these recaptured sharks have been caught up to five times, with a maximum period between the first and last captures of 2.5 years (table 1). Repetitive data on the same individual over an extended time span gives a better insight into the shark's growth rate, which is surprisingly slow (approximately four centimetres, or 1.5 inches, for some individuals), and also shows how restricted their movements are during the first years of their life (capture locations are only 500–1,000 metres, or 1,640–3,280 feet, apart).

| Catch date | PCL (cm) | Weight (g) | Umbilical scar stage |
|---|---|---|---|
| 26/11/2014 | 51.0 | 1500 | partly open (born in the 2013/14 pupping season) |
| 11/04/2015 | 52.6 | 2250 | closed |
| 22/09/2015 | 55.5 | 1800 | closed |
| 13/04/2016 | 57.3 | 2050 | closed |
| 04/10/2016 | 60.2 | 2200 | closed |

Table 1. A sicklefin lemon shark from St Joseph Atoll that was caught five times within 2.5 years. Note the small growth rate.

In total, the number of recaptured sharks versus newly caught sharks does not exceed 30%, suggesting that St Joseph Atoll provides a safe and protected habitat for a large number of juvenile sharks. The multiple recaptures of certain individuals are testimony to their use of this habitat for the first years of life.

An innovation in 2016 was the addition of three girth measurements to the baseline data, which gave us a better understanding of the shark's body condition relative to its size and how these juveniles were coping with their environment in their first weeks and months of life.

After sharks were tracked manually in 2014 and 2015, another innovation in 2016 was the construction and testing of a new tracking device. The new GPS tags were equipped with small VHF transmitters that enabled us to retrieve them after deployment. The first 10 were tested on six sicklefin lemon sharks and four blacktip reef sharks in October 2016. For the first time, this combined device allowed us to obtain data on the sharks' fine-scale movements over a 24-hour period, including at different stages of the tide. It is also equipped with a galvanic timed release (GTR), which triggers the tag to pop off after the 24-hour recording time. Preliminary data of both species equipped with these as well as the previously used tags show high overlap in their habitat use.

During the first field trip in 2016, the collection of stomach contents and blood samples for stable isotope came to an end. In total, 303 gastric lavages have been conducted and blood from 60 sicklefin lemon and 60 blacktip reef sharks has been collected. Preliminary analysis of prey items and isotopic signatures suggests segregation in the diet between these two species.

## ANALYSIS OF THE IMPACTS AND IMPLICATIONS OF SPATIO-TEMPORAL PERTURBATIONS IN OCEANOGRAPHIC PROPERTIES AROUND THE D'ARROS ST JOSEPH ISLANDS

**AUTHOR:** RYAN WEMBRIDGE
**PRINCIPAL INVESTIGATOR:** RYAN WEMBRIDGE (PLYMOUTH UNIVERSITY)
**FIELD PERSONNEL:** SOSF-DRC STAFF

The D'Arros and St Joseph island ecosystem experiences significant temperature changes due to regional and localised scale processes in the Indian Ocean. Temperature changes around the island and atoll could have a detrimental impact on local coral reef populations, notably coral bleaching, and thus an understanding of the processes throughout the region is critical to the development of effective conservation strategies.

Temperature data were collected at the D'Arros Research Centre over a three-year period from 1 January 2012 to 31 December 2014 via long-term coral monitoring loggers deployed at various points and depths (five, 15 and 25 metres, or approximately 16, 50 and 82 feet) around the study site. Data analysis involved combining the temperature data with various additional secondary data, including remote sensing observations, to evaluate and theorise how each process affected the study site.

The aims of the study are to: identify the basin scale and local oceanographic processes that drive temperature changes around the study site; establish their depth dependences; and identify the impact of temperature change on local coral reef populations.

Research was conducted into the various oceanic and meteorological processes that occur around the study site. The south-west Asian monsoon resulted in a cooling from 30.117 °C (86.21 °F) in May 2012 to 25.501 °C (77.9 °F) in July 2012 (figure 8). The Madden Julian Oscillation has been shown to cause fluctuations of 1 °C (1.8 °F), over timescales of days, while drops occur in the maritime phase (figure 9). Other processes evaluated include El Niño Southern Oscillation, Indian Ocean Dipole and internal waves, each of which are covered more extensively in the final report. The identification of each process to temperature changes is ongoing. Currently, temperature variance spectra graphs are being produced to analyse the direction of the prevailing internal wave field implicated in the differences in coral mortality on either side of D'Arros, as the north side of the island shows much greater temperature variation than the south side does.



Figure 8

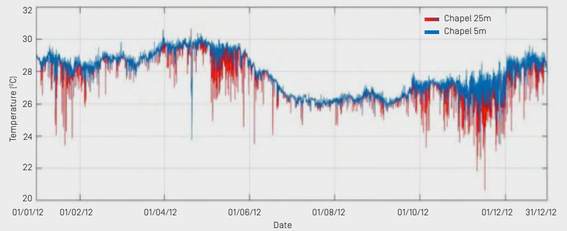
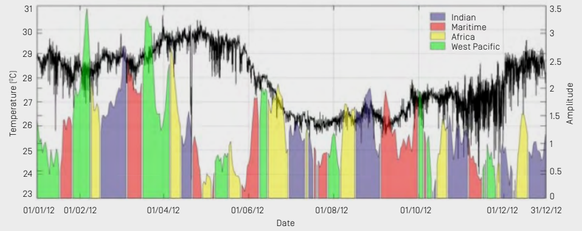



Figure 9




< Figure 8. Temperature data collected from the north of D'Arros Island at five metres (blue) and 25 metres (red) across 2012.

> Figure 9. Temperature data compared to phase and amplitude of the Madden Julian Oscillation (MJO) within the year 2012 north of St Joseph Atoll at five metres. Each peak represents the phase or location of the MJO, with purple representing the Indian Ocean, red indicating Maritime, yellow indicating the Atlantic and green representing the West Pacific.

Photo by Justin Blake

< A pygmy blue whale passes D'Arros Island heading east towards St Joseph Atoll. This is one of the few records of this species in the Seychelles and a first for D'Arros and St Joseph.

## NOTABLE SIGHTING AT THE D'ARROS RESEARCH CENTRE IN 2016

On 28 November at least two blue whales – probably the subspecies pygmy blue whale *Balaenoptera musculus brevicauda* – passed nearby, north of D'Arros Island. Historical whaling data support the occurrence of a Seychelles population of pygmy blue whales, although their current conservation status is unknown. This population probably moves south through the Mozambique Channel to Crozet and Prince Edward islands as part of their annual migration, since their foetal size comparison data suggest a southern hemisphere breeding season, unlike that of the blue whales of the North-western Indian Ocean and Arabian Sea. There is very little literature on these enormous animals, but it is suspected that they winter in the Seychelles.


Photo by Grant Atkinson

# SOSF SHARK EDUCATION CENTRE

ELEANOR YELD HUTCHINGS

save our seas
shark education centre

2016 was the year that the new incarnation of the Save Our Seas Foundation (SOSF) Shark Education Centre really came together. It was a very busy year, full of hard work (and lots of fun), and by the time it drew to a close there was finally an end in sight to all the changes we've been making … and a beginning to ensuring that we get the very best out of these changes in the future.

The annual South African Marine and Coastal Educators Network (MCEN) meeting was held in early January 2016, this time in Hermanus, Western Cape. Educator Paul Millar and assistant educator Zanele Mayiya joined me as we spent the week with a host of other environmental educators. We were all able to share lessons learnt during the course of our work and give examples of activities and lesson plans that we run, and we enjoyed some very interesting field trips. This week is always a time to recharge our batteries, re-connect with colleagues and be re-inspired about what we do and why we do it. It's also a chance to pick up some new tips and tricks, and we spend much of our time frantically writing down ideas to use in our own contexts throughout the coming year. This was also the first year that I served as the Western Cape representative on the national steering committee, so I was able to contribute to the running of this network that is such a vital support to those of us in the field. In addition, the Shark Education Centre hosted the Western Cape Regional MCEN conference in November 2016. It was a very successful day and the positive feedback on the proceedings and the venue was encouraging.

After the national conference in January it was back to the centre in Kalk Bay to plunge headlong into getting 2016 well and truly under way. The first item on the agenda was to get the front room, formerly used as an office, transformed into its new identity as 'Shark Central' – a space for exhibits dedicated to everything about sharks. The talented Chantal Ely, who has painted some of the spectacular murals around the centre, came back on board to create a shark-focused timeline, showcasing just how ancient sharks are. We relocated our fragile bio-facts to custom-made artefact stands that protect them from inquisitive little fingers and set up the other exhibits in the room. Some of these were specially designed to ensure that all the different learning senses, as well as a range of different technologies, are used when engaging with them. A physical egg-case match-up game has little surprise pictures of the baby sharks and rays. A light-up 'wheel of fortune' shows the different shapes of shark teeth and how they compare to human tools, as well as what prey they are designed for. Highly detailed and realistic 3D models of some of the world's most amazing sharks are mounted on the 'Wow!' wall. And then there's the high-tech touch table with a custom-built 'shark game' that was relocated to Shark Central from the foyer.

The cherry on top of the Shark Central cake, however, was most definitely the arrival of the Shark Senses virtual reality exhibit in mid-2016. This was commissioned to enable the user to understand at first hand what it feels like to be a shark in search of its prey and to use all the senses that sharks deploy in their hunts, which are different and more powerful than the senses that humans use every day. The user is positioned inside a life-size model of a shark's head, which enables them to see through the eyes of the shark. They hear, see and smell as a shark would, feel the electrical impulses given off by their prey, and swim through the environment until they have caught it. This was a real breakthrough for us and is very different from anything else on offer anywhere in the world. It has been awarded an internationally acclaimed 2016 Red Dot Award for Communication Design. We are extremely proud of our one-of-a-kind, immersive, cutting-edge interactive. With signage up, everything in place and the door removed, Shark Central was a go!

Also inside the building, the final additions were made to the renovated exhibits. Dial-an-animal is a new, themed, wall-mounted telephone with five 'animals' to call. When called, each one spends a minute or two talking about its life, what it eats, where it lives, etc. – a real hit with our learners! A peep-hole viewing station, with secret drawers containing information about what we can do in our everyday lives to help the oceans and with brochure holders containing information pamphlets, was built around a TV screen showing an animation loop about the threats that sharks are facing. This animation was made especially for the Shark Education Centre. A new artwork, made from Perspex, of a shark swimming through a shoal of sardines was mounted onto the Seashore classroom wall. Then the final signage was installed, some additional touch panels were added, and we were just about ready to go.

Another great achievement of 2016's finishing touches to the renovations was the addition of an outdoor sustainable living courtyard. The back garden, where visiting groups take their snack breaks, has been turned into a showcase

of upcycling, recycling and re-using. The pool is now covered with a removable deck, which serves as a safety device and provides an extra seating area. The walls feature all sorts of ideas for how to use space and create new items from waste: a mural made from glass bottles; two vertical wall gardens with water-wise succulents planted in plastic cool-drink bottles and old coffee sacks; pallet gardens; and painted car-tyre planters.

A seascape mosaic path, made of plastic bottle caps set in clear resin, has been inlaid into the paving stones leading from the back door of the centre to the large new recycling station, from which metal, plastic, paper and glass are collected weekly. As a gesture of goodwill and an incentive to get more people recycling, we have made the station available to the local community to dispose of their recyclables. Also found in the back garden are a smack of jellyfish, a large turtle, an orca, a number of crabs, a baby seal and a hammerhead shark – all made from upcycled trash objects!

The front garden has been entirely replanted with water-wise indigenous plants and is now thriving. Plants that resemble a coral reef were allocated to a special section in preparation for the arrival of one of our most spectacular commissions: a four-metre-long (13-foot), anatomically correct sculpture of a great hammerhead shark made entirely out of recycled tyres. This was created to our specifications by Cape Town artist Jules Armstrong. In pride of place on the corner of Main and Dalebrook roads, the huge shark has become a major visitor attraction. It replaces the sculpture of a white shark, which is now prominently positioned next to the front door, perfectly highlighted against the building's white walls. The blue entrance gate has been replaced with a beautiful custom-designed metal gate featuring sharks and rays, and a welcoming mural has been created on the wall facing the gate. Now learners coming to the centre really do feel welcomed and excited about their experience right from the start!

Looking forward, only a few small additions are still to be made before we can finally say 'We've finished!'

Unfortunately, we also had a major setback in 2016 in the form of a burst geyser in the roof, which flooded the building and caused major damage. Because



Photo by Grant Atkinson

Photo by Michael Scholl

Photo by Grant Atkinson

Photo by Grant Atkinson

Photo by Michael Scholl


Photo by Grant Atkinson

Photo by Grant Atkinson

Photo by Grant Atkinson

Photo by Grant Atkinson

of the complications that accompany heritage status as a listed building in terms of structural repair and methodology, as well as the very old building itself (which has clay bricks and oregon pine floors more than 100 years old, for example), this proved more of a setback than might have been expected. Very fortunately, none of the new exhibits were damaged, but it took six months to fix the structural damage to the building and the work was finished only just in time for the end of the year. Thanks to the completed Ship Classroom (formerly the garage), we were able to shift most of our teaching across and still managed to accommodate our group bookings during this period.

During 2016 more than 60 groups visited the Shark Education Centre for a day out to explore the rock pools and to learn about sharks and what we can do to help conserve our oceans and marine environment. Ranging from Grade R through to Grade 12 and beyond to tertiary level, a total of approximately 2,000 learners from a wide range of economic, social and cultural groups came from all over Cape Town. There were also occasions when learners were not able to visit the centre, and then the education staff went out to the schools, making about one visit every two months during the course of the year.

In addition, we gave many successful public talks to clubs and associations, quite a few of which were followed up with bookings for excursions to the centre. One highlight for all was the collaboration between the Shark Education Centre, Metrorail and the Mary Kihn School for the Hearing Impaired and Deaf, an educational day out to celebrate Mandela Day (held annually in July to honour Nelson Mandela); another was the visit from 10 young people involved in the Pangaea/Pole2Pole Project with Mike Horn, the well-known explorer.

We also continued with our very successful Marine Explorers initiative, operating two six-month programmes in 2016. Once again, these were run with Capricorn Primary School and Muizenberg Junior School, both of which are within easy reach of Muizenberg beach and False Bay. In each programme, 12 Grade 5 learners were introduced to surfing for three months, followed by snorkelling for three months. Our supporters were as generous as ever. Xpression on the Beach sponsored board rental for the programmes. Pisces Dive Centre and

Photos by Daniela Vrlenic

PADI provided a dive instructor and dive master to teach the necessary skills, supervise pool and sea dives, and make sure that by the end of three months every participant was awarded PADI skin diver certification. The University of Cape Town's (UCT) Underwater Club volunteers provided weekly in-water supervision and help that was absolutely critical to the programmes' success. And Reef Wetsuits sold us all the equipment for the programmes at generous rates.

Following on from the Marine Explorers programmes, 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, but because 30 children attended each camp, those who were not able to participate in the Marine Explorers programmes could still be exposed to some of the wonders of our coastline. For three days they were immersed in the best sort of learning – experiential, field-based, active and fun! The residential camps were fully sponsored by the SOSF and the Shark Education Centre, and this meant that those who normally would never have the opportunity to experience activities like these were given a chance to do so. UCT's Underwater Club volunteers joined us on both camps, making our job easier and enriching the experience for the participants.

In the South African school holiday periods we again offered our Holiday Clubs for children aged 6–11 who want to have fun and learn about the ocean. Due to popular demand, in 2016 we offered four of these, one in each holiday. As in the past, they proved extremely popular and were fully booked long in advance, with up to 20 children attending each day. Each Holiday Club lasted for between two and four days and included such activities as shark lessons, rock-pooling, science experiments, beach hunts, coastal walks, harbour tours, arts and crafts, baking and, of course, a lot of swimming! 2016 saw the start of a great collaboration between Shark Spotters and the Shark Education Centre, with Shark Spotters participating and running several activities as part of the Holiday Clubs.

Towards the end of the year we participated once again in the annual Wavescape Film Festival, of which the SOSF is a key sponsor. This year our

Photos by Daniela Vilema

involvement took a slightly different form as, together with the SOSF media team, Shark Spotters and the National Sea Rescue Institute, we played a role in the new event 'Beach Reach', running an activity for young beach-goers to learn more about sharks and the oceans around us and how to look after our marine environment.

We also hosted a scientific mini-conference, the National Underwater Imagery Science workshop, which was attended by about 45 delegates daily over a three-day period. The delegates were scientists from different spheres in South Africa: government, academic, NGO and parastatal. This was a double-edged opportunity: for us to stay linked into the South African marine science network, and to introduce to the scientists the work we are doing. The revamped Shark Education Centre and all its exhibits were a huge hit with all, as were the SOSF magazine and calendar that each delegate received.

A highlight of the year was the visit of Daniela Vilema, environmental communicator with the Darwin Foundation in the Galápagos. She stayed with us for three weeks over November and December, giving us a wonderful opportunity to collaborate, share ideas and learn from one another – and, of course, for the groups that we had during that time to learn a little more about the Galápagos' unique and iconic marine ecosystem. Her visit was timed to coincide with a large variety of our activities: Marine Explorers, Marine Awareness Camp, Holiday Club, Wavescape Film Festival and some school group visits. Collaboration is vital in so many ways, and it was so valuable to us all to be able to work together.

Our small team had a bit of change in 2016 when Heidi Thormählen, our facilities administrator, left at the end of February and was replaced by Claire Metcalf, who arrived at the beginning of May. Claire immediately fitted into the team and has been a wonderful addition.

Looking back over the year, the theme that stands out for me is that of collaboration. There have been so many new collaborative initiatives that we have been part of or have started: we have had visits; we have attended networking meetings; we have collaborated on events. There are longstanding collaborations that continue to run and grow from strength to strength, proving what a powerful tool this can be. And there are new collaborations that we are very excited about starting. One of my favourite quotes from Aristotle, 'The whole is more than the sum of its parts', is key to this, I believe, and will hopefully set the tone for the exciting year to come!

Photo by Eleanor Heidi Hutchings


Photo by Christine Testerman

# SOSF SHARK RESEARCH CENTER

MAHMOOD SHIVJI

save our seas
shark research center

The Save Our Seas Shark Research Center (SOSSRC) is located at Nova Southeastern University, Florida, and housed in the modern research facilities of the Guy Harvey Oceanographic Center.

The SOSSRC staff conduct research using a combination of methods obtained from the disciplines of genetics, genomics and ecology. This integrative, multi-disciplinary approach to research is based on our philosophy that a holistic understanding of species is imperative for implementing the best conservation practices. Our team has a special fondness for and focus on studying sharks and rays that are of conservation concern, but we have also been fortunate to participate in exploring the mysteries of the ocean depths and of the beautifully bizarre, glowing fishes that live in darkness below 500 metres (1,640 feet).

Given the breadth of SOSSRC research, many of our projects can only be done effectively by combining resources and talents from multiple sources. We work in close partnership with the Guy Harvey Research Institute on a wide variety of shark-related projects. The deep-sea fish research, a relatively new theme, is being done in close collaboration with the DEEPEND Program (*http://www.deependconsortium.org/*), which is funded by the Gulf of Mexico Research Initiative. Besides these key programmatic partners, we also collaborate with scientists from around the world.

In addition to our regular research activities, the year 2016 gave the SOSSRC team a wonderful opportunity to welcome back old friends and make new ones by hosting two international students. Ornella Weideli, a PhD student from Switzerland, re-visited us for two months to collect more data about analysing the prey items that she so expertly obtained from the stomachs of live sharks in the Seychelles. Ornella had learnt the DNA analysis techniques of prey identification by working with the SOSSRC's staff in 2015 and she joined us again in 2016 to complete the project. Her work is making a super contribution to understanding the feeding ecology of sharks at the spectacular St Joseph Atoll in the Seychelles.

We were also happy to host another Swiss student, Kerstin Glaus, whose PhD work includes studying the population genomics of the bull shark. Kerstin, who is based at the University of the South Pacific in Fiji, has become quite an expert on bull shark biology, and we are pleased to be collaborating with her on this project to investigate the population dynamics of bull sharks across the globe.

The SOSSRC's primary research made substantial progress in 2016. We focused our efforts on the conservation genetics and genomics of sharks, but also contributed to studies of their migration ecology. Individual projects conducted by staff members and collaborators are described in detail below.

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## I. GLOBAL POPULATION DYNAMICS OF SHARKS

A long-term, multi-species study at the SOSSRC is investigating the genetics and genomics of sharks and rays to understand if and how populations of widespread species are connected; to assess the level of genetic diversity they possess; and to decipher trends in their population sizes. A key issue in the management and conservation of globally distributed shark species that are captured in fisheries is answering a basic question: how many populations of the species are there? This typically refers to identifying how many genetic stocks exist, where they occur, and to what extent they differ genetically from one another.

Why is this important? A fundamental requirement for properly managing exploited marine life is to conserve genetic variation in species. This type of variation is critical for enabling a species to adapt to ongoing changes in the environment, thus giving it a buffer against extinction. In other words, genetic variation allows some individuals in a species to adapt to changes in their environment that might otherwise wipe out other individuals. And the individuals that can adapt because of their genetic make-up will be able to survive, find mates and reproduce, leaving offspring with their genes – the very definition of biological fitness (also known as Darwinian fitness) – and thus ensuring the survival of the species.

Project updates for 2016 on species being investigated by SOSSRC staff are as follows:

### 1. POPULATION DYNAMICS OF TIGER SHARKS

Dr Andrea Bernard, research scientist at the SOSSRC, continued investigating this topic in the magnificent tiger shark *Galeocerdo cuvier*. Previous and ongoing research by scientists from the Guy Harvey Research Institute and SOSSRC on tracking tiger sharks shows the species to be quite at ease undertaking enormously long migrations. It is also well known to have a non-fussy diet (it is not too discriminating when selecting things to eat) and is found in ecosystems that range from shallow coral reef to truly oceanic. This combination of lifestyles suggests that tiger sharks are well equipped to be large-scale ocean wanderers – and the more sea you cover, the more mating opportunities you should encounter, right? This being the case, Andrea investigated the prediction that tiger sharks would be amorously exchanging genes across huge expanses of ocean and therefore would consist of only a single population, or at best very few genetically different ones.

But who says tiger sharks are predictable? By looking at DNA markers from tiger sharks across most of the species' global distribution, Andrea found that tiger shark males have a genetically roving disposition, freely exchanging genes (via mating) across much of the Indo-Pacific. Interestingly, however, there is less exchange between the Indo-Pacific and Atlantic oceans, which suggests there may be a barrier keeping males in these two oceanic regions from routinely crossing over and fraternising with the females. Such a barrier would thus ensure that the populations of these two areas remain genetically different. The picture with tiger shark females is quite different and equally interesting. Even though females grow even bigger than males and therefore seem to be physically capable of just as extensive travels, their DNA markers indicated that they prefer to stay closer to home – or at least if they do wander far away, they return to specific areas to give birth. This behaviour by the females serves to create even more populations of genetically different tiger sharks across their distribution.

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The bottom line revealed by tiger shark DNA is that despite this species' ability to travel enormous distances, its impressive facility to use very different habitats (shallow coastal to deep, open-ocean environments) and its quite unfussy dietary preferences, it still forms many more genetically differentiated populations than anticipated. The management implications are that conserving these different tiger shark genetic pools (i.e., conserving genetic variation) will require paying attention to fishery management practices so that none of the individual populations are extirpated due to inadvertent overfishing. Andrea's work on this and her related findings about tiger sharks were published in 2016 in the journal *Molecular Ecology*.

There is always more to learn, so the work on tiger sharks has not stopped. In 2016, we were able to obtain more tiger shark samples from new global locations. To gain a more refined view of the species' population dynamics, Andrea developed several thousand genome-wide markers to illuminate in even greater spatial detail the global population dynamics and population size history of this important ocean predator.

## 2. POPULATION DYNAMICS OF OCEANIC WHITETIP SHARKS

Cassandra Ruck, a research assistant at the SOSSRC, wrapped up her Master's thesis on a genetic investigation of the enigmatic oceanic whitetip shark *Carcharhinus longimanus*. A globally distributed, open-ocean predator, the oceanic whitetip has suffered significant declines in abundance throughout its range due to high rates of by-catch as well as it being targeted for its large, paddle-like fins. For this reason, the species is listed as globally Vulnerable on the IUCN Red List of Threatened Species, and as Critically Endangered in the north-western Atlantic and western Central Atlantic. Satellite tracking research has suggested that although these large sharks are capable of long-distance movements, they actually exhibit a behaviour known as site fidelity. Simply put, data suggest that individual oceanic whitetip sharks have a home base. While they are certainly capable of roaming the high seas opportunistically searching for food, many of them subsequently return to the same location year after year. These returns may not be specifically motivated by mating, but having a home base has implications for where and with whom individual oceanic whitetips reproduce.

One key driver of animal movements is reproductive opportunities. By analysing DNA from oceanic whitetip sharks throughout their global distribution, Cassandra was able to unravel the biological outcomes of oceanic whitetip reproduction, revealing genetically distinct populations. She learned that there are at least two large genetic stocks – or meta-populations – of oceanic whitetips: one in the western Atlantic and one in the Indo-Pacific. Furthermore, upon combining oceanic whitetip mitochondrial DNA data from other researchers with her own data, Cassandra uncovered fine-scale matrilineal population structure within the western Atlantic Ocean. Specifically, there is a genetic distinction between sharks from the western North Atlantic and sharks from the Caribbean and western South Atlantic (including the Cayman Islands, western Caribbean and Brazil). This was the first indication of fine-scale genetic population structure of a pelagic shark species in the western Atlantic.

The ultimate goal of genetic investigations of threatened species is to guide policy-makers to scientifically sound management decisions. However, it is not every day that a researcher, particularly a graduate student, gets the opportunity to see his or her research directly impact a policy decision. In the summer of 2016, after presenting her research at the American Elasmobranch Society conference in New Orleans, Cassandra was asked to communicate her findings to the National Oceanic and Atmospheric Administration (NOAA) committee in charge of assessing the status of oceanic whitetip sharks for consideration of listing on the US Endangered Species Act (ESA). Of particular note, Cassandra's work indicates there is probably a distinct maternal lineage of oceanic whitetip sharks in the western North Atlantic. NOAA released a status review of the oceanic whitetip in December 2016, citing Cassandra's work multiple times, and ultimately proposed to list the species as Threatened on the ESA.



## 3. POPULATION DYNAMICS OF COMMON ANGEL SHARKS

Cristín Fitzpatrick continued her Master's thesis study on the genetics of the Critically Endangered common angel shark *Squatina squatina*. Although its flattened shape makes it look superficially like a ray, the species is in fact a true shark. Unfortunately, however, it is anything but common. Once widespread in the western North Atlantic, it also ranged from Scandinavia down to the Canary Islands off north-western Africa and into the Mediterranean and Black seas. Now it is rarely found outside the waters around the Canary Islands. Due to its bottom-living nature, it is easily caught both in direct fisheries and as by-catch, leading to severe overfishing through most of its distribution. The common angel shark is in urgent need of conservation measures to prevent its extinction in the wild. Unfortunately, there is little biological and almost no genetic information about it to guide conservation efforts.

Cristín's research focuses on using genetic approaches to understand the population dynamics of the remaining angel sharks in the Canary Islands. In 2016 she investigated the genetic stock structure, diversity and mating systems of the species, including the impact of the massive reduction in its geographic range on the genetic properties of this slow-growing shark. In addition to using a range of genetic markers, Cristín generated the first entire mitochondrial genome DNA sequence of this species, which she is now using for a more detailed investigation into its population history. To date, the genetic data are painting a disturbing picture. Although the DNA from more than 300 individual angel sharks has been examined, almost no genetic diversity has been seen thus far across both mitochondrial and nuclear regions – a very worrying circumstance in terms of the prospects for population resilience in a species whose abundance has already declined so steeply.

Cristín's work is providing an instructive case study on how the genetic properties of an elasmobranch can be affected by a rapid decline in its abundance. Once completed, the research will also give us a baseline for future genetic monitoring of the Canary Islands' population of common angel sharks. We hope it will also guide the way to a more hopeful future for this Critically Endangered species.

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## II. SHARKS AND THEIR GENOMES

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

### 1. SEQUENCING THE ENTIRE WHITE SHARK GENOME

Our goal is to obtain a high-quality DNA sequence of the whole genome (genetic blueprint) of one of the world's most charismatic animals, the white shark *Carcharodon carcharias* – a species that is probably one of the most recognised animals in the world. Our progress on this project made large strides in 2016 when new collaborators from the Monterey Bay Aquarium and California State University, Monterey Bay, joined the research team. Our new sequencing results have further refined the size estimate of the white shark genome, revealing it to be massive – about *four billion, six hundred and thirty million* DNA letters in size, which is about 55% larger than the human genome. This huge amount of DNA added considerable technical and computational challenges to stitching the white shark genome DNA sequences into a coherent assembly. But we now have it.

After first generating a draft assembly of the white shark genome, we followed this up by even more next-generation sequencing and high-powered computational analysis to improve the completeness of the assembly. Our current genome compilation is now of high quality by current technology standards and so far is the largest vertebrate genome sequenced.

To explain this highly technical process further, the next-generation sequencing technologies we used produced millions of short snippets of white shark DNA sequence, which then had to be stitched into much larger sections (called 'contigs' and 'scaffolds') of the shark's genetic code. One way to understand this procedure is to think about these small DNA snippets as analogous to short, incomplete sentences that do not yet make sense when read. These incomplete sentences then have to be assembled into complete, properly formed sentences (i.e., 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). It is only after this process, and much editing, that this 'book' of genome DNA sequences can finally be read to reveal a biological story that provides understanding of the genetic underpinnings of how white sharks function. This genome assembly work, known as bioinformatics, is computationally rather intensive and analytically complex, requiring very powerful computers.

Why the white shark genome is so large, what number and type of genes reside in it, how these genes compare to genes from other species, which genes give sharks their novel immune system and other adaptations, and which genome regions are duplicated are the overriding questions – and the subject of our ongoing investigations. Incremental progress on the work was presented twice in 2016: at the American Society of Ichthyology and Herpetology Conference and at the Plant and Animal Genome Conference. The latest progress update on the research was presented at the inaugural Global Genome Biodiversity Conference in February 2017. The process of sifting through this massive genome to discover white shark genes and their unique characteristics is now in full swing.

### 2. COMPARING SHARK GENES AT THE GENOME SCALE

Our goal for this long-term study is to properly understand the functional genetic features of sharks and rays (elasmobranchs) and what makes them such amazing animals. To get at this functional aspect, the genomics investigation must be done in a comparative context. In this regard, we continued our sequencing of the entire genome of another endangered shark, the iconic great hammerhead. In 2016 we advanced in this work to develop a draft assembly of the great hammerhead's whole genome. This draft is currently undergoing further refinement to produce the best quality genome possible. Once complete, the genomes of the great hammerhead (a cold-blooded species) and the white shark

Photos by Guy Harvey Research Institute

(a warm-blooded species) will be compared in detail, with the goal of discovering which genes they have in common and which genes are unique to each species to explain their very different physiological properties.

In 2016 we also finished the assembly and analysis of all the expressed gene sequences (collectively known as transcriptomes) from four elasmobranchs (white, shortfin mako and great hammerhead sharks and yellow stingray) and three bony fishes (swordfish, and the coral reef species, hogfish and ocean surgeonfish). Comparison of the transcriptomes from these seven species, plus the zebrafish (a well-established biomedical model) revealed some very exciting findings that highlight novel aspects of the elasmobranch immune system. These results were published in the scientific journal, *BMC Genomics*.

Sharks and rays are known to be highly efficient wound healers. It is suspected that they also show a greater resistance to cancers, although this aspect does need further study. These properties are probably tied to their immune systems, which have been fine-tuned over 400 million years of evolution. By comparing genes across several species, we discovered unique modifications in the shark and ray immunity genes that may underlie this rapid wound healing and possibly higher resistance to cancers. Two shark immune genes, *legumain* and *Bag1*, stood out in particular. Both these genes, it turns out, have counterparts in humans, where their overexpression is well known to be associated with a range of cancers. Our research showed that these genes in sharks have not only become modified, but have also undergone evolutionary natural selection. These results are intriguing because out of all the thousands of genes we examined, we found evidence of evolutionary adaptation in these specific shark immunity genes, which just happen also to be involved in promoting cancer in humans.

Although the notion that sharks and rays are more resistant to cancers needs rigorous scientific confirmation, the results of our study raises the enticing prospect that the proteins produced by the *legumain* and *Bag1* genes have modified functions in sharks, including the possibility of actually protecting the animals from acquiring cancer. The *Bag1* gene, for example, codes for a protein that in humans is involved in inhibiting an essential natural process



called ‘programmed cell death’. This is important because the programmed cell death process works to eliminate dysfunctional cells, and one of the hallmarks of cancer is the ability of malignant cells to evade this key natural process. So the shark-specific signature of adaptation found in the *Bag1* gene may indicate an alternative, or modified, role for this important gene – one that could alter its tendency to inhibit programmed cell death in sharks.

The novelty of the shark and ray immune system does not end there. What might explain the rapid wound-healing abilities of elasmobranchs while immersed in seawater with its myriads of bacteria that would be expected to cause infections in open wounds? Our gene comparison study provided further clues. We found that compared to bony fishes, the four species of sharks and ray examined not only had a much higher proportion of genes involved in antibody-mediated immunity, but also that several of the infection immunity-related genes were expressed *only* in the sharks and rays. These findings of a higher proportion of genes involved in adaptive (antibody) immunity function could be a key reason behind the infection-fighting and fast wound-healing abilities of sharks and rays. Of note is that previous studies of the shark immune system have already yielded some surprises in terms of their unique antibody structure, and our new genetic findings further add to the box of biological novelties in this highly successful vertebrate lineage.

The above discoveries are not surprising. After all, the immune system of sharks and rays has been battle-tested and refined over hundreds of millions of years. Genomic-scale approaches to understanding their immunity genes is likely to produce many more exciting discoveries, some of which could even potentially translate into human medical benefit down the road. Now we have another important reason to make sure we don’t lose these marvellous and ecologically critical species to overfishing. We’ve just scratched the surface in terms of learning what these ancient animals can teach us, as well as possibly provide us in terms of direct biomedical benefits.

## III. MIGRATION ECOLOGY OF THE SHORTFIN MAKO SHARK

A shark species that we are focusing a lot of research attention on is the spectacular shortfin mako. This is one of only a handful of shark species that can maintain a body temperature higher than its surrounding water. It is also thought to achieve the fastest swimming speed of any shark. The mako shark is a commercially valuable species in industrial and recreational fisheries worldwide and therefore is rarely released, even when caught incidentally. Unfortunately, mako populations are declining and the species is in need of additional and improved management.

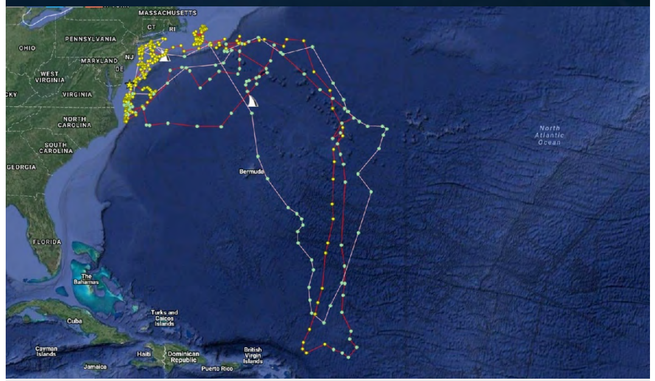
The mako is also an impressive long-distance traveller that can cover thousands of kilometres in a year. Therefore, obtaining a good understanding of mako movements and how they use their three-dimensional, open-ocean home is an important component of formulating science-based management and conservation measures for restoring its populations and preventing overfishing. To this end, the SOSSRC is engaged in a long-term partnership with the Guy Harvey Research Institute to increase biological and ecological knowledge of this species, including its migratory behaviour and its genetic and genomic make-up and function.

Our recently published studies investigating mako migratory behaviour in the western part of the North Atlantic, including the Gulf of Mexico and the Caribbean, revealed new insights about how shortfin makos use their habitat in these environmentally different regions. Earlier data obtained from conventional tagging and recapture studies in the northern parts of the Atlantic suggested that makos moved into the Sargasso Sea during the winter, leading to a hypothesis of a circular migration pattern between the USA, Canada and the Sargasso Sea. Until our studies, very little was known about mako shark movements in the Caribbean and the Gulf of Mexico.

By tracking satellite-tagged individual sharks over extended periods of time, in several cases for over a year, we were able to test these hypothesised migratory pathways and additionally identify areas heavily used by the makos in different seasons. We were also able to examine whether mako sharks differed in their movement patterns in subtropical as opposed to temperate waters.








W. North Atlantic Mako Sharks
© Guy Harvey Research Institute

Our results showed that the previously hypothesised movements of mako sharks in the western North Atlantic, as derived from conventional tagging data, were oversimplified. The satellite tracking revealed that during the winter, movements in the western North Atlantic were much more geographically dispersed, with many sharks also moving far out into pelagic waters during the cooler months (winter and spring) and some even making unexpectedly directed migrations down as far as Venezuela and back without pausing much along the way. In contrast, mako movements in the Gulf of Mexico were much more restricted and displayed no obvious seasonal patterns. In fact, the core usage area here was virtually unchanged year round. These differences indicate that mako shark movements are region-specific. Surprisingly, there was almost no overlap between the movements of mako sharks in the western North Atlantic and the Gulf of Mexico, despite the species' ability to travel very long distances and even though there are no physical barriers between these areas. We also found that mako sharks are truly international rovers, crossing the management jurisdictions of at least 17 countries.

This research will continue over the next several years. The high cost of satellite tags will continue to be a challenge in the near future, but the information being generated has tremendous utility for improving the conservation of the shortfin mako and other important apex marine predators.

## IV. SCIENTIFIC OUTPUT

### 1. JOURNAL PUBLICATIONS

Bernard AM, Feldheim KA, Heithaus MR, Wintner SP, Wetherbee BM, Shivji MS. 2016. Population genetic dynamics of a highly migratory, apex predator shark. *Molecular Ecology* 25: 5312–5329.

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Marra NJ, Wang M, Sun Q, Pavinski Bitar PD, Stanhope MJ, Shivji MS. 2016. Mitochondrial genome of an Atlantic white shark (*Carcharodon carcharias*). *Mitochondrial DNA Part B 1: 717–719. DOI: 10.1080/23802359.2016.1222248*

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Vaudo JJ, Byrne ME, Wetherbee BM, Harvey GM, Shivji MS. 2017. Long-term satellite tracking reveals region-specific movements of a large pelagic predator, the shortfin mako shark, in the western North Atlantic Ocean. *Journal of Applied Ecology. DOI: 10.1111/1365-2664.12852*

### 2. PROFESSIONAL CONFERENCE PRESENTATIONS

Bernard AM, Ruck CL, Richards VP, Gelsleichter JJ, Feldheim KA, Shivji MS. 2016. The genetic connectivity of a euryhaline elasmobranch, the Atlantic stingray (*Dasyatis sabina*). American Elasmobranch Society 32nd Annual Meeting, New Orleans, LA, USA.

Fitzpatrick C, Bernard A, Osaer F, Navaraez K, Shivji M. 2016. A Genetic Exploration in a Last Refuge: The Common Angelshark (*Squatina squatina*) in the Canary Islands. European Elasmobranch Association 20th Annual Meeting, Bristol, UK.

Fitzpatrick C, Bernard A, Osaer F, Navaraez K, Shivji M. 2016. A Genetic Exploration in a Last Refuge: The Common Angelshark (*Squatina squatina*) in the Canary Islands. American Elasmobranch Society 32nd Annual Meeting, New Orleans, LA, USA.

Marra NJ, Wang M, Bitar PP, Sun Q, Komissarov A, O'Brien SJ, Stanhope MJ, Shivji M. 2016. Comparative Genomics and Transcriptomics of Elasmobranchs: Insights into a Primitive Adaptive Immune System. American Elasmobranch Society 32nd Annual Meeting, New Orleans, LA, USA.

Marra NJ, Wang M, Bitar PP, Sun Q, Komissarov A, O'Brien SJ, Shivji M, Stanhope MJ. 2016. Genome Sequence of the White Shark (*Carcharodon carcharias*): Insights into Genome Size Evolution, Life History Characters, and a Primitive Adaptive Immune System. American Elasmobranch Society 32nd Annual Meeting, New Orleans, LA, USA.

Marra NJ, Wang M, Bitar PP, Sun Q, Komissarov A, O'Brien SJ, Shivji M, Stanhope MJ. 2016. Genome Sequence of the White Shark (*Carcharodon carcharias*): Insights into Genome Size Evolution, Life History Characters, and a Primitive Adaptive Immune System. Plant & Animal Genome Conference XXIV, San Diego, CA, USA.

Ruck C, Bernard A, Hazin F, Jabado R, Shivji M. 2016. Global-Scale Genetic Population Structure and Diversity in the Oceanic Whitetip Shark, *Carcharhinus longimanus*. American Elasmobranch Society 32nd Annual Meeting, New Orleans, LA, USA.

# OUR PARTNERS

REPORTS FROM THE SAVE OUR SEAS FOUNDATION
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Photo by Shark Spotters

# SHARK SPOTTERS

## ALISON KOCK & SARAH WARIES

Photo by Sea Shepherd Australia

SHARK SPOTTERS
SAFETY CONSERVATION EDUCATION RESEARCH

Sarah Waries

Alison Kock

Sikweyiya Monwabisi

### SHARK SAFETY

In 2016 we recorded 112 shark sightings at the eight beaches where we operate, which brought to 2,079 the total number of shark sightings since our programme began in November 2004. Although the number of sightings in 2016 was below the annual average of 170, the seasonal trend was similar to that of previous years, with peak sightings in summer and very few in winter. Of the total number of sightings, 53% resulted in the beach being closed while the shark was in close proximity to water-users – a measure that reduces the chance of a negative shark encounter.

The shark exclusion net at Fish Hoek once again proved to be popular among local and international visitors and was deployed when the wind and swell conditions were favourable in spring and summer, seasons that see a peak in both recreational use of the bay and shark activity close inshore. We were able to deploy the net on 108 occasions, retrieving it at the end of each day to limit its impact on the environment and ensure that it is not harmful to marine life.

Our shark spotters are often the first responders at the beaches where we operate and all 40 team members therefore receive training in first aid and emergency management, which is refreshed annually. In addition, all spotters undergo training in marine biology and this year, with the help of the team from the Save Our Seas Shark Education Centre in Kalk Bay, they got a first look at the smaller marine animals found along our rocky shores. All the new spotters also had the opportunity to join the research team in the field to see the white sharks up close at Seal Island.

Highlights in 2016 included being invited to several locations within and outside South Africa to provide assistance and guidance in areas experiencing high human–shark conflict. In January our research manager, Alison Kock, was invited by the Atlantic White Shark Conservancy in the USA to visit Cape Cod, where white sharks have made a big come-back. Then the World Surf League asked several members of our team to visit Jeffreys Bay in the Eastern Cape to assess whether shark spotting could be an effective option during big surf competitions there. In March team members travelled to Plettenberg Bay, this time at the invitation of a local businessman and the municipality, to give advice about the large number of white sharks spending a lot of time very close inshore. An increase in the number of shark incidents at various coastal areas in Australia led to the organisation No Shark Cull inviting project manager Sarah Waries and field manager Monwabisi Sikweyiya to tour several states and share our experience of non-lethal shark safety measures. By sharing knowledge and collaborating with others in this field, we can maximise our growth, improve our service to the community and advocate for non-lethal approaches to shark safety.

Since our visits, a number of our recommendations have been followed up. In Cape Cod, new signage and educational brochures have been developed and emergency networks established. In Western Australia, the local Greens MP has provided funding to Sea Shepherd Australia for 'acute shark attack packs' to be installed in remote locations in the south-west of the state, where a number of shark bites have taken place. These packs were devised in consultation with Shark Spotters and modelled on the shark attack kits we have on our beaches here in Cape Town. In New South Wales, again with support from the local Greens MP as well as an independent councillor, Sea Shepherd Australia conducted a two-week shark-spotting trial at Wategos near Byron Bay, one of the beaches that we identified as having good potential for shark spotting during our visit in March. The trial was successful, with five sharks being seen during the two weeks. A proposal was subsequently sent to the local council to provide funding for shark spotting to take place at selected beaches over the festive season.

### NEW TECHNOLOGY

In 2016 we embraced technology to provide an even better beach experience for all water-users. In June we launched a crowd-funding campaign through Back-a-Buddy to develop a mobile app. Our supporters came out in full force and within a month we reached our funding goal. Then, with the generous support of BulkSms and Two Oceans Aquarium and the collaboration of Taproot Technologies, we launched the app in September. To celebrate this achievement and the exciting new app, we held a launch party at the Earth Fair Market in Tokai, celebrating in style with performances by South African comedian

We strive to protect people and conserve sharks in Cape Town by applying innovative and responsible shark safety solutions, furthering knowledge with applied research, and raising awareness for better understanding.

Rob van Vuuren and music band the Rudimentals. Our app is free to download and provides information about the latest shark sightings, flags and warnings, sightings of other marine animals, ocean conditions and even videos of the surf conditions. This means that people have access to useful information before they even head down to the beach.

Taking the use of technology a step further, at the end of 2016 we partnered with electronic device servicing company weFix, which sponsored two Phantom IV drones together with the relevant training course for two of our shark spotters. The drones are deployed on our two most popular beaches, Muizenberg and Fish Hoek, and when the spotter on look-out duty detects a shark or other marine life in the area, the drones are sent up to confirm the sighting, identify the species and learn more about the animal's behaviour close to shore. They are not used to replace shark spotters because their battery power is limited to 20 minutes and continuous surveillance is needed for shark spotting. So far, the drones have captured unique footage of bronze whaler sharks swimming through schools of fish off Fish Hoek, massive pods of bottlenose dolphins swimming near Muizenberg and the nuts and bolts of *treknet* (purse-seine) fishing.

## RESEARCH AND CONSERVATION

Applied research plays a key role in our awareness and education messages and also ensures that we base our management and safety decisions on reliable scientific information. Dave van Beuningen did an internship with us in 2015 and this year we welcomed him to the full-time position of research technician. In addition, we supported three MSc students from the University of Cape Town: Leigh de Necker, Kristina Loosen and Tamlyn Engelbrecht. Providing support to students not only helps to build capacity for marine research in South Africa, but also enables us to meet our scientific objectives.

Our primary research projects focus on the behavioural ecology of white sharks around Cape Town. 'Sharks on the Urban Edge', an initiative funded by the Save Our Seas Foundation, aims to identify why white sharks use the inshore areas of False Bay. We also collect data to better understand the ecological role that white sharks have on the structure and function of the ecosystem and to monitor the size and structure of the population in the bay over time. The student projects feed into this umbrella initiative by adding pieces to the big puzzle. Leigh's project focused on the diet and trophic interactions of sevengill sharks and white sharks in False Bay; Kristina's investigated the relationship between water temperature, fish presence and shark presence at Fish Hoek and Muizenberg; and Tamlyn's is identifying the spatial ecology of sevengill sharks in South Africa. Leigh's and Kristina's projects are due to run until March 2017, while Tamlyn has successfully upgraded to a PhD and will continue her work until 2019.

In 2016 we conducted 60 field trips in total, tagged white and sevengill sharks and deployed animal-borne cameras on white sharks. We also extended our acoustic array to include four sites along the Atlantic seaboard and west coast – Dunes (Noordhoek), Duiker Island (Hout Bay), Robben Island and Saldanha Bay – that had previously not been covered. We partnered with the BBC and Customised Animal Tracking Solutions to deploy animal-borne cameras on white sharks and were able to fit six individuals with cameras, despite there being little shark activity at Seal Island. In September we joined up with South Africa-born explorer Mike Horn and his Pangaea expedition to tag sharks along the west coast of South Africa. Nine sevengill sharks at Robben Island and six at Saldanha were successfully tagged and some very large skates and rays were caught and released. An extraordinary team of 10 young explorers from all over the world joined us, getting hands-on shark research experience. In addition to meeting our scientific objectives, we used the expedition to raise awareness of sharks to a large international audience.

Through strategic partnerships we can ensure we maximise our resources and outputs, and we continue to build relationships with organisations that share our vision. We are still collaborating with the South African Institute of Aquatic Biodiversity on the Acoustic Tracking Array Platform and with the University of Cape Town's recently established Human–Wildlife Institute. During



Photos by Shark Spotters

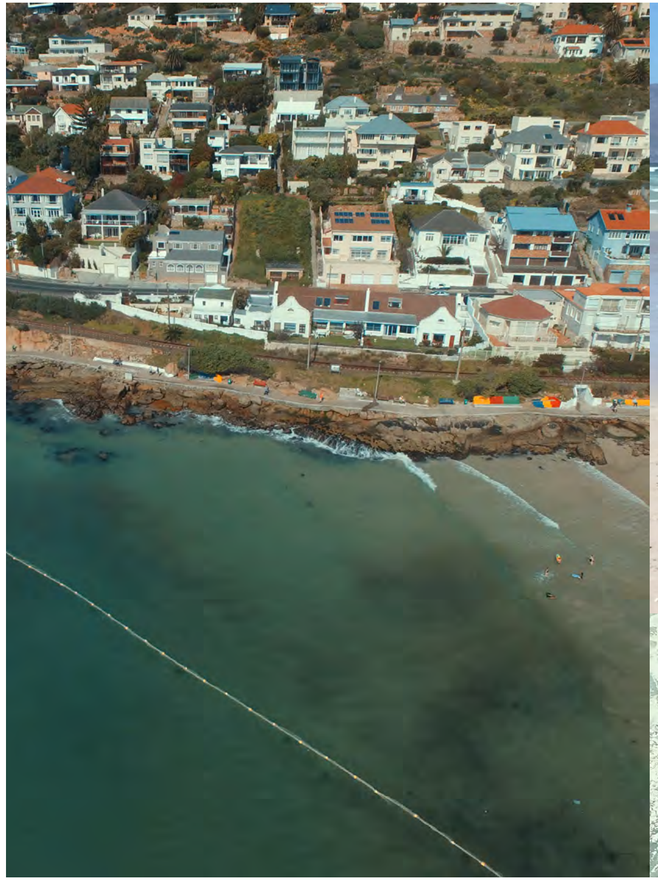


Photo by Shark Spotters


Photo by Sam Lowe

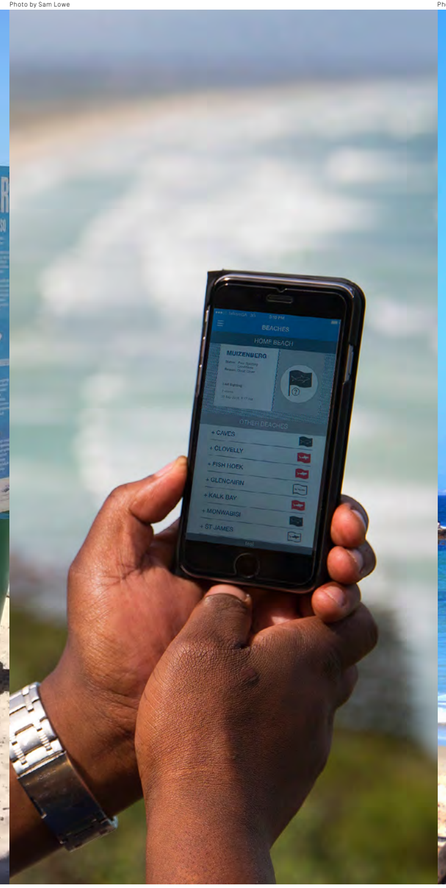



Photo by Leigh de Necker

the year we participated in a number of workshops on ocean conservation, such as the Shark Biodiversity Management Plan workshop hosted by the Department of Environmental Affairs (DEA); a White Shark Research Group meeting in Gansbaai; a pre-CITES workshop hosted by Pew Environment; a Marine Protected Areas Forum hosted by WWF-SA and the DEA; and a workshop on a relatively new conservation strategy using ecological or biological sensitive areas (EBSAs). We also attended a statistical modelling course in Mossel Bay and an animal ethics course at the University of Cape Town to ensure that we apply the current best practice in our research methods.

Members of the public often report sick or injured turtles, sharks and seabirds at our information centre at Muizenberg. The centre's coordinator, Nicole Lockett, previously worked at the bird rehabilitation unit of the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB), so we are now also able to administer initial treatment to stabilise injured seabirds before transporting them to SANCCOB.

## EDUCATION AND AWARENESS

Education and awareness, together with a proactive communication strategy, are a cornerstone of our operations. Our social media reach continues to grow and we have 22,600 followers on Twitter and 13,500 on Facebook. This year we started an Instagram account and can already count 1,700 followers. At the beginning of the year we ran a *#LoveFalseBay* social media campaign, highlighting each week a different species or issue in False Bay to foster a passion among local communities for the unique marine world on our doorstep. The campaign was very well received, with tens of thousands of interactions on Twitter, Facebook and Instagram.

The appointment this year of a coordinator for the information centre, Nicole Lockett, enabled us to expand our education and awareness projects significantly. We also employed a graphic design intern, Imaan Shah from Inscape College, who designed some fun infographics for us. In addition, a science communication course in Stellenbosch attended by Sarah and Alison gave them great insights into ensuring that communication is both engaging and effective.

As well as providing on-site education and awareness on a daily basis, we visited a number of schools and participated in numerous holiday clubs and environmental awareness days. Some of the highlights were partnering with the Save Our Seas Shark Education Centre on its Holiday Club programmes and providing interactive educational exhibitions at an eco-fun day and the Safety Summer Festival hosted by the City of Cape Town, a Beach Reach event hosted by Wavescape, the Chrysalis Blue Flag Beach programme, Camp Cape Town, Dreams to Reality in Muizenberg and the Believe in Schatzi organisation in partnership with Projects Abroad. We also delivered presentations to the Old Mutual Aquatic Club and the St James Retirement Hotel.

We drive a proactive relationship with many different media and featured in no fewer than 110 news articles and 34 TV and radio shows. We also wrote four blogs for the Save Our Seas Foundation and two articles for its magazine, *Save Our Seas*, as well as a feature for *Sharks*, a coffee-table book by photographer Michael Muller. The book is distributed by Taschen Books and some proceeds from the sale of it have been channelled into our research projects.

## FUNDING

As a non-profit organisation, we rely on the generosity of our donors to ensure that we provide our services 365 days of the year. Our main funding is provided by the City of Cape Town and the Save Our Seas Foundation. We were also kindly supported by the Two Oceans Aquarium again this year, with co-sponsorship of the mobile app and logistical support for our field work and through a photography exhibition and auction curated by award-winning photographer Jean Tresfon and presented by comedian and friend Nik Rabinowitz. We continue to rely on Wavescape and its Art Board Project, which not only raises awareness of our oceans, but also supports at least four ocean charities.

We also received generous backing from several individuals, such as Ross Lindsay, a local surfer, and Greg Bertish of True Blue Travel. This year,

with the help of Great White Sport & Surf in Fish Hoek, we welcomed a new sunglasses sponsor, Pure Fishing South Africa, which kindly sponsored 40 pairs of Berkley Fishing polarised sunglasses. Caroline Berry Optometrists sponsored cases to ensure that the sunglasses stay in excellent condition. Lastly, we are now registered as part of the Woolworths MySchool scheme, which means that when people sign up for a Woolworths card they can choose us as a beneficiary and we will earn money every time they shop.

## RECOGNITION AND AWARDS

We were extremely proud to be the recipient of three awards in 2016: a Gold Award for innovation in the Best for Beach Tourism category of the African Responsible Tourism Awards; another Gold in the City of Cape Town Mayor's Portfolio of Urban Sustainability; and a Drowning Prevention Award by Lifesaving South Africa, which went to four of our members (Sarah Waries, Dave van Beuningen, Firdous Henricks and Thandile Xhalabile). In addition, Sarah featured in the City of Cape Town's social media campaign #*CTPeople*, which looks at people making a positive contribution to improving Cape Town, and Alison was recognised for her research and conservation work by *Forbes Woman Africa* and *Maritime Review Africa* magazines.



Photos by Shark Spotters

Photo by Janie Wray

# CETACEA LAB
# THE NORTH COAST CETACEAN SOCIETY

JANIE WRAY & HERMANN MEUTER

Janie Wray

Hermann Meuter

The following summarises our study of two orca populations, humpback and fin whales during the 2016 season.

The North Coast Cetacean Society (NCCS) has been stationed year-round at a remote field station, Cetacea Lab, on Gil Island off the coast of British Columbia, Canada, since 2001. Here we monitor whale activity using a network of radio-linked hydrophones and land-based and boat-based surveys. Until 2008 our efforts to document cetaceans in this region focused mainly on the waters surrounding Gil Island, with occasional boat-based surveys in Caamano Sound. In June 2008, the society expanded its network of radio-linked hydrophones into Caamano Sound by installing a hydrophone station at Rennison Island. Then in 2013, with the permission of the Gitga'at First Nation and funding support from the Save Our Seas Foundation (SOSF), it established a land-based out-camp at the Wall Islets in order to assess more accurately the occurrence and travel patterns of cetaceans.

With plans to build a theodolite station and cabin on Fin Island in early 2017, the NCCS will begin an intensive study of the effects of ambient noise on cetaceans. Our survey efforts will also increase to include Prince Rupert and encompass the entire Great Bear region as far as Bella Bella.

FORWHALES.ORG

## I. METHODS

Between May and October 2016 we employed four different platforms for our research:

- Cetacea Lab, the main research facility on Gil Island
- The Wall, the out-camp on the Wall Islets
- The hydrophone network
- Marine vessel surveys

### CETACEA LAB

From May until the end of October 2016, our trained land-based observers conducted scheduled scans of the entire area viewable from Cetacea Lab, generally beginning at 6 am and finishing at 8 pm. Four to six of these interns rotated on two-hour shifts in order to maintain a constant watch in daylight hours. Each one would keep casual watch during the shift and conduct a five-minute rigorous scan every 15 minutes, documenting all marine mammals seen during the entire shift.

The observers used a combination of naked eye, Nikon 8x40 and 7x50 hand-held binoculars and a tripod-mounted 20–60x80mm Vortex Skyline ED spotting scope to search for marine mammals. When they saw a whale, they noted its direction of travel and its behaviour. Whenever possible, they took photos of the identifiable features of individual whales. For orca these features are on the dorsal fin and dorsal saddle. For fin whales the dorsal fin features are unique, whereas for humpbacks the dorsal fin and fluke patterns are distinctive. The photos were then compared to previously compiled photo-ID catalogues to identify individuals by means of their distinctive markings.

### WALL ISLETS OUT-CAMP

From May until September, observers at the out-camp kept a lookout for marine mammals from a platform nine metres (29 feet) high. From this vantage point they had an unobstructed viewing arc of more than 180 degrees looking north into Caamano Sound, and when conditions were perfect they could see whales at a distance of approximately seven nautical miles. Using Pentax 8x40

Photo by James Hall

Photo by Janie Wray

hand-held binoculars in combination with 25x100mm OberwerkTM tripod-mounted binoculars, the observers conducted a 15-minute rigorous scan every half hour. They kept watch between 6.30 am and 8 pm, with casual observation continuing until 11 pm. The signal from the hydrophone installed at the Wall Islets was monitored 24/7.

When whales were sighted, the observers would stop scanning and focus on tracking them, using the same methods as at Cetacea Lab. When possible, individuals within a group of whales were identified visually by an experienced observer.

## ACOUSTIC MONITORING

This method of research opens an acoustic window into the lives of cetaceans and is ideal for determining how whales use their habitat. The network of seven strategically placed radio-linked hydrophones maintained by Cetacea Lab in the study area enables researchers to monitor for whale activity 24/7 in any weather conditions and provides maximum coverage of the waters surrounding Gil Island. Each hydrophone is positioned at a depth of between 15 and 30 metres (50 and 100 feet). During the 2016 season, the live signals from three of them were continuously sent via radio transmitter to Cetacea Lab, where they were monitored at all times by researchers. The only gaps occurred when the equipment was damaged by adverse weather. We recorded 24 hours a day in order to maintain a permanent register of all acoustic encounters and develop a baseline of ambient noise, while all the cetacean vocalisations we picked up helped to identify groups and behaviour. Researchers determined the general location and movement patterns of vocalising whales by using an audio mixer to detect which hydrophone was transmitting whale sounds. Signals from four of the hydrophones were set up to record at the site and these were processed at a later date (figure 1).

An application for a Mathematics of Information Technology and Complex Systems (MITACS) Postdoctoral Fellowship, in cooperation with our partners WWF-Canada and the Gitga'at First Nation, has been accepted. The postdoctoral researcher, Ben Hendricks, will analyse the acoustic data from the

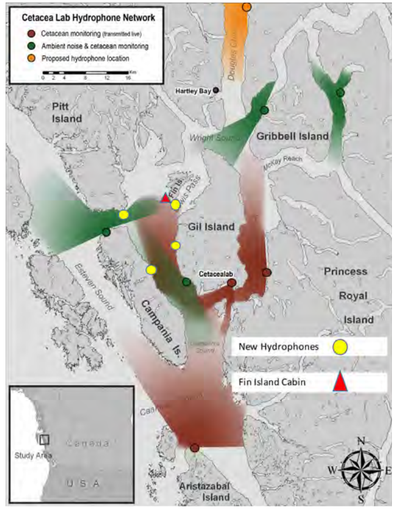



Figure 1

long-baseline arrays of hydrophones to detect, locate and track cetacean (orca, humpback and fin whale) movements based on their vocalisations. Specifically, the project aims to develop tracking algorithms that provide highly accurate results for individual signals. We will use the results to analyse the detailed movement pattern for a broad range of vocalising cetaceans and the effects of ambient noise from shipping traffic on their behaviour, both acoustic and physical.

A permit has been granted to NCCS to build an additional land-based facility in Gitga'at territory in Squally Channel on Fin Island. The camp will operate from May to the end of September and will house two interns and two lead researchers, Dr Eric Keen and Janie Wray. The project will include a theodolite station to pinpoint visually the exact location of a whale, then compare this to the acoustic information available through triangulation of the already existing four hydrophones in place. This project, in conjunction with the hydrophone project described above, will establish the capacity required to fill a gap in our understanding of how cetaceans will respond to increased shipping and acoustic disturbance in the confined waters of the Kitimat Fjord system.

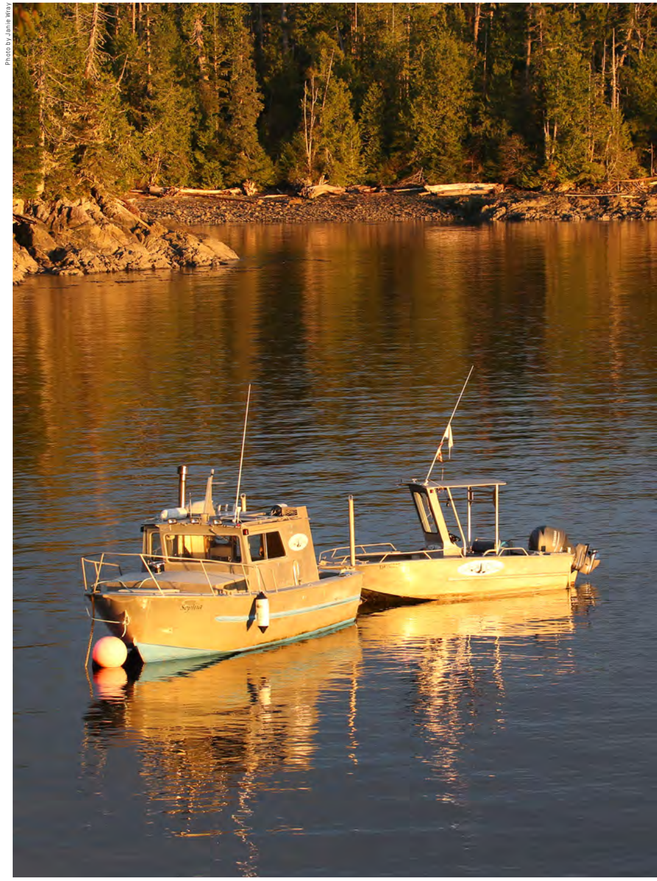


Photo by Janie Wray


Photos by Janie Wray

## MARINE SURVEYS

Boat-based effort took place during daylight hours in the form of dedicated weekly surveys, as well as opportunistically if whales were detected acoustically, visually or from third-party reports. Forty-five surveys were conducted during the season. The vessels used in the surveys were a 20-foot aluminium-welded, centre-console boat or a 26-foot aluminium cabin cruiser.

When conducting surveys, researchers travelled one of several pre-determined routes of the study area in good weather and sea conditions. These routes included the waters of Campania Sound, around Gil Island, the southern section of Estevan Sound and the waters around Gribbell Island. During the survey, researchers periodically stopped and turned off the engine for approximately 15 minutes to scan for whales using the naked eye and Nikon 8x40 hand-held binoculars, and to deploy a portable hydrophone to listen for whales. Marine surveys ended in late September due to weather.

When a whale was encountered, a researcher recorded the time and location and attempted to take identification photographs. The vessel operator positioned the boat approximately 100 metres (325 feet) away from the whale and travelled parallel to it in the same direction while another researcher took identification photos. When possible, individual whales would be identified from memory by lead researcher Janie Wray.

Afterwards, whales were identified by comparing their photograph with previously compiled photo-ID catalogues. In addition to collecting photo data, researchers took notes on a whale's behaviour and direction of travel and the vessel traffic around it. When possible, both scat and prey samples were collected.

Humpback whales are divided into three categories for the purpose of identification. Each fluke is assigned a number in conjunction with the letters BC (British Columbia) and then another letter that reflects the amount of pigment seen on the fluke: X for black, Y for white and black and Z for almost all white.

For parts of the 2016 season, boat-based photo identification of whales was possible thanks to the efforts of the Gitga'at First Nation Coastal Guardian Watchmen stationed on Rennison Island.



< Resident orca
Y Transient orca
Y Offshore orca

Photos by Janie Wray

## II. STUDY SPECIES

The cetaceans we observe are orcas – resident, transient and offshore – and two species of baleen whales: humpback and fin. Both baleen species demonstrate strong site fidelity to this region, but humpbacks have made the stronger return to the north coast of British Columbia.

## ORCA

In our research area there are three orca ecotypes: resident, transient (also known as Bigg's) and offshore. They differ in terms of social structure, diet and behaviour. We see transient and resident orcas most frequently in our research area and in the past 15 years have sighted offshore orcas only four times; three of those sightings occurred in 2015. We saw no offshore orcas in 2016.

### RESIDENT ORCAS

Resident orcas exhibit extremely strong and complex family bonds. The relationship between mother and son is particularly strong; males will never leave their mother during her lifetime. Daughters stay with their mother until they become the matriarchs of their own families. Because of this separation, every family has a distinct dialect that enables us to identify it simply by listening. The primary food source for residents is Chinook salmon. During a feeding event the older females share their catch with calves and juveniles. Males are typically seen feeding at a distance, though they often share their catch with their mothers.

The northern resident population comprises three clans, each with its own unique set of call types; in other words, its own language. Within each clan there is a number of pods that share certain call types and different dialects when using these calls. NCCS has observed five social events at which members from different clans were present. During these encounters the whales were extremely excited and very vocal, and it is possible that this is when mating occurs. Members of the same clan will never 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

Photo by Janie Wray

Photo by Janie Wray

their language and is therefore not related to them. Genetic work has supported this theory of mating outside the clan and has revealed that only the oldest males are fathers. Most of the resident orcas observed in the 2016 season appeared healthy except for one male, I46, which on three occasions in 2015 was seen at a great distance from his family and is now believed to have died. In early 2017 a southern resident orca known as 'Granny' also passed away. She was believed to be 100 years old!

### TRANSIENT ORCAS

Often referred to as the 'wolves of the sea', transient orcas hunt marine mammals, including other whales, and have thus earned orcas the alternative name of 'killer whale'. This population travels mostly in silence to avoid detection by other species, so there is little opportunity for a specific dialect to be passed on to family members. When we hear transient orca call types over the hydrophone, we know which population we are recording but cannot determine the family group by distinct acoustic call types.

Our recordings have revealed that transient orcas are very vocal after a successful hunt. In our research area they prey mainly on Dall's porpoises, then on seals and sea lions. There has also been a documented kill of an elephant seal. We have witnessed two attacks on young humpbacks, both of which were unsuccessful. Many humpback calves arrived with teeth rake marks on their fluke, indicating a transient attack earlier in the season, perhaps during the migration. Transient orca numbers were lower in 2016 than in other seasons, possibly due to an increase in the number of humpback whales seen and the observed interference of humpbacks when transient orcas were hunting other marine mammals, especially sea lions, which are known to be companions of young humpbacks. In September 2016 several sea lions were killed at a known sea lion haul-out close to Cetacea Lab. Four transient orcas began this dramatic hunt and by the end of it more than 16 were present and feeding.

The family structure of transient orcas is much more fluid than that of residents, with families breaking apart and joining other families for periods of time. As in the residents' structure, however, the relationship between a mother and her oldest son lasts a lifetime.

### OFFSHORE ORCAS

Relatively little is known about this population as it stays mostly near the continental shelf. We do know, however, that these orcas feed on sharks and large bottom fish such as halibut. In 2015 we sighted offshores for the second time in our 15 years of research and saw the same family three times that season. During each event we were able to take identification photos and make acoustic recordings of its particular dialect, which is very different from that of transients or residents. We saw no offshores in 2016.

## HUMPBACK WHALE

The return of humpbacks to our research area has been dramatic and we see these whales on a daily basis during the field season. Thanks to this high abundance, we have been able to gain great insight into the social behaviour and habitat use of this robust cetacean. It is a migratory species, feeding from spring until fall in high-latitude, nutrient-rich waters. In early winter humpbacks migrate to subtropical and tropical waters for calving and breeding, and do not feed during this winter migration.

Every fall we know that one by one the whales will slowly begin their annual migration south. The first to leave are the mothers and calves, then sub-adults, 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 themselves during the rigours of the long migration, then giving birth to and nursing their calves. There is no food available for these mothers in the calving grounds and they will not forage for their next meal until they travel northwards again, this time with a calf at their side.

Some of our humpback whales migrate to a group of islands east of Japan; others make the long voyage to Baja and Hawaii. The migrations take between four and eight weeks and the estimated distance each way is more than

4,800 kilometres (3,000 miles), which is one of the longest known migrations of any mammal. Now, however, we have reports of humpback whales that do not migrate at all, but remain in this area for the entire year.

Historically, humpback whales were hunted commercially from the late 1800s until 1965, during which period an estimated 28,000 were caught in the North Pacific. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) proposed that the population be listed as Threatened, based on the low observed density of the species in British Columbia. COSEWIC recently reassessed this status and the increase in population has led to the humpback being downlisted to Special Concern. This reassessment is being challenged by a number of researchers.

### 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) and herring, capelin and other shoaling fish, along with squid and copepods. Like other baleen whales, it strains its food from the water through baleen plates.

Large numbers of fin whales were hunted in British Columbia, with more than 7,600 taken by coastal whaling stations between 1905 and 1967, and thousands more taken by pelagic whalers until the 1970s. In British Columbia, the species is typically found in exposed waters off western Vancouver Island and in Queen Charlotte Sound, Hecate Strait and Dixon Entrance. From sightings and acoustic detections, researchers estimate that this population is currently 50% below the numbers of 60–90 years ago and the fin whale has consequently been designated as Threatened by both COSEWIC (2005) and the Species at Risk Act (SARA).

Fin whales were first documented by NCCS in 2006. Since then, increasingly frequent sightings suggest that the species is beginning to re-occupy this area, which has been highlighted as an important location for it and probably represents unique near-shore fin whale habitat on Canada's Pacific Coast. The whales' return raises questions about the current and past importance of coastal fjords for this species, which was considered to typically prefer an offshore

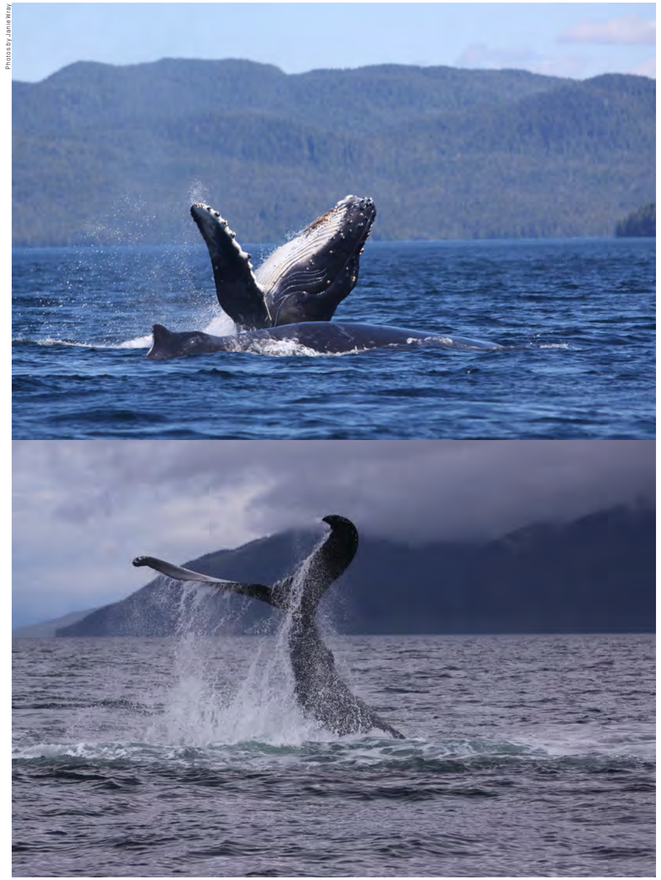


Photo by Jane Wray

habitat. As fin whale populations continue to recover, we will determine to what extent they may rely on this coastal habitat – and the potential importance of these whales to the ecological function of British Columbia's north coast.

### III. SUMMARY OF SIGHTINGS 2016

A total of 205 individual humpback whales were identified in 2016, of which 43 were documented as new arrivals to the area. Only 12 mother-and-calf groups were sighted, which is low. However, all the calves appeared to be very healthy and energetic. This year we noted an increase in the number of calves that displayed rake marks from attacks by transient killer whales. For the first time we saw multiple mother-and-calf groups interacting and travelling together. An increase in female escorts staying with a humpback calf at the surface while its mother fed at depth was also observed. This has never been documented along the feeding grounds in northern British Columbia and may be a result of the increased population and the need to protect calves from transient orca attacks. This increase and the possibility that humpback calves are now a target for transient orcas need further study and will be a project for the 2017 season.

The resident population of humpback whales in our region now stands at more than 436. There has been a steady increase since 2004, when this population comprised only 42 whales. In September 2016, no fewer than 75 individual humpbacks were identified during a single survey day – almost double the entire population in 2004! Moreover, Cetacea Lab and the dedicated lead researchers

Figure 2
There has been a significant rise in the number of humpback and fin whales seen along the coast of British Columbia. Of all areas, though, it is the waters surrounding Cetacea Lab that have witnessed the most significant increase. This may be due in part to the efforts of the facility's research staff, which is why NCCS will broaden its research efforts to other known cetacean hotspots along the north coast of British Columbia.

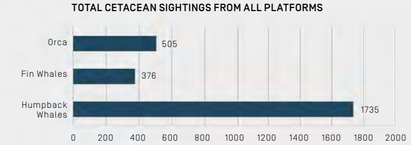



Figure 3
A matriline is a group of orcas that are related to each other and travel as a family group, which may vary in size from four to 15 members. Sightings of resident orcas occurred from May to July, coinciding with the highest abundance of Chinook salmon, the main component of their diet, in the region. Transient orcas can be seen at any time of year.

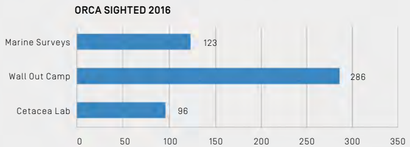



Figure 4
We had an unusually high occurrence of humpback encounters during marine mammal surveys in April and May, with a steady climb and a peak in September.

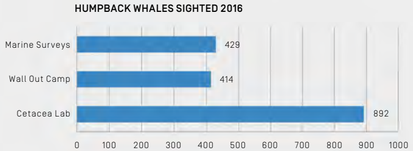



Figure 5
Fin whale sightings increased from 223 in 2015 to 376 in 2016.

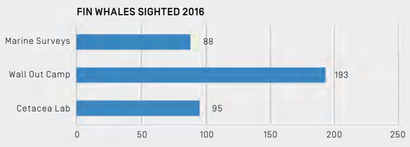
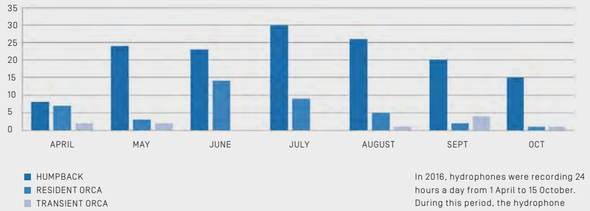



Photo by Jane Wray

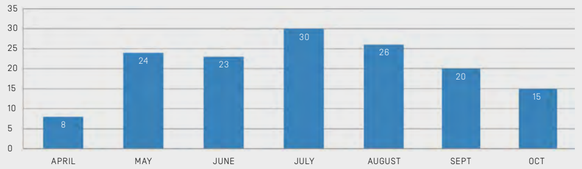
## HYDROPHONES

**CETACEAN VOCAL ACTIVITIES**
**DAYS DETECTED**




In 2016, hydrophones were recording 24 hours a day from 1 April to 15 October. During this period, the hydrophone network made acoustic recordings of humpback whales on 146 days, and of orcas on 59 days.

**HUMPBACK BNF AND SOCIAL CALLS**
**DAYS DETECTED**




The hydrophone network also records calls made by humpback whales while bubble net feeding (BNF).

and interns have documented the largest catalogue of the seasonal resident humpback whale population along the entire coast of British Columbia (figures 2–5).

### HUMPBACK WHALE BEHAVIOUR

As populations of humpback whales recover in Gitga'at territory, patterns in their behaviour and habitat use have become better understood. Yet the more we know about these whales, the more we realise how much we still have to learn. Below we summarise some key points about different behaviours, as well as some questions we hope to answer in the future.

#### FORAGING

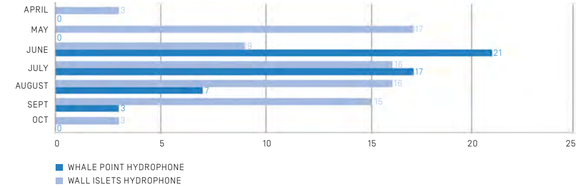
Humpback whales within our research region are often observed bubble net feeding in groups of up to 14 individuals. During these feeding events we identify each member of the group, as well the GPS location of the event. Whenever possible, we collect prey samples while observing the whales feeding to determine the composition of their diet. This is accomplished using a fine-meshed pool skimmer attached to a two-metre (six-foot) pole. Faecal matter is collected in much the same way in order to find out what the whales have been eating and other health-related information. All prey samples are collected and sent to the Department of Fisheries and Oceans for analysis, which has revealed that herring and krill are the humpbacks' primary food sources.

This information has enabled us to understand the importance of geography for bubble net feeding (figure 6). The whales appear to use the slope of deep fjord systems for this technique. They often follow the shoreline and seem to have specific hotspots where they regularly feed. In early spring to mid-summer, most bubble net feeding takes place near the Wall Islets out-camp (in yellow) in groups of between six and 13 individuals. Later in summer and fall the whales move further into the fjords and bubble net feed in smaller groups of between two and six individuals.

From our photo-identification work we have been able to establish that the same nine humpbacks have been practising this feeding behaviour together for the past decade or more. We have observed others trying to join the group


Figure 6

Figure 7 **HUMPBACK BUBBLE NET FEEDING DAYS PER MONTH**




and some have been accepted, others not. We are not sure what the criteria are to join, but it is obvious that when a humpback fails the test the entire group reacts with tonal blows and robust behaviour until the would-be recruit departs. More interestingly, bubble net feeding appears to be a behaviour that is learnt and passed on. Now individuals are separating from the main group and developing their own smaller bubble net feeding groups.

When bubble net feeding, humpback whales use a distinct call type. All feeding calls are recorded by the hydrophone network and added to a database that identifies individual whales. Using this library of call types and individual humpback identifications, NCCS will eventually have an acoustic fingerprint for every whale that participates in bubble net feeding. This will enable us to analyse whether this feeding call is changing over time and between groups, which would demonstrate a dialect particular to individual whales and feeding groups (figure 7).

Humpback whales that do not participate in bubble net feeding use other foraging techniques, such as lunge feeding, tail flicking and feeding at depth. Bubble net feeding has not been documented south of the central coast and is quite specific to our region and north to Alaska.

#### RESTING

Humpback whales rest by floating on the surface, a behaviour seen only in cooler waters. We have observed them resting at all hours of the day and close to shore, in the middle of channels or in bays. Mothers and calves are often seen resting side by side for up to six hours at a time. This is when they are vulnerable to ship strikes. When resting whales are encountered, we document the size and type of the group, the length of time spent resting and the reaction of the whale to any acoustic or physical disturbance.

#### SOCIAL DYNAMICS AND ROBUST BEHAVIOUR

In early fall we witness a change from cooperative feeding to more robust types of behaviour such as breaching and tail or pectoral slaps. At this time of year whales have replenished the fat cells that had been depleted during their long

Photo by Janie Wray

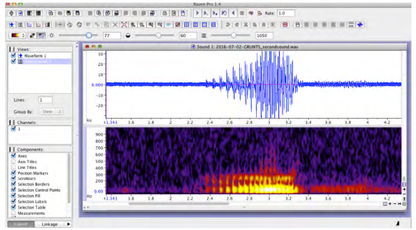


Figure 8
An example
of a humpback
whale 'grunt'.

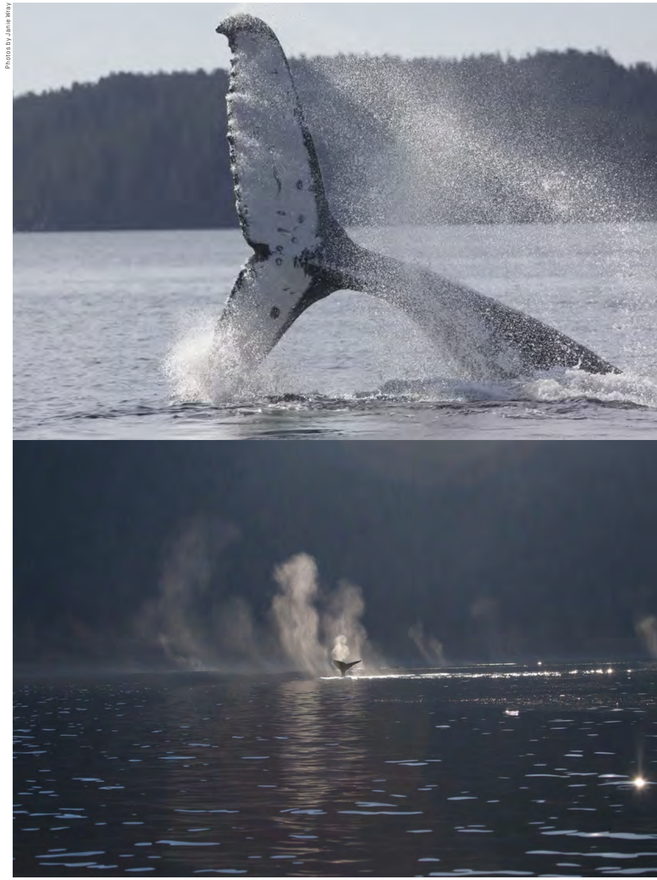
winter fast and migration. With this renewed energy they become much more active and social when not feeding. Males form posturing groups and compete to escort a female, sometimes becoming quite aggressive towards one another. On many occasions we have seen a group dive together and resurface to the sound of tonal blows echoing along the channels and with fresh, bloody scratches along their bodies after having battled each other under water. On the surface they perform tail and pectoral slaps and breach very close to one another.

When witnessing these social events, we record the group size and the sex and life stage (adult, juvenile or calf) of each whale taking part. When whales resurface after a long dive, we take photographs to check for any fresh scratch marks and to look for old scars that would indicate an injury from a net entanglement or boat strike. We also document and photograph all surface behaviour. If we encounter a lone whale and there are skin samples on the surface, we collect them for analysis to determine the animal's sex. It is also at this time of year that the males begin to sing their beautiful songs at night.

Although humpback whales are extremely social and are often seen in the company of other whales, there are some exceptional individuals that have chosen a more solitary lifestyle. Our curiosity about the social bonds of this species has initiated a 10-year research project. We have come to understand that humpback whale relationships evolve through a series of events that allow individuals to choose companions based on gender, the time of year, behaviour and location. These social connections do not necessarily relate to a family bond. In the coming years we hope to obtain a better understanding of the complicated and intimate relationships shared by the North Pacific population of humpback whales.

There has been another interesting observation with regard to the night-time vocal activity of humpback whales in our research area. We are in the process of producing a library of these call types, with the goal of interpreting them and determining whether they are related to feeding or locating their prey source (figure 8).

Photo by Janie Wray



## IV. FOCAL FOLLOW SAMPLING OF HUMPBACK AND FIN WHALES IN THE KITIMAT FJORD SYSTEM

This research was a team effort between Eric Keen and NCCS and will soon be published in two peer-reviewed papers.

Overall, oceanographic associations were better modelled for fin whales than for humpbacks. For all three humpback modelling exercises (food, oceanography and site loyalty), explanatory power was relatively poor. This is probably due to the fact that humpbacks used the entire study area, spanning wide ranges in oceanographic conditions, and their geographic concentration shifted substantially month to month. Fin whales, in contrast, practised a spatially confined and seasonally stable use of certain channels within the fjord system (figure 9).

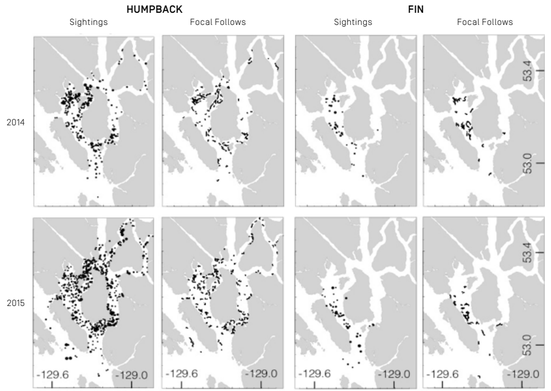



Figure 9
Locations of whale sightings (all effort) and focal follows in 2014 and 2015 for humpback and fin whales.

### HUMPBACK WHALE

Despite highly variable results in humpback models, their correlation to certain ocean features, in particular the depths of the thermocline and mixed layer, was unexpectedly strong. There was also a consistent but weaker relationship with sea-floor depth. Humpback associations with shallow thermocline and mixed layer were apparent in all relevant analyses, for both total backscatter and patch depth. Of all features sampled, these two related variables have the greatest potential as an oceanographic cue for humpback prey (figures 10–12).

This whale–thermocline–prey relationship, in turn, offers the best available explanation of the 'whale wave', a curious pattern of this fjord system's humpbacks in which whale aggregation shifts from outer channels to inner channels as summer turns to fall. As storm energy and katabatic winds strengthen in late summer, mixing begins in the exposed outer channels and progressively encroaches into the protected channels. It may be a coincidence that the timing of this process aligns with the shift in humpback habitat use, but this is unlikely given the results of our backscatter~oceanography GAMs. It is safe to suggest that the onset of autumn weather influences the volume and depth of krill patches, which in turn informs humpback distribution. In this scenario, the whale–thermocline–prey relationship would be further coupled to regional meteorology and fjord circulation processes, both of which are susceptible to the inter-annual, decadal and longer-term dynamics of global climate (figures 13–14).

Furthermore, our finding that humpbacks prefer strong salinity gradients aligns with other studies about the importance of tidal fronts and island wake systems to foraging humpbacks. The only significant difference between feeding and non-feeding humpback whales related to the surface salinity gradient ($p = 0.022$); feeding humpbacks preferred a steeper gradient. There was also a consistent relationship to sea-floor depth when humpback whales were bubble net feeding (the topic of the next paper). With regard to lunge feeding or feeding at depth, humpback associations with shallow thermocline and mixed layer were apparent for both total backscatter and patch depth (figure 15).



Figure 10

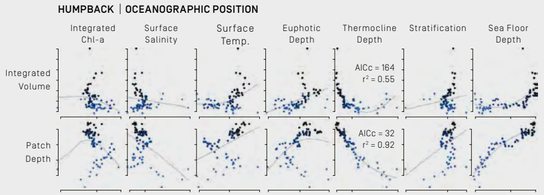



Figure 11

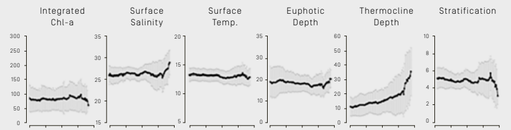



Figure 12

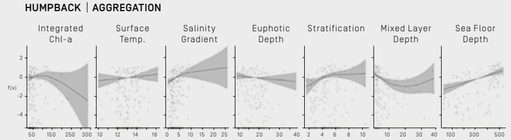



Figure 13

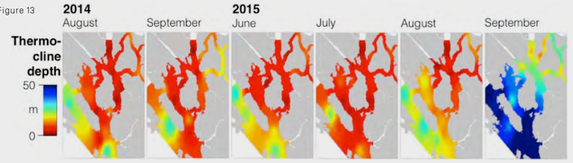
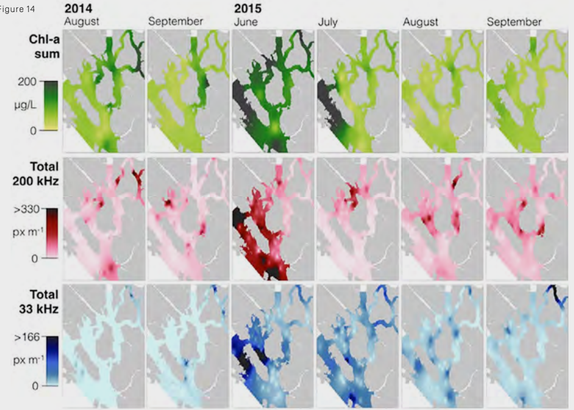
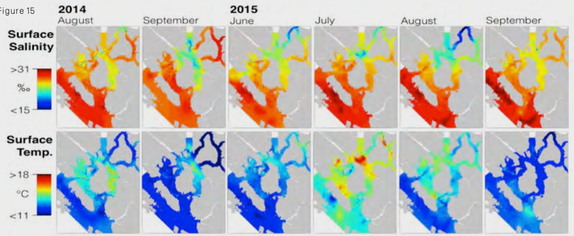



Figure 14




Measurements of marine algae (Chl-a sum, top), krill (inferred from 200 kHz backscatter, middle) and small schooling fish (inferred from 33 kHz backscatter, bottom).

Figure 15



## FIN WHALE

Fin whales were found in deeper waters (446 ± 132 metres) than were humpbacks (355 ± 158 metres), with less sea-floor slope, higher salinity, low chlorophyll-a levels, a deeper euphotic zone and less stratification. Fin whales position themselves more strongly with respect to deep prey patches than to high integrated volume, and this association with deep patches was stronger than that for humpbacks. Keen (Thresholds) discussed the unexpectedness of this pattern based on current optimal foraging theory. Position curve correlation analysis (PCCA) showed that fin whale positioning to high-volume prey patches was poorly correlated to their oceanographic positioning, with the weak exception of sea-floor depth. In stark contrast were PCCA results for positioning to deep patches, which was strongly correlated to their positioning to all oceanographic features except thermocline. This differs diametrically from the humpback PCCA for patch depth. All of these patterns make sense given the relationships found in oceanographic GAMs of patch depth, with the possible exception of surface temperature. To the extent that deep patches are a preferred prey feature for fin whales, several oceanographic cues are available to abet that association (figures 16–18).

Fin whale habitat is distinguishable from the remainder of the fjord system by high backscatter volume, deep patch depth, deep sea-floor depth and moderate stratification, and simple visual review suggests that the channels used by fin whales also have relatively deep euphotic zones and low chlorophyll-a levels. The alignment of these findings – fin whale positioning to prey preferences and to oceanography, those prey features as functions of oceanography, and fin whale habitat description based on these same features of prey and oceanography – points to the viability of site loyalty as a habitat use strategy for fin whales within this fjord system and explains the high rank of site loyalty models over food- and environment-association models.

These findings may explain why fin whales use only a subset of channels within the Kitimat Fjord System, but there remains evidence that within those channels, fin whales are excellent at positioning themselves among the deepest prey patches. That is, site loyalty explains fin whale habitat use on the scale of



Figure 16 **FIN | FEED**

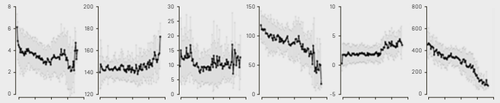


Figure 17 **FIN | OCEANOGRAPHIC POSITION**

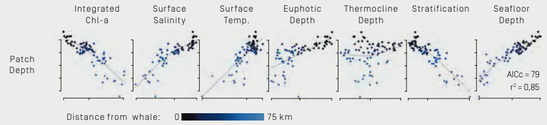



Figure 18 **FIN | AGGREGATION**

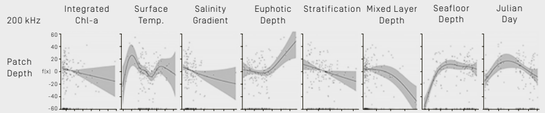



Photo by Janie Wray

Photo by Janie Wray

Photo by Janie Wray



the fjord system, but on the smaller scale of primary fin whale habitat the species exhibits impressive prey associations that are probably achieved by attending to oceanographic cues. The majority of fin whale sightings were in Squally Channel, the location of the new hydrophone network and the site of the new facility being built on Fin Island.

### V. ENTANGLEMENTS AND SHIP STRIKES

From September to November 2016 we had three reports of humpback whales being entangled in fish farm anchoring systems near Klemtu. In the first incident the whale was rescued, but in the second the whale was unfortunately found dead close by. In the third, on 29 November, a dead juvenile humpback was found entangled in a fish farm anchorage.

When another whale was reported to be entangled, this time in fishing gear, we all reacted as quickly as possible, but a private citizen attempted to disentangle the whale himself. Although this had been done with the best of intentions, the whale apparently still had rope wound around its body and the trailing cork line had been cut off, which made rescue of this whale uncertain. We have not seen it again.

There were also two reports of serious collisions between marine vessels and humpback whales. In both cases we searched for the potentially injured humpback, and in one were able to find and identify the whale.

All these incidents illustrate how important it is to educate the public about what steps should be taken when they see a whale that is in difficulties. Proper rescue protocols are urgently needed for this stretch of the coast and NCCS is already working with other organisations to find solutions to these tragic occurrences.

### VI. FRIENDLIES

This is a new term associated with humpback whales along the coast of British Columbia. For years, humpbacks showed little interest in boats and tourists. The situation has now changed dramatically, to the point that literature needs to be made available to boaters to guide them as to how to react when a humpback whale decides to 'people watch'. The experience may be extremely rewarding for some, but it can also be frightening when a 15-metre (50-foot) whale decides to float under or beside your boat for a considerable length of time. We are in the process of providing boaters with literature about this topic, as well as other protocols to follow when in the presence of whales and other marine mammals.

We would like to thank the Save Our Seas Foundation for its generous support for the North Coast Cetacean Society and the team of interns and researchers who help protect this coast for whales.

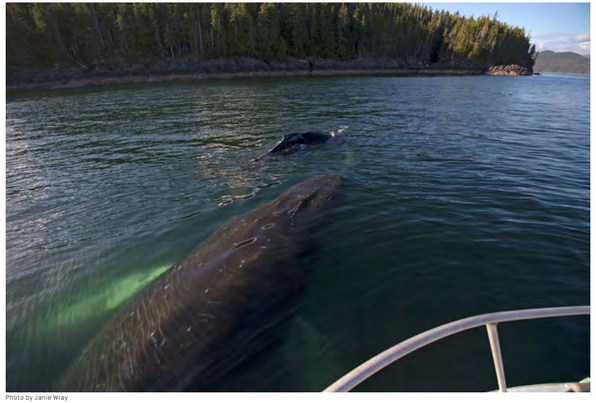


Photo by Janie Wray

# THE MANTA TRUST

## GUY STEVENS

Photo by Guy Stevens © Manta Trust

Guy Stevens

In September 2016, thanks to a concerted effort by the Manta Trust, our partners and collaborators, mobulid scientists, funders and many other supporters, we achieved a listing of all species of mobula rays on Appendix II at the 17th Meeting of the Conference of Parties (CoP17) to the Convention of International Trade in Endangered Species (CITES). Of the participating countries, 83% voted in support of the proposal.

This listing means that international trade in mobula rays and their products is now regulated. The export and import of mobula products is only permitted if strict measures are applied and if the take is not detrimental to the population. With fishery being the key threat to these species, particularly the targeted fishery for their gill plates for use in the Asian medicinal trade, this is an incredible achievement. Mobula rays now receive the same level of protection through CITES as their larger cousins, the manta rays, which were added to CITES's Appendix II in 2013.

Many of those who witnessed the attainment of this important conservation goal for mobula rays only did so because they were following the proceedings of CITES CoP17 in Johannesburg, South Africa. For the many committed to the proposal, however, the conference represented the culmination of a huge amount of effort over the course of the preceding three years. The often thankless work that goes into the run-up to such an important convention usually goes unnoticed. Three years ago, when manta rays received greater protection by being listed on CITES's Appendix II, it was clear that the same level of protection was required for the equally vulnerable mobula rays. The latter face the same threats from targeted and by-catch fisheries as their larger cousins do, yet the scientific evidence required to support such a listing was weak.

Because of its global network and affiliated projects, the Manta Trust was the ideal organisation to gather such evidence, so we set about the task in earnest. Through our contacts and projects around the world we were able to gather the latest data, both published and grey literature, that provide insights into the biology, ecology, threats, decline and conservation status of these poorly understood rays. Our efforts aided the proposal that resulted in the successful listing of all nine mobula species on both appendices of the Convention on the Conservation of Migratory Species (CMS) in 2014, an important milestone on the way to achieving the CITES listing.

The Manta Trust helped to secure a record number of countries (more than 50) to co-sponsor or support the mobula ray and shark CITES proposals. During 2016 we engaged with governments from around the world – such as Indonesia, India, Sri Lanka, the Philippines and Peru – in numerous pre-CITES workshops with our partner NGOs and collaborators, all with the aim of educating the key decision-makers and raising awareness for mobulid conservation. The trust's chief executive, Guy Stevens, and associate director, Josh Stewart, defended the mobula ray proposal as the scientific experts at the Food and Agriculture Organization (FAO) panel meeting mid-year in Rome, Italy. We developed materials for the proposal, such as the 'Devils in Distress' brochure and fact sheets, which we translated into numerous languages, to communicate to stakeholders and the general public the current status of mobulas and the need for action to protect them.

The Manta Trust also helped to facilitate a global summit on sharks and rays at the Four Seasons Resort Maldives on Landaa Giraavaru, which was held before the CITES convention and was hosted by the Maldivian government. From around the world government representatives gathered at this summit for pan-global discussions to ensure sharks and rays were a priority at CITES CoP17.

As part of the Manta Trust's media work, our communications manager spearheaded a conservation media campaign *#LOVEminiMantas* to support the mobula ray proposal at CoP17. The main focus of the campaign was a 360° virtual reality (360 VR) film made in the Azores. The film told the story of Ana Sobral and her love for the island of Santa Maria and the mobulas that visit its waters. The big idea was to take the CITES delegates, who are typically non-divers and know little about marine conservation issues, on an underwater VR encounter with Ana and the rays she studies. The film was to serve as a novel and exciting ice-breaker to make sure that delegates became engaged with the mobula proposal and gave it the attention it deserved.

Photo by Danny Copeland

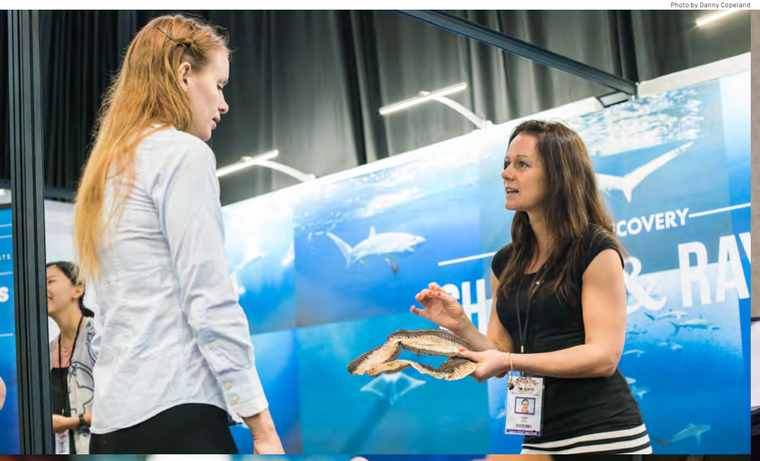


Photo by Danny Copeland

Photo by Guy Stevens




The 360 VR campaign was a huge success. More than 350 delegates from 56 of the 152 nations in attendance came to view the film, titled *The Mini Mantas of Maria*. Although it is difficult to quantify the role the film played in securing the CITES victory for mobulas, the consensus among colleagues from the Pew Charitable Trusts, WWF and other partnering NGOs was that it was responsible for swaying at least five undecided nations into voting favourably for mobulas and sharks. This may seem a small number, but its significance cannot be understated. A two-thirds majority is required for a proposal to be approved at CITES, and although the bulk of the votes in favour of a proposal are often secured before the actual CoP, it's the decisions made by the 15 to 25 'on-the-fence' nations at the conference itself that often decide whether a proposal will be successful or not. This film ultimately played a small but significant role in ensuring that by the final voting stage the ballots were stacked comfortably in the green zone for the mobula proposal.

A coordinated CITES outreach and media strategy approach for sharks and rays by NGOs and IGOs also contributed to the successful listing. The Manta Trust worked closely with its partners and collaborators before and during CoP17 to align our media activities and ensure a unified message was sent to key stakeholders and governments.

An additional highlight subsequent to CoP17 was to see the *#LOVEminiMantas* film also receive international recognition. It was awarded the top prize out of 10 finalists in the Extreme Virtual Reality Competition held at the Ocean Gala fundraiser in San Francisco, in collaboration with the Ocean Elders, MaiTai Global and VR Festival. It is now one of only a very few award-winning VR short films about a marine species in the world. We are very interested to see how 360 VR can be used in future projects, probably in conjunction with some of the charity's funding partners. 360 VR movies have incredible potential to demonstrate the need for conservation, bringing key decision-makers closer to the subject.

During 2016 we undertook our third expedition with the National Geographic Society CritterCam team, this time to Raa Atoll in the Maldives. We managed to film more than 40 hours of onboard footage of reef manta rays through the CritterCams, capturing some extremely exciting and revealing behaviour. For the first time we were able to observe what these rays do when they leave the reefs and venture into deeper water, away from humans.

The Manta Trust also conducted a total of 16 Manta Expeditions aboard tourism vessels in three countries. During these expeditions we visit key manta sites to provide in-water encounters for divers and snorkellers and to teach the general public about these amazing rays, the threats they face and what we can do to protect them. We also encourage tourists to become citizen scientists by collecting and submitting data, such as sightings and photographs of manta rays, to our global database. Chief executive Guy Stevens also participated as a science team member at the 'Manta Mania' week in Yap, sharing insights from his PhD research on manta rays in the Maldives.

In collaboration with award-winning photographer Thomas Peschak, we created and launched the first-ever natural history book on manta rays. This beautiful coffee-table volume provides a comprehensive overview of our latest understanding of manta biology and ecology, the threats these rays face and their conservation status. Illustrated by unique images, *Manta* gives a glimpse into the secret life of manta rays from populations around the world. It also includes our latest insights into the reproductive behaviour and characteristics of these amazing animals from Guy's PhD research.

Another important publication we completed this year was the first comprehensive global identification guide for manta and mobula rays. Developing such a guide presented us with incredible challenges. There is a great deal of confusion about the taxonomy of manta and mobula rays. It is unknown, for example, how many species really exist in the world (partly because one species may be known under numerous scientific names). Nor do we know the defining characteristics that separate one species from another. The aim of this guide is to address these challenges and develop a clear and accurate reference, with supporting images, that can be used for research purposes, fisheries monitoring and law enforcement around the world. Both the *Global*

*Mobulid ID Guide* and the book *Manta* were launched at CITES CoP17 in South Africa.

We have expanded our global network of affiliated projects even further and now include some new and exotic manta study sites in Papua New Guinea. The Manta Watch Camp project, launched there in collaboration with Conservation International, aims to build a research database to gain valuable scientific information about the manta population of Papua New Guinea and provide a platform for discussions about protecting the marine habitat from net entanglements, dynamite fishing and human intervention. It also aims to provide an open-source database by satellite tracking manta rays and allowing interested parties to follow their movements in real time to study their behavioural patterns. The ultimate goal is to bring responsible ecotourism to Papua New Guinea by means of science, education and community-based initiatives and by supporting the development of sustainable government legislation.

Other projects affiliated to the Manta Trust have been started in Latin America. These include Projeto Megafauna Marinha do Brasil, conducted by IPROMAR, a local organisation that studies not only manta rays, but also a range of large marine species in Brazil. We are now also collaborating with the Fundacion Megafauna Marina del Ecuador, which has been studying the Ecuadorian population of oceanic manta rays for several years. We are excited to be working with our new affiliated projects in these fantastic locations.

Our existing projects continue to grow and develop. In New Caledonia, we extended our partnership with Conservation International to include the National Aquarium, Noumea Aquarium de Lagoons, and incorporate a local Manta Trust representative, Hugo Lassauce, into the team. Hugo is starting his PhD on the manta rays around New Caledonia, using photo identification and tagging methods to investigate them and the potential interconnectivity of this population with others in the South Pacific region. His PhD will be co-supervised by the University of Queensland and the University of New Caledonia.

In French Polynesia, we welcomed two volunteers from SEA LIFE London Aquarium to our manta project. They did a terrific job of collecting data, helping



Photos by Guy Stevens © Manta Trust

to integrate the project with the community, and raising its profile through their blog *www.themobulablogula.weebly.com*. In Mexico, the Manta Trust's Josh Stewart and Bob Rubin visited the Mexican Caribbean Manta Project to conduct a one-week research training course for our local project team. A Master's student from the UK completed her thesis on the tourism pressures in the Mexican Caribbean working with our local project.

The Manta Trust entered into an official Memorandum of Understanding with Project Manta in Australia, based at the University of Queensland. Over the coming years we will collaborate on our global genetics study of manta and mobula rays. We will also work together to investigate the migration patterns and connectivity of Australia's manta populations with those of neighbouring nations, such as New Caledonia, Papua New Guinea, Fiji and Indonesia, by comparing photo-identification databases. Guy Stevens will act as a supervisor to a new PhD on mantas starting at the University of Queensland.

In 2016 the Manta Trust became an official collaborating partner to the Sharks Memorandum of Understanding of the CMS, joining other international NGOs such as the Shark Trust, Project AWARE and IFAW. The joining ceremony took place during the first meeting of the Advisory Committee of the CMS Sharks MoU in Costa Rica in early February. With government representatives from around the world present at this meeting, it was a perfect opportunity for the Manta Trust to raise further awareness and support for the *Mobula* CITES proposal.

2016 also saw us complete the final draft of the Best Practice Guide for Shark and Ray Tourism. The aim of this collaborative project between Project AWARE, the Manta Trust and WWF is to provide free and practical best-practice guidance that can be used by tourism operators, NGOs and local communities. We want to help create and maintain well-managed tourism operations that will not only contribute to the conservation of shark and ray species (directly, and indirectly by increasing the awareness of participating tourists to the species' existence and plight), but also benefit local communities. After consultation with a technical advisory committee comprising scientists, researchers and academics,





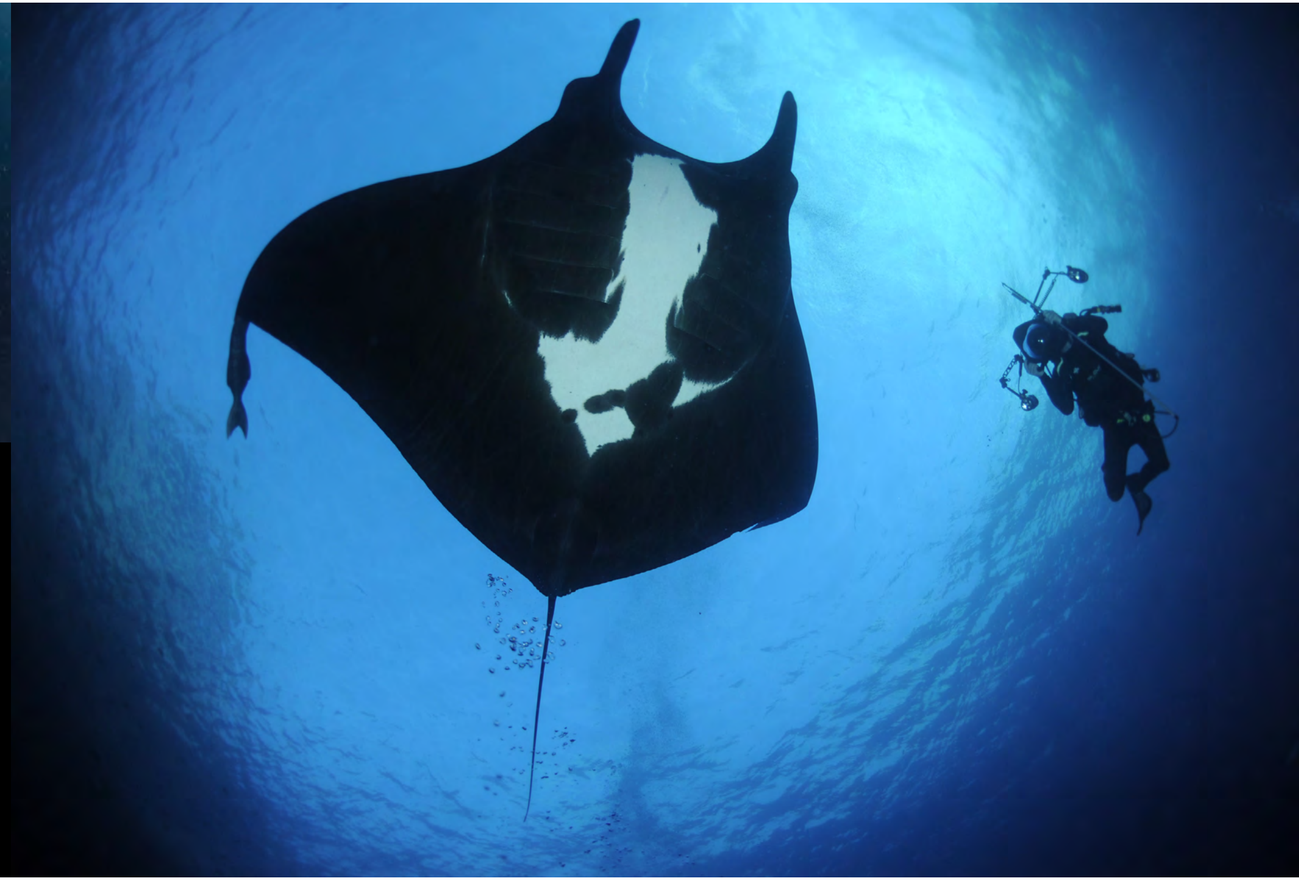



Photo by Chakra Fotografi © Manta Trust

I believe 2016 will be remembered as the year in which the almost impossible happened. This statement, of course, relates to wildlife conservation and not politics.

the guide has been compiled from the best available science to help stakeholders create specific guidelines appropriate to local circumstances (such as species and location) where the current general recommendations are insufficient.

The information in the guide is extensive and includes advice about selecting sites; involving local communities; working with local authorities and the tourism industry; establishing operating guidelines and a management framework; minimising disturbance and changes to the natural behaviour of sharks and rays; monitoring effectiveness and impact; financial agreements; and ensuring long-term success. A dedicated industry advisory group comprising dive operators and managers was also consulted and gave input in the form of local perspective and knowledge, as well as practical advice and information relating directly to the industry. We conducted our first webinar to introduce the guide in late 2016. With more than 80 participants joining from around the world, it was clear that there is interest in, and a need for, such a guide.

We expanded the Baa Atoll Education Programme in the Maldives across several age groups and introduced a few new locations. The aim of this education programme is to foster a conservation-minded future generation of Maldivians who will claim ownership and stewardship of their environment. Through both theory and practical classes, we seek to educate primary and secondary school children about marine species, the threats they face and conservation solutions. Activities range from engaging with young children in educative games about saving turtle hatchlings and decreasing plastic in the ocean to taking high school students to a waste management site and discussing approaches for managing ocean pollution. As Baa Atoll is a UNESCO Biosphere Reserve and Hanifaru Bay marine protected area attracts the largest known aggregation of reef manta rays in the world, we believe that education and awareness are the key to ensuring the continuation of both the Biosphere Reserve status and the atoll's rich biodiversity.

The various social media platforms are the primary channel that our charity uses to publicise the research and conservation initiatives we are part of. We use them to convey the latest news and discoveries relating to mantas and their habitats. They are the most powerful tool we have to connect directly with our followers and rally them behind specific causes on an international scale. While the exact strategy and goals may differ for each platform, the overarching purpose of our social media output remains unified. We use social media to raise awareness about manta conservation and, to a lesser degree, provide education about our marine ecosystems. Simply put, social media platforms are arguably the most effective way for us to raise awareness on a consistent basis, and to an ever-growing audience.

Social media have served as one of the cornerstones of our communication and public outreach strategy since the Manta Trust's foundation. They have grown from a Facebook page with 900 followers in 2012 to an audience that numbers tens of thousands across three platforms – and it continues to grow at an astonishing rate. In 2016 we had more than 21,000 followers on Facebook, over 11,500 on Twitter and close to 14,500 on Instagram. The Manta Trust now has arguably some of the most active and engaged social media followings of any conservation NGO, in both the elasmobranch realm and the wider marine conservation community.

The Manta Trust would like to thank the Save Our Seas Foundation, one of our key funders, for its continued support over the years. We thank you for the incredible opportunities that have been created and the progress and achievements made – in 2016 as well as in previous years – as a result of the Save Our Seas Foundation's generous funding towards research into and conservation of manta and mobula rays, as well as our outreach and educational efforts relating to these magnificent animals.


Photo by Ibrahim Lutf

# BIMINI BIOLOGICAL FIELD STATION FOUNDATION

## TRISTAN GUTTRIDGE & SAMUEL GRUBER

Photo by Michael Scholl

Tristan Guttridge

Samuel Gruber

The BBFSF is officially recognised as a charitable organisation in The Bahamas as well as a 501 (3)c US non-profit. It has officially purchased the land occupied by the station and is currently coordinating the raising of the current station for improved hurricane protection.

The 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. The BBFSF is an isolated research facility located on the island of South Bimini in The Bahamas, 85 kilometres (53 miles) east of Miami. The environs provide access to a diverse and abundant shark and ray fauna that occupies varied marine habitats, including mangrove edge, shallow-water lagoons and coral reefs sloping to deep waters.

Since its inception, the BBFSF has contributed significantly to scientific knowledge about sharks through its numerous peer-reviewed publications and by hosting and training large numbers of national and international interns and students, both graduate and undergraduate. It has also played a role in education about sharks through its outreach projects directed at the local community and has contributed to conservation through the establishment of improved management and protection measures for sharks in The Bahamas and the USA. Given its 26-year history, 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 impacted elasmobranch species. One focus is on the recovery of global shark populations and the effective sustainable management of them for future generations. Through our educational outreach, we aim to improve marine science education and the public's perception and understanding of these charismatic predators.

We are extremely grateful to have completed our 26th year of operation. During this past year our activities ranged from the tagging and satellite tracking of great hammerhead sharks and the acoustic tracking of green turtles to the collection of genetic samples from newborn lemon sharks. We are pleased to present in detail our 2016 annual report, which includes scientific and conservation milestones and our outreach and media activities, as well as a short summary of what we expect to accomplish in 2017.

Photo by Eugene Kritzler

# SCIENTIFIC RESEARCH
## LONG-TERM PROJECTS

### MOVEMENT NETWORKS AND HABITAT PREFERENCES OF ELASMOBRANCHS

It's been two years since we established an extensive array of bottom-mounted acoustic receivers (VR2W, Vemco) throughout Bimini's environs to monitor the movements of a diversity of sharks and rays. Our team's long-term aims are threefold: to build a theoretical framework to predict the spatio-temporal distribution of habitat use in elasmobranchs in Bimini by addressing potential underlying mechanisms such as competition, intra-guild predation and species-specific habitat preferences; to identify drivers (physical and biological) of movement and migration; and to identify hotspots in order to manage and conserve local populations.

This year, through a collaboration with the Ocean Tracking Network and continued support from the Save Our Seas Foundation (SOSF), we expanded our acoustic array to 67 receivers and are now able to monitor areas north and south of Bimini, such as Great Isaacs Cay. The habitats currently being monitored include shallow-water sandy areas with interspersed macro-vegetation, mangrove-bordered sea-grass beds and shallow- and deep-water coral reefs. Some of the locations for the acoustic receivers required drilling into bedrock to ensure the stability and longevity of the equipment. These new locations open up a variety of research questions regarding habitat connectivity and ecosystem dynamics.

Currently the BBFSF, in collaboration with Florida State University, monitors 188 individual marine vertebrates representing nine species: lemon shark *Negaprion brevirostris*, bull shark *Carcharhinus leucas*, blacktip shark *C. limbatus*, Caribbean reef shark *C. perezi*, nurse shark *Ginglymostoma cirratum*, great hammerhead *Sphyrna mokarran*, tiger shark *Galeocerdo cuvier*, southern stingray *Dasyatis americana* and green sea turtle *Chelonia mydas*. Early analysis from our first download period in 2014 until our array download in fall 2016 has revealed that some species show very limited movement. Green turtles, for example, are resident in Bimini, but were detected on only two to three receivers, which is on average equivalent to an activity space of two square kilometres (0.7 square miles). The activity spaces of other species, on the other hand, are clearly broader; those of lemon, nurse and bull sharks ranged between 17 and 19 receivers on average, equivalent to 15 square kilometres (5.8 square miles). Tiger sharks, which are transient, were detected on six receivers on average during short visits. Some receiver locations and their associated habitats appear to be more important than others and may serve as corridors or highways for local shark movements. For example, the number of animals detected by receivers on the west side of Bimini, parallel to the Gulf Stream, ranged between 38 and 73 individuals, compared to between three and 43 animals on the sand flats east of Bimini on the Great Bahamas Bank. Some individuals were detected in the array on many days over extended periods: a reef shark for 551 days, a nurse shark for 429 days, a bull shark for 329 days and a great hammerhead for 281 days.

Calculating residency indices (IR) as the number of days detected in the entire receiver array divided by the number of *possible* days detected in the array, we found values ranging from 0 to 0.9 (a value of 1 = always present; 0 = never present). Interestingly, not all species followed our expectations. We anticipated, for example, that large coastal sharks such as great hammerhead, bull and lemon sharks would show sporadic or intermittent detections for limited periods. However, one hammerhead had an IR of 0.54 (present on the array for 285 of 530 days), a lemon shark had an IR of 0.70 and a nurse shark had an IR of 0.67. Such IRs are comparable to those of reef sharks, which show high annual residency here (with an IR of up to 0.9) and in other studies.

We continue to document more individuals, such as great hammerheads, making broader-scale movements or migrations (see published report below) between Bimini and the east coast of the USA, as well as between Bimini and other parts of The Bahamas. Additionally, five nurse sharks travelled to Florida from Bimini and another two were detected at the Bahamian islands of Eleuthera and Andros. For the first time in this study, we received detections of a mature blacktip shark in Florida and lemon, bull and hammerhead sharks in the Gulf of Mexico, all of which had been tagged in Bimini. Using our extensive array as a tool, we are increasingly motivated to learn more about the distributions of species and their movements, and we will evaluate our dataset in detail over the coming year, incorporating abiotic environmental factors such as water depth and temperature into the analyses.



Photos by Eugene Kitsios

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

2016 marked our 22nd annual PIT (Passive Integrated Transponder, or RFID tag, a microship the size of a rice grain) tagging programme for lemon sharks. This is our longest-running shark census, in which gill nets are set and manned for six nights each in two mangrove-fringed nursery habitats in North Bimini. The goal is to explore the mating system, population dynamics and life-history traits of the lemon shark. On capture, each shark is weighed, measured, sexed and fitted with a PIT tag. Small pieces of fin containing DNA (genetic material) are collected from newly captured sharks and shipped to Dr Kevin Feldheim at the Pritzker Laboratory of the Chicago Field Museum, where they are genotyped at 11 species-specific microsatellites. With these results, we can infer parent/offspring and sibling relationships between sampled individuals and reconstruct genetic information from the shark's parents, thus identifying which adults sired a particular newborn lemon shark. Indeed, we have never seen or captured the vast majority of sires and dams. In this way we are able to add new members to our existing lemon shark family tree, which comprises more than 4,000 individuals. Using the data and pedigrees, we are able to investigate questions such as: how many females pupped in Bimini in 2016; how large their litters were; whether these mothers had visited Bimini in previous years and if so, how many times they had given birth; whether they were on a biennial cycle (parturition every other year); whether the adult females giving birth in Bimini in 2016 had been born in Bimini themselves decades earlier and were therefore demonstrating natal philopatry, like certain sea turtles and salmon; and if this is the case, how common is this behaviour?

We were particularly excited to learn that three adult female lemon sharks we had tagged with 10-year acoustic transmitters in 2014 were detected on receivers in Bimini's lagoon and nursery areas in the spring of 2016. Interestingly, two of these sharks arrived in early March and their signals were picked up intermittently until August, whereas the third individual was detected only over an eight-day period between 23 and 31 May. Genetic analysis of the newborn sharks captured in June during PIT (see summary below) should enable us to determine whether any of these females gave birth. We hypothesise that females

giving birth remain in Bimini for only a short time after parturition, whereas those that return to Bimini on their 'year off' to mate stay for longer periods. Alternatively, some mature female lemon sharks may be more resident in Bimini than we expect. This was particularly interesting to us considering that female lemon sharks we previously captured off Jupiter, Florida (160 kilometres, or 100 miles, north-west of Bimini) migrate annually north to Georgia and Carolina during the summer months. Clearly, the Bimini and Jupiter populations display very different migration paths, despite being close to one another geographically. This corroborates our team's previous genetic findings of restricted female-mediated gene flow within the North Atlantic. Taken together, the results are concerning because these populations are vulnerable to local overfishing, which suggests that this species should be strongly managed on a sub-regional geographical scale.

*PIT Summary 2016*. A total of 196 juvenile lemon sharks were caught during our 2016 tagging campaign. Of these, 115 were captured in Sharkland and 79 in North Sound. Historically, we have caught far more lemon sharks in Sharkland; for the period 1996–2016, the mean for Sharkland is 115 and the mean for North Sound is 80. This pattern is therefore not surprising (see figure 1). As in previous years, most sharks were caught in the net sectors closest to the mangrove edge, which emphasises the importance of mangroves to the early development of juvenile lemon sharks in Bimini.

## GREAT HAMMERHEADS: A CRITICAL NEED FOR DATA

Over the next few years, the BBFSF team aims to improve our understanding of the ecology, movements and behaviour of the great hammerhead sharks using acoustic and satellite tracking in The Bahamas and the USA. Through collaboration and communication with the US National Marine Fisheries Service, we intend to provide critical spatio-temporal data to improve the management and recovery of this endangered species.

In 2016, to provide long-term monitoring, we continued tagging great hammerheads with 10-year acoustic transmitters. Over the period January to



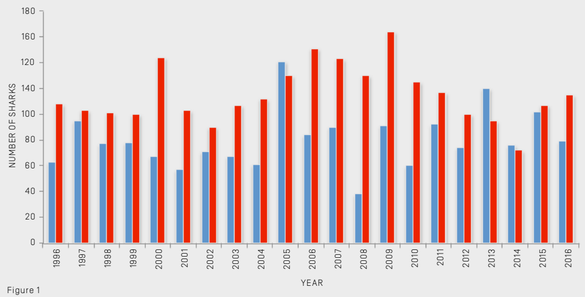



Figure 1
Annual juvenile lemon shark captures in gill nets during the PIT tagging programme in Bimini, The Bahamas, 1996 to 2016. Red bars indicate captures from Sharkland nursery; blue bars indicate captures from North Sound. Nets are set for six nights every June in each nursery.

Photo by Michael Scholl

April, intermittently in Jupiter, Florida, and continuously in Bimini, we tagged 10 more great hammerheads, comprising three males and seven females. Five of these sharks were equipped with temperature- and depth-sensing tags, which enable us to gather new data on their thermal and vertical habitat use. In addition, we developed a photo-identification database and measured lengths of 11 new and free-ranging great hammerheads using laser photogrammetry, all of which contributed new data for our understanding of the species' demographics, site fidelity and seasonal residency in Bimini. We also deployed pop-off archival satellite tags with a nine-month duration on two female great hammerheads in April. Both these tags successfully sent data. The first popped off close to Georgia in late May, just a month after tagging, while the other lasted for nearly nine months, popping off in January 2017 off Delray Beach, Florida. This tag was retrieved and has been fully downloaded, giving us almost nine months of high-resolution data on the vertical and horizontal movements of a female great hammerhead. We believe this is one of the longest periods, if not the longest, that a satellite transmitter has been on a hammerhead and has been retrieved. Importantly, this shark was detected on acoustic receivers in Bimini from March until May and intermittently off the coast of Charleston, Carolina, from June to October 2016. These comparable data from two different techniques are extremely useful for ground-truthing the migration route that this shark took and will provide new information about its habitat use during the summer months.

## CAUSES AND CONSEQUENCES OF LEMON SHARK PERSONALITY

This year we were delighted to continue our support of PhD candidate Félicie Dhellemmes from the Humboldt Institute in Germany, who arrived in Bimini in February 2015. Her research on the ecological consequences of personality for sharks continues and expands our previous PhD student's research. She is investigating the connection between behaviour and personality in free-ranging juvenile lemon sharks. Due to the longitudinal nature of this research project, we will be able to examine whether traits are inherited and explore

Photo by Michael Scholl

foraging specialisation, as well as study life-history traits and movements in the context of personality.

Immediately after our annual PIT census of juvenile lemon sharks in June 2016, 77 sharks were transferred to holding pens and tested for behavioural traits in sociality (are some more social than others?) and exploration (how do sharks explore a novel environment?). Each shark was tested twice, as these tests are designed to quantify repeatability in behaviours (does the score from test one correlate with that from test two?). It is particularly difficult to monitor the behavioural traits of free-ranging aquatic vertebrates across years because most use large ranges and are difficult to recapture. It will therefore be illuminating to record and understand how these traits are expressed over a lifetime, as individual sharks grow and learn about the environment.

***Do personality measures in captivity reflect those of free-ranging lemon sharks?*** In August, we surgically implanted acoustic transmitters in 14 juvenile lemon sharks whose behavioural traits had already been tested. These 14 individuals will be tracked through summer 2017 both actively (manually from a moving boat) and passively (via stationary acoustic receivers). So far, from two years of deployment, we have found correlations between the home ranges of sharks (using traditional movement analyses such as maximum convex polygons and kernel utilisation distribution; see figure 2) and their exploration score in captivity (the number of zones they move through during a trial). In addition, we found that each shark's mean distance from shore, as calculated from active tracking, correlated with the same shark's exploration score in captivity. These early results strongly suggest that behavioural traits of lemon sharks in captivity may be a good proxy for their behaviour in the wild. If confirmed, this will help us considerably to interpret personality in free-ranging lemon sharks.



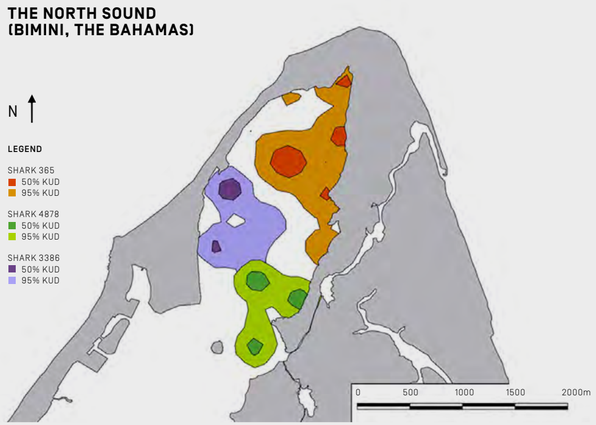



Figure 2
Home range size estimates derived from acoustic tracking of size-matched juvenile lemon sharks in Bimini, The Bahamas.

## POPULATION DYNAMICS OF LARGE SHARKS

Not only are population dynamics intrinsically important, but it is essential to understand them in order to implement the effective conservation and management of coastal sharks. Fishery-independent surveys can offer valuable information about species for which data are limited. Since 2004, our team has conducted monthly standardised long-line sets in shallow water around the east coast of Bimini. Each survey comprises five individual long-lines, each 500 metres (1,640 feet) long and containing 15 hooks. Lines are soaked for 24 hours and are checked every four hours to reduce fish mortality. On capture, each shark is restrained briefly alongside the vessel and measured, tissue samples are taken and finally the animal is tagged and released.

In 2016, we completed 11 sets and caught 72 sharks of seven species, including tiger, lemon, nurse and blacktip, which compromised 95% of the catch (see figure 3). Seasonal trends indicated an abundance of nurse, blacktip and lemon sharks during the warmer summer months, which agrees with our decade-long results from the period 2004–2015. Summarising this study, graduate student Alex Hansell (University of Massachusetts) has submitted a paper entitled 'Local indicators of abundance, trends and demographics for the coastal shark assemblage of Bimini, The Bahamas', to the journal *Fisheries Research*.

Our monthly long-line sets continue under the direction of graduate student Matt Smukall (University of Alaska), who is focusing his efforts on the ecology of the tiger shark using methods that include acoustic telemetry, stable isotope analyses, behavioural trials and long-lining. This year Matt set 12 additional long-lines off South Bimini running south-eastward onto the Great Bahamas Bank to supplement our standard captures. The catches totalled 108 sharks, of which 76 were tiger sharks, ranging in total length from 86 to 373 centimetres (2 foot 10 inches to 12 foot 3 inches).

Figure 3
Monthly size distribution of sharks captured on long-lines in Bimini, The Bahamas: (a) tiger shark, (b) nurse shark, (c) blacktip shark and (d) lemon shark. The box represents the first and third quartile, and the solid middle line represents the median. Extending lines represent maximum and minimum points, with outliers marked as circles.

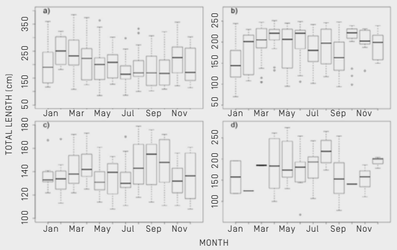
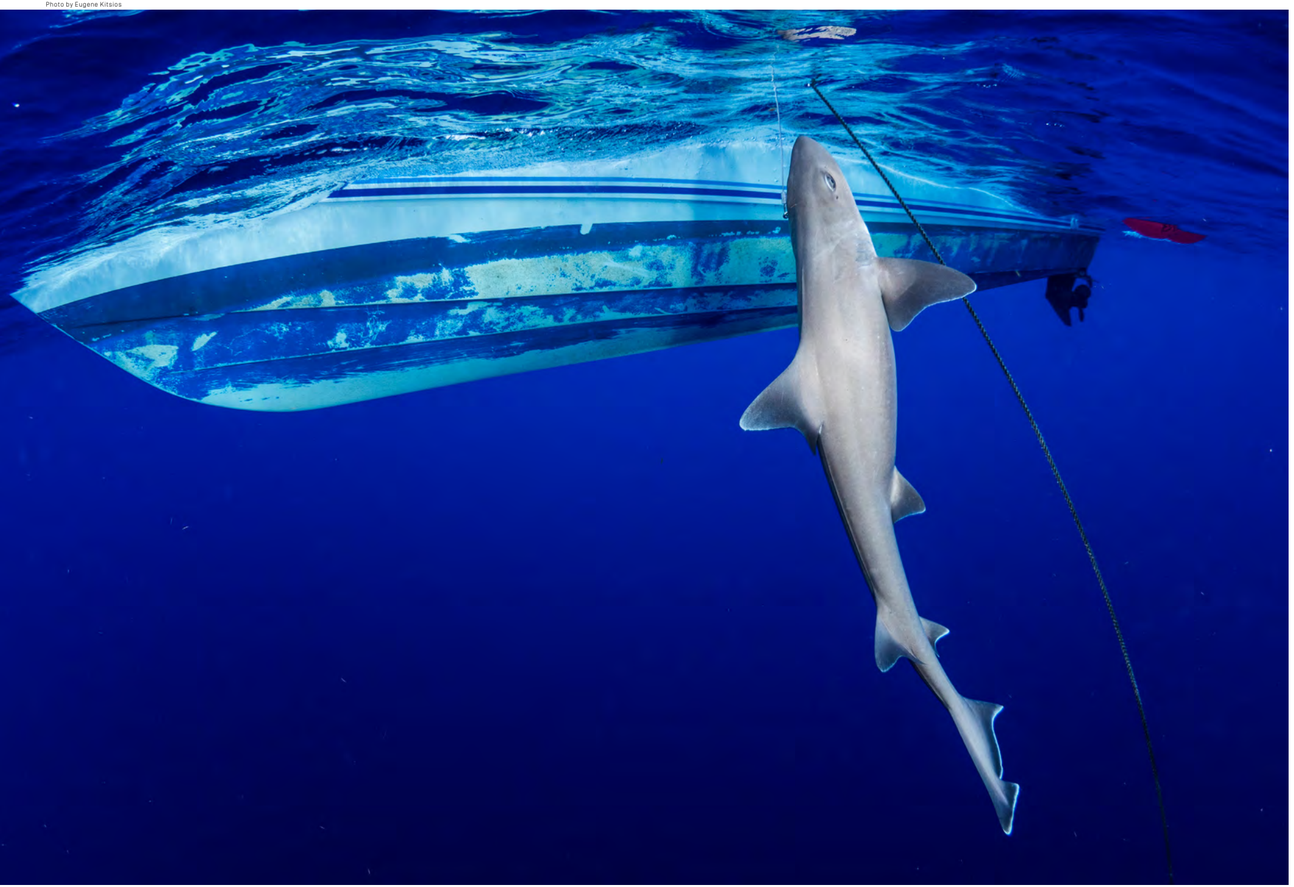



Photo by Eugene Kitsos

Photo by Eugene Kitsios





# PUBLISHED RESEARCH PROJECTS

## POPULATION TRENDS OF THE LEMON SHARK IN BIMINI

In Bimini, the consistent employment of long-lines, beginning in 1982, has provided a rare opportunity to explore population trends for large resident sharks. In this study, our team assessed three shallow-water long-line surveys for the lemon shark, which is categorised as Near-Threatened on the IUCN's Red List of Threatened Species. The surveys were divided into 1982–1989, 1992–2002 and 2003–2014, with the aim of determining trends in annual catch per unit effort (CPUE). We used a general additive model (GAM) to analyse for any non-linear annual CPUE values over the entire 32-year research period. The GAM displayed high variability of annual CPUE, with a peak value of 0.026 lemon sharks per hook day (hooks day–1) in 2000. The temporal pattern of CPUE indicated a cyclic abundance trend, with a complete cycle, from trough to trough, occurring over a period of approximately 18 years. The 1982–1989 survey period saw both the highest proportion of mature individuals (19.8%) and the smallest average pre-caudal length (LPC; 124.8 cm). The 1992–2002 survey period showed the highest average annual CPUE (0.018 hooks day–1), while the 2003–2014 research period recorded the largest average LPC size (134.8 cm) and the lowest average CPUE values (0.009 hooks day–1) of the entire research period. The long-term trend identified in this study provides a baseline for future assessment.

Kessel ST, Hansell A, Gruber SH, Guttridge TL, Hussey N, Perkins R. 2016. Lemon shark (*Negaprion brevirostris*) catch per unit effort (CPUE) trends, Bimini, Bahamas, derived from a fishery independent, 32-year shallow water longline survey. *Journal of Fish Biology* 88 (6): 2144–2156.

## LEMON SHARK AGE

A combination of mark–recapture and genetic sampling was used to estimate and then extend the minimum longevity (lifespan estimate) of the lemon shark. Published data suggested that the average longevity of the lemon shark was about 26 years, a value often cited in the literature. In fact, we unequivocally determined, using direct evidence from recaptured lemon sharks, that this species lives to be at least 37 years old. This increase in lifespan could mean an increase in the time it takes an exploited stock to rebound back to a virgin-like population. While this study may prove logistically difficult to replicate for other species, it does highlight the importance of long-term, standardised tagging projects, including the collection and analysis of genetic samples for life-history parameter research.

Brooks JL, Guttridge TL, Franks BR, Grubbs DR, Chapman DD, Gruber SH, Dibattista JD, Feldheim KA. 2016. Using genetic inference to re-evaluate the minimum longevity of the lemon shark, *Negaprion brevirostris*. *Journal of Fish Biology*. 88 (5): 2067–2074.

## LEMON SHARK PERSONALITY

Personality differences are widespread throughout the animal kingdom and can have important ecological and evolutionary consequences. Despite a rapidly increasing body of literature, large marine vertebrates remain underrepresented in personality research, most likely due to the technical and logistical difficulties associated with such studies. However, given their unique life-history traits (slow growth and reproduction rates and long lifespan) and their pivotal role in ecosystem processes, this paucity of information represents an important gap in our current knowledge. In this study, we investigated consistency and plasticity in the movement behaviour of wild juvenile lemon sharks by repeatedly subjecting them to tests in a 10 x 18-metre (33 x 59-foot) holding pen in the open environment, herein referred to as a 'novel open-field'. Each shark completed six tests over 12 days, therefore one every two days. We had three aims: to identify whether there were differences between individuals in their rate of movement in a novel open-field; to determine whether rate of movement in the novel open-field reflected an individual shark's general activity or reaction to novelty; and to estimate individual differences in habituation (diminished response) or sensitisation (enhanced response) rates over trial repetition, and examine if these rates were predicted by the initial rate of movement within the novel open-field. Results revealed that lemon sharks showed consistent individual differences in rate of movement in a novel open-field. Interestingly, sharks showed habituation in their rate of movement over repeated trials, indicating that the rate

of movement during the first trial was a reaction to novelty rather than general activity. Individuals, however, differed in their rate of habituation (plasticity) and this rate was negatively related to an individual's movement behaviour in the first novel open-field trial. Consistent individual differences in novel open-field tests have been demonstrated in many taxa, including teleost fish, birds and mammals, but this is the first demonstration in elasmobranchs. This finding is an important prerequisite for linking captive behaviour with field observations and paves the way for future studies aimed at understanding the proximate and ultimate causes of these differences.

Finger JS, Dhellemmes F, Guttridge TL, Kurvers RMV, Gruber SH, Krause J. 2016. Rate of movement of juvenile lemon sharks in a novel open-field; are we measuring activity or reaction to novelty? *Animal Behaviour* 116: 75–82.

### GREAT HAMMERHEAD PHILOPATRY

A thorough understanding of the movement patterns of a species is critical for designing effective conservation and management initiatives. However, generating such information for large marine vertebrates is challenging, as they typically move over long distances, live in concealing environments, are logistically difficult to capture and, as upper-trophic predators, are naturally low in abundance. As a large-bodied, widely distributed tropical shark typically restricted to coastal and shelf habitats, the great hammerhead epitomises such challenges. Highly valued for its fins (in target and incidental fisheries), it suffers high by-catch mortality coupled with low fecundity and a conservative life history and is therefore vulnerable to over-exploitation and population depletion. Although very few species-specific data are available, the absence of recent catch records gives us cause to suspect substantial declines across this species' range. In this study, we used acoustic and satellite tracking techniques, conventional tagging, laser-photogrammetry and photo identification to investigate site fidelity and residency for great hammerheads to coastal areas in The Bahamas and the USA, and the extent of movements and connectivity of great hammerheads between the USA and The Bahamas. The results revealed large-scale return migrations (3,030 kilometres, or 1,883 miles), seasonal residency to local areas (some for five months), site fidelity (annual return to Bimini and Jupiter for many individuals) and numerous international movements (see figure 4). These findings enhance the understanding of movement ecology in great hammerhead sharks and have potential to contribute to improved conservation and management.

Guttridge TL, Van Zinnicq-Bergmann M, Bolte C, Howey-Jordan L, Kessel ST, Brooks J, Bond ME, Winram W, Jordan LK, Cashman R, Tolentino E, Grubbs RD, Gruber SH. 2017. Philopatry and regional connectivity in the great hammerhead shark, *Sphyrna mokarran* in the U.S. and Bahamas. *Frontiers in Marine Science. https://doi.org/10.3389/fmars.2017.00003*.

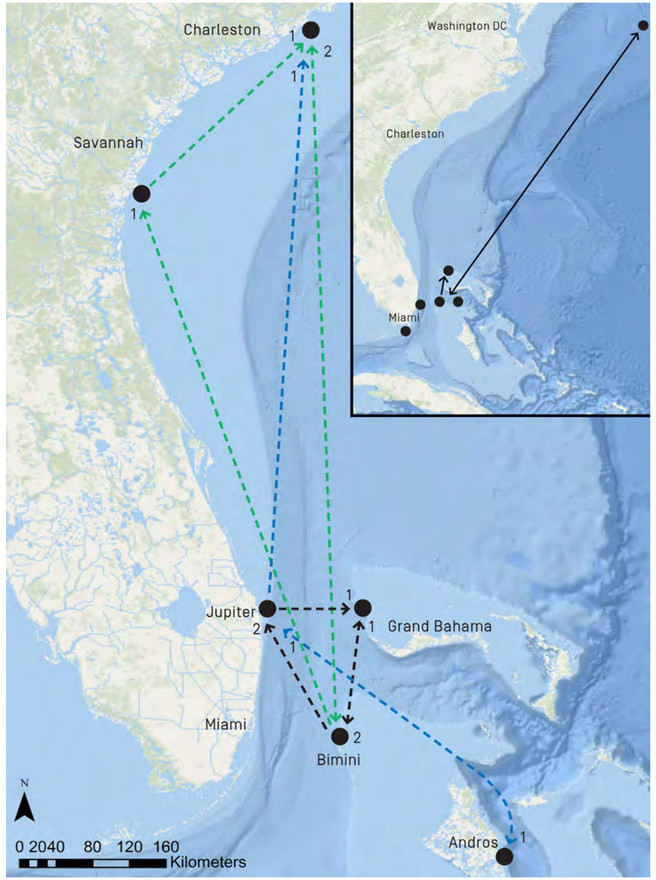



Figure 4.
Regional movements and migrations of great hammerhead sharks tracked using satellite telemetry and photo ID (insert), and acoustic telemetry (main map). The track of great hammerhead #12 is shown by the black dashed line and of great hammerhead #13 by the green dashed line; the tracks of multiple individuals are indicated by the blue dashed line. Numbers below symbols denote # directed movements between locations.



# SCIENTIFIC OUTPUT

### PUBLICATIONS

Four papers were accepted in high-impact, peer-reviewed journals (such as *Animal Behavior*) on topics varying from personality in lemon sharks to long-term trends in the abundance of lemon sharks using fishery-independent methods. We were pleased to see the publication of the first paper on our great hammerhead project. See above for more details.

### PRESENTATIONS

Scientists, BBFS Principal Investigators and students presented at three conferences this year. Five of our team gave presentations at the American Elasmobranch Society conference in New Orleans, USA; one at the Mediterranean Science Commission conference in Kiel, Germany; and two at the annual meeting of the European Elasmobranch Association in Bristol, UK.

### CONSERVATION

We are beginning to reveal the migratory pathways of the endangered great hammerhead shark, a species that overwinters in Bimini. Preliminary findings indicate annual migrations of females to Carolina, USA, which we hypothesise to be linked to parturition as pups have been documented in this region. Continued tagging, coupled with genetic analyses, screening of blood hormone and ultrasound (to determine if Bimini serves a reproductive purpose for great hammerheads) will contribute important data for this threatened, highly mobile predator. Our movement data were recently used to corroborate NOAA and others' (Mote, US Bottom Long Line Fishery) catch data, used to create Essential Fish Habitat (EFH) for great hammerheads in the western North Atlantic and Gulf of Mexico. In addition, our smalltooth sawfish paper published in 2015 has led to discussions with The Bahamas' government to consider adding this imperilled large marine vertebrate to the protected species list, under the Bahamas Shark Sanctuary.

# EDUCATION & OUTREACH

### DOCTORAL RESEARCH

Three doctoral candidates presently supported through BBFSF scholarships (Matt Smukall, Alaska University, on the tiger shark ecology of Bimini; Félicie Dhellemmes, Berlin University, on the ecological consequences of personality in lemon sharks; and Maurits Van Zinnicq Bergmann, Florida International University, on the movement ecology of sharks and rays) continued their three-year tenure.

### MASTER'S DEGREE RESEARCH

Two field projects were completed, by Patrick Burke, Erasmus Mundus MER Consortium (Baited Remote Video Surveillance), and Joffrey Baeyaert, University of Algarve, Portugal (lemon shark personality).

### VOLUNTEERS

The BBFSF hosted 44 interns representing European countries as well as Canada, USA and Mexico for stays of between one and six months.

### UNIVERSITY COURSES

Throughout the year we also hosted 65 students across four university courses in shark and marine biology.

### RESEARCH EXPERIENCE

We demonstrated to 54 members of the public hands-on research techniques with several shark species, including bull, lemon, nurse, great hammerhead, tiger and reef, in intense five-day courses.

### HIGH SCHOOL SHORT COURSES

Marine and shark biology classes were given to 65 high school students from Mote Marine Lab, Camp Live Oak, Young Persons Organization and Shedd Aquarium.

### EDUCATIONAL OPEN DAYS

In March and October, 45 local students from McDonald High School, North Bimini, were given the opportunity to learn about marine biology and the importance of a healthy marine ecosystem.

### PUBLIC TOURS

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

### BAHAMAS SCHOLARSHIP

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

### VETERINARIAN CLINICS

On three occasions we conducted spay and neuter clinics for mostly feral cats and dogs, providing important management for Bimini's feral animal problem.

### TRASH CLEAN-UP

The BBFSF organised and took part in local beach and roadside clean-ups at which up to 500 kilograms (1,100 pounds) of trash was collected and disposed of.

Photo by Sirachai Arunrugstichai

# MEDIA

### FILM TEAMS

We hosted five film teams from the USA and Canada, who shot three *Shark Week* specials on 'Shark social lives', 'Sharks in the shallows' and 'Tiger sharks at night'; Canadian TV star Cyril Chauquet's popular 'Chasing Monsters'; and a Smithsonian Channel feature on all our current research projects. BBFSF director Tristan Guttridge co-hosted the *Shark Week* special 'Shark social lives', which featured his doctoral research and a re-run of the social learning experiments that were conducted at BBFSF in 2007. PhD candidate Matt Smukall starred in the 'Tiger sharks at night' show, in which he attached accelerometer tags to juvenile and adult tiger sharks to explore rates of movement by day and by night.

### SOCIAL MEDIA

Through our online media platforms we provide updates from the field, often 'live', on our various research projects. We have 33,200 followers on Instagram and 6,800 on Twitter, 11,386 likes on Facebook and approximately 6,500 unique visitors per month to our website.

### *SHARK DOC, SHARK LAB*

The BBFSF's founder, Samuel 'Doc' Gruber, worked in partnership with the SOSF to create this exciting autobiography, which includes the early days of his work on sharks and how the Shark Lab was created. We were extremely gratified to see this published early in 2016 to celebrate Dr Gruber's remarkable career and his legacy, the Shark Lab. About US$20,000 has been generated so far from the sale of the book, with all proceeds going towards building a modern, hurricane-proof facility.



# FUTURE

### SHARK LAB RENOVATIONS & DEVELOPMENT

In 2017 we hope to raise enough funds to re-build our facility and make it 'green', so that we will have a platform to continue successfully for another 25 years.

### GREAT HAMMERHEADS

We aim to produce a second paper on great hammerheads that will examine their thermal and vertical habitat use as well as migration and general movement patterns throughout the western North Atlantic Ocean.

### NEW PROJECTS

We have three new projects in the pipeline: the deep-sea sharks of Bimini; predator–prey interactions between sharks and turtles; and baited remote video surveillance to determine the abundance and distribution of prey and predators across diverse habitats.

Photo by Eugene Kitsios

Photo by Ryan Daly

# THE ACOUSTIC TRACKING ARRAY PLATFORM

PAUL COWLEY

Paul Cowley

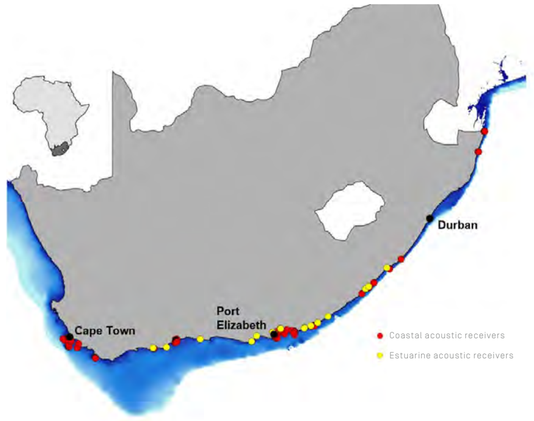
A sustainable marine science platform that monitors the movements and migrations of marine animals tagged off the coast of southern Africa.

Information about the movement behaviour and migrations of animals is essential for effective conservation and management, particularly for species that are of socio-economic value or conservation concern. The collection of quantitative information about the movements of aquatic animals has been enhanced by the application and popularity of acoustic telemetry methods. The successful use of this technology in recent years has also led to the development of several large-scale acoustic receiver arrays or networks around the globe, such as South Africa's Acoustic Tracking Array Platform (ATAP), which is managed by the South African Institute for Aquatic Biodiversity (SAIAB).

The ATAP array was established to facilitate the large-scale, long-term monitoring of acoustically tagged marine animals. The SAIAB maintains the nationwide network of receivers and provides researchers with the data on their tagged animals that are downloaded from the receivers. In this way, the ATAP provides local researchers with a sustainable, cost-effective means of gathering movement data on their tagged animals and also fosters broader collaboration at an international level. To date, more than 20 researchers from 14 different organisations benefit from the data collected by the ATAP.

## THE SCIENCE

The ATAP network spans some 2,200 kilometres (1,370 miles) of the southern African coastline with 14 monitoring sites situated between False Bay (Cape Town) and Ponto do Oura on the Mozambique border. In addition, 20 estuaries throughout the region are equipped with moored receivers. In its current format, the array's design enables researchers to address a number of key questions pertaining to animal movements. These include estuarine–marine connectivity, inter-estuary connectivity, bay-scale movements, movements in relation to MPA boundaries, large-scale annual migrations, trans-boundary movements and a host of ecological aspects, such as spawning aggregation dynamics and predator–prey interactions. Considerable focus on the movements of large sharks also facilitates the study of shark–human interactions.




Besides being a global biodiversity hotspot, this region hosts the greatest marine migration event on the planet in the form of the annual sardine run. Dubbed the 'greatest shoal on earth', this migration of small pelagic fish is pursued by a host of apex predators, including sharks, birds, dolphins and numerous predatory fish species. Collectively, these features make southern Africa a perfect 'natural laboratory' in which to study the movement behaviour and migration biology of marine animals.

## 2016 HIGHLIGHTS

2016 marked the fifth anniversary of the ATAP, which continues to show growth in terms of the number of animals tagged. To date, more than 700 animals representing 27 species have been tagged in the region.

The ATAP continues to gather valuable information about a number of apex predators, including white, bull (Zambezi), raggedtooth and tiger sharks as well as several other smaller species, many of which were tagged more than four years ago. The collection of this long-term data comes at no cost to the independent researcher, highlighting the value of this monitoring platform. The increase in the number of requests for data reports from its collaborating partners provides testimony of the success of the ATAP. During 2016, the SAIAB produced 21 data reports compared to only eight in 2015.

Great success is being achieved by two projects on iconic and charismatic fishery species. A multi-collaborative project on the giant trevally *Caranx ignobilis* witnessed more individuals being tagged at a known spawning aggregation site in Mozambique and the subtropical coastline off KwaZulu-Natal. Previous telemetry studies conducted in Hawaii and Australia revealed that this species is a resident reef-dwelling predator. However, some individuals tagged within the ATAP array have travelled distances in excess of 500 kilometres (300 miles), while others have shown multiple return visits to the aggregation site. A concurrent tagging study on this species is being conducted at the D'Arros Island and St Joseph Atoll complex in the Seychelles. In addition, these movement studies are being complemented by detailed population genetics and stable isotope studies across the South West Indian Ocean.

The dusky kob *Argyrosomus japonicus* is a large, estuarine-dependent fishery species that has suffered significant population declines in South African waters. Previous research on the movement patterns and habitat connectivity of this species focused on juveniles in estuaries. However, in 2016 researchers managed to capture and acoustically tag more than 30 large adult individuals in the Western Cape. This study will yield much-needed information for the corrective management of this threatened species.



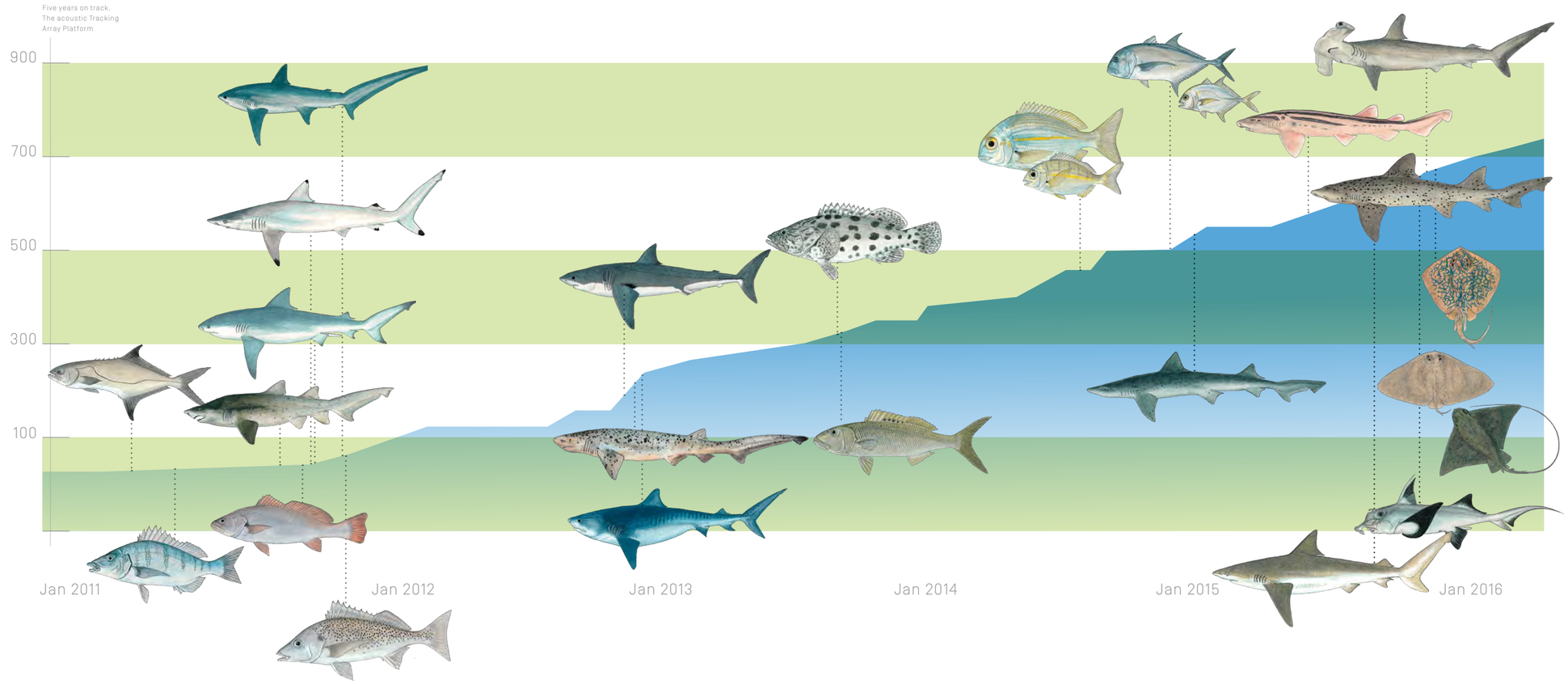


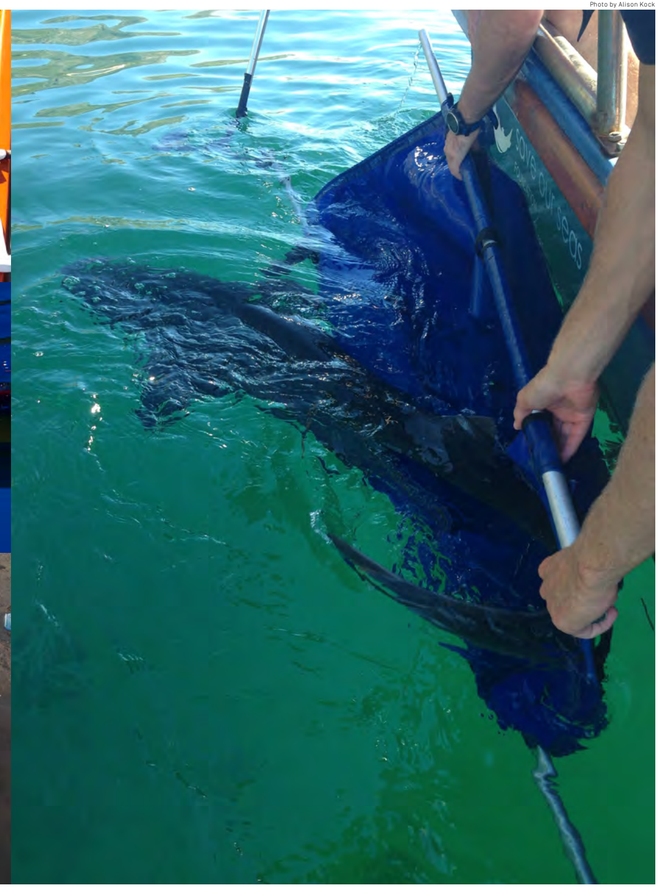
Photo by Paul Cowley

Photo by George Filmalter

Photo by Camilla Floros

Photo by Rob Kyle

Photo by Alison Kock



An exciting project on the potato bass *Epinephelus tukula* in the iSimangaliso World Heritage Site in KwaZulu-Natal, South Africa, has revealed that these resident iconic animals derive benefit from this no-take marine protected area.

The ATAP receivers deployed in southern Mozambique were downloaded at the end of 2016 and yielded very interesting information about the trans-boundary movements of a host of species tagged in South African waters. These included white, tiger and bull (Zambezi) sharks, and potato bass and giant trevally.

Another exciting project that benefits from the ATAP array is monitoring the movements of the sevengill cowshark *Notorynchus cepedianus*. To date, 64 of these unassuming apex predators have been tagged in the cooler waters of the Western Cape.

In 2016, the ATAP received a grant from the Save Our Seas Foundation (SOSF) to provide extra transmitters to interested researchers on an open competitive call basis. Two projects were supported: one on the commercially important soupfin shark *Galeorhinus galeus* and the other on the iconic giant guitarfish *Rhynchobatis djiddensis*.

During the course of the year, ATAP researchers attended several fishing competitions to capitalise on the opportunity to tag more animals. The team attended the national rock and surf fishing competition and managed to tag 28 animals, including 14 bronze whaler and six smoothhound sharks and several stingrays of various species.

In early November the ATAP management team hosted a workshop at the South Africa/Norway Science Week expo in Cape Town. The function was attended by numerous researchers, industry partners and science managers from the two countries. The ATAP initiative received many favourable comments and it was viewed as being a wonderful opportunity to foster collaboration between the two countries, as well as broader international partnerships.

Photo by Stuart Laing


Photo by Paul Cowley


Photo by Paul Cowley

## EDUCATION AND OUTREACH

The ATAP engages with the public in many different ways. Besides attending a number of fishing competitions, which allows for direct interaction with an important user group, the ATAP features a live exhibition during the annual SciFest Expo in Grahamstown. Every year thousands of young school learners come to learn about the study of fish movements and the need to conserve our oceans' resources.

## FUNDING

The ATAP's inauguration in 2011 was facilitated by a loan of acoustic receivers from the Canada-based global Ocean Tracking Network project. This hardware was matched by capital equipment grants from the National Research Foundation. Running expenses and costs linked to servicing the hardware are provided by the SOSF and the African Coelacanth Ecosystem Programme. Collectively, the support from these organisations has enabled us to establish a significant marine science platform off the coast of southern Africa.

# PROJECT LEADER PROFILES

AN INTRODUCTION TO OUR NEW PROJECT LEADERS WHOSE PROJECTS WERE FUNDED DURING 2016

Photo by Brian J Skerry © National Geographic Creative

**WHO I AM**

I developed a keen interest in science, particularly in animals and their behaviour, as a young child growing up in Colombia. I wanted to study marine biology, but the political turmoil and economic instability of that country limited my opportunities to learn and get involved in research, since routes to the coast were blocked by the guerrillas and many areas were deemed unsafe to travel to. In 2000 I moved to the United States, where I was exposed to opportunities that reinforced my desire to be a scientist. One key experience was volunteering at my local aquarium, the Discovery Place Museum in Charlotte, North Carolina. I spent many hours over the summers watching the exhibit tanks and was spurred on by the way I saw members of the public react negatively to sharks. This is where I ultimately decided I wanted to pursue shark research. Since then I laid the foundations for a career in marine research and conservation by getting involved in many studies whose subjects ranged from invertebrates to leatherback sea turtles and to artisanal fishermen, until finally I was given the opportunity to work with sharks for my PhD at Florida International University. All my interests and experiences have centred on behavioural ecology with the goal of specialising in fisheries management. I believe that an understanding of how predators and trophic cascades affect community structure and fish stocks is crucial for effective management and conservation efforts.

**WHERE I WORK**

In addition to following my research interests, I have made it my goal to increase scientific research in countries like Colombia. A beautiful country with bountiful natural habitats, including Atlantic and Pacific coastlines, deep Amazonian rainforest and high Andean mountain peaks, Colombia also boasts both the highest number of species per unit area and the largest number of endemic species of any country in the world. With all this beauty surrounding me as a child, it's not difficult to imagine why I was inspired to study biology. Yet privileged as it is to have so much magnificent flora and fauna, Colombia has also had a long history of political unrest, which has made it difficult to visit, research and manage many of our ecosystems.

The numerous setbacks notwithstanding, many efforts have been made in Colombia to understand and preserve its elasmobranch (shark and ray) populations, and various institutions in the region have collected general catch information. Most of the data are unreliable, however, since they are not collected consistently or at the species-specific level. Furthermore, most of the landings have been reported from the Pacific coast; less is known about the status of elasmobranch fisheries on Colombia's Caribbean coast.

**WHAT I DO**

Population trends and conservation status are not sufficiently understood for many elasmobranch species in the Caribbean, and even less is known about the intensity and type of artisanal fisheries that exploit these species, or take them as by-catch. Artisanal fisheries account for more than 95% of




# CAMILA CACERES

Photos by Julián Rodriguez


**MAGNITUDE OF ELASMOBRANCH EXPLOITATION AND BY-CATCH IN ARTISANAL FISHERIES OF COLOMBIA USING FISHERS' KNOWLEDGE**
**FLORIDA INTERNATIONAL UNIVERSITY**
**2016**
**COLOMBIA, CARIBBEAN COAST**
RESEARCH, CONSERVATION, EDUCATION
GREAT HAMMERHEAD (*SPHYRNA MOKARRAN*), SMALLTOOTH SAWFISH (*PRISTIS PECTINATA*), CARIBBEAN ELECTRIC RAY (*NARCINE BANCROFTI*)

fishers in the world, especially in the developing countries of the Americas, Africa and the Indo-Pacific region. In these countries, artisanal fisheries are of considerable social and economic importance to regional human populations. For my study, I will fill gaps in the data on elasmobranch density and diversity by conducting interview surveys with artisanal fishers. Filling these gaps will contribute to the proper management of species that are important to the health of Colombian coral reefs (the third largest barrier reef in the world) and to the economic viability of coastal fishing communities.

By enabling me to study the socio-economic aspects of fisheries and their potential effects on trophic cascades in a data-deficient region like the Caribbean, my course of research will allow me to pursue both my career and my personal goals. I believe that better recognition of the importance of both animal and human behaviour will result in more effective approaches to conservation, particularly in developing countries where artisanal fisheries are of great importance.

*'The support of the Save Our Seas Foundation (SOSF) has been fundamental in all the phases of my project. Among the best aspects of this grant have been the complete freedom of choice I had and the support of SOSF staff in making the public aware of my work. In short, without the foundation's trust, my project would not be ongoing at the moment.'*

**WHO I AM**

I graduated in conservation biology and recently enrolled in a PhD course at the University of Pisa. I've always been interested in animal behaviour and for the preparation of my MSc thesis I started to work on sea turtles, tracking the movements of loggerheads *Caretta caretta* in the Mediterranean Sea by satellite. The research project of my PhD is on the spatial behaviour of turtles and birds, especially in relation to environmental conditions, with the aim of understanding how the environment influences an animal's choices.

**WHERE I WORK**

My current activities are mainly computer based, analysing satellite-tracking data and mapping environmental parameters in relation to animal movements. Most of my working time is spent at the Department of Biology in Pisa, but now and then I travel to various parts of Italy to attach satellite tags to turtles at rescue centres and to help release rehabilitated turtles. These occasions are very important because they give me the opportunity to meet interested people and to explain my work and why it is so important to manage and protect sea turtles.

**WHAT I DO**

So far I'm using the Argos satellite system (*http://www.argos-system.org/*) to track sea turtles. Although this is the best tracking technology at present, it still has a number of limitations, especially for marine animals. The main problems relate to precision and the number of positions that can be obtained in this way. The accuracy of Argos localisations is inherently rather poor (error about 150–1,000 metres, or 490–3,280 feet, depending on the number of satellites connecting with the transmitter) and the transmitters can only send signals when the animal surfaces, which greatly limits the amount of data we can obtain. These problems can be overcome by using combined GPS–Argos transmitters that acquire GPS positions and relay them to satellites, thus using Argos only as an information channel. Even this approach has its limitations: from experience, we estimate that only 30% of GPS locations reach the user through the Argos channel.

An efficient solution found for terrestrial animals is the use of transmitters that send GPS information through a GSM (mobile phone) channel. Many birds are now tracked with this technology, and the Islameta Group at the University of Pisa believes it can be adapted for the marine environment too. Researchers in the group are trying to develop a new tag that will be suitable for sea turtles (and applicable to other marine animals) and will use GSM instead of Argos as a channel for GPS information. This system could be a valid alternative to Argos and even more accurate, as it may send a greater number of more precise locations (GPS error is less than 10 metres, or 33 feet), reducing data loss. Most importantly, the system would be much more cost-effective than the existing Argos telemetry, especially as the cost of maintenance will be limited to the cheap GSM fees. Once created, the new system could be implemented with other sensors in addition to GPS, potentially giving us more information than just the geographical




# GIULIA CERRITELLI

Photo by Giulia Cerritelli

**FEASIBILITY OF A NOVEL, LOW-COST TRACKING SYSTEM TO MONITOR THE MOVEMENTS OF MARINE TURTLES**

**UNIVERSITY OF PISA**

**2016**

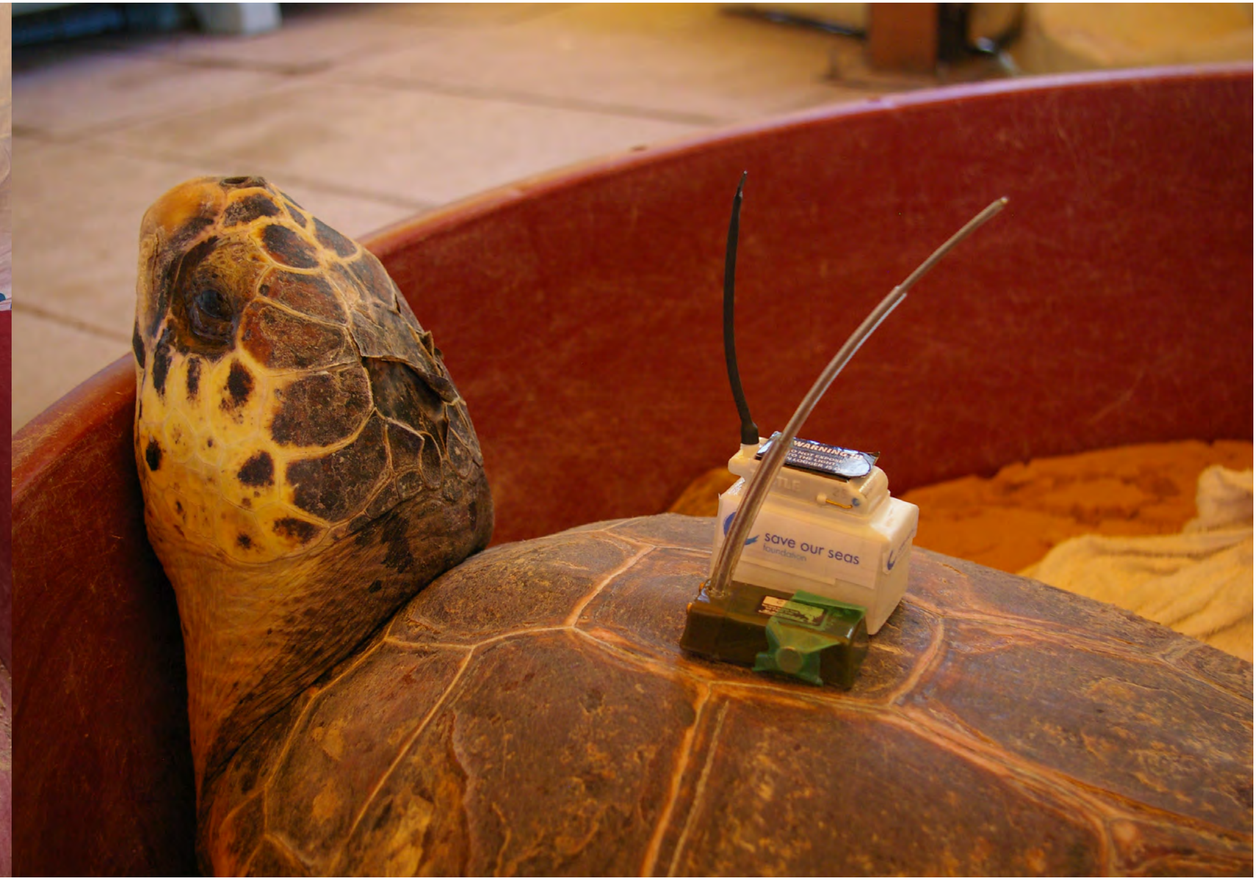
**ITALY, CENTRAL MEDITERRANEAN SEA**

RESEARCH, CONSERVATION

*CARETTA CARETTA*

position of the animal, such as the depth of turtle dives or the direction of movement.

Although my project has just started, some progress along these lines has already been made. Thanks to funds from the University of Pisa, we have been able to buy two GSM–GPS tags originally designed for birds (*http://www.ecotone-telemetry.com/en*), which have been modified for deployment in the marine environment. We are now testing these units and are going to release sea turtles with this prototype in late spring.




Photos by Paolo Lutzhi.

**CALIBRATING AN EMERGING TROPHIC ECOLOGY TOOL FOR WILD ELASMOBRANCH POPULATIONS USING AQUARIUM-HELD ANIMALS**
**FLORIDA INTERNATIONAL UNIVERSITY**
**2016**
**UNITED STATES OF AMERICA**
RESEARCH
SAND TIGER SHARK (*CARCHARIUS TAURUS*), SANDBAR SHARK (*CARCHARHINUS PLUMBEUS*), ATLANTIC STINGRAY (*DASYATIS SABINA*)

### WHO I AM

If you ask anyone who knew me as a child, they will probably tell you that I talked incessantly about becoming a marine biologist. I was fortunate to grow up in California and spent much of my childhood exploring tidal pools, marvelling at the diversity of species in them and poking at various creatures to see how they would respond. The rocky intertidal zone along the central coast of California is one of the most diverse marine habitats in the world and I had this practically in my backyard. A BSc in marine biology, and later a PhD, made my scientific aspirations a reality.

I have since worked for public aquariums in Oregon, the US Virgin Islands, Alaska and Florida as both an educator and an aquarist. I was privileged to work alongside staff who not only cared about the animals, but were also dedicated to educating the public about the ocean and the importance of conservation. I'm now a postdoctoral associate at Florida International University and adjunct faculty at two other colleges.

### WHERE I WORK

The public spaces of an aquarium are bustling with excitement. Slipping through a door to go behind the scenes is like being transported to another world entirely. Bright colours and carefully arranged exhibits give way to concrete walls, PVC pipes and filtration equipment. The noise of the crowds fades away and is replaced by the rush of water and the hum of pumps. The back area of public aquariums may seem utilitarian and boring, but these spaces contain everything necessary to look after marine animals that are often living hundreds of miles from the nearest coast. Behind the scenes, dedicated husbandry staff spend their days taking care of the sharks and rays used in our research.

### WHAT I DO

Understanding the feeding ecology of sharks and rays is critical to the conservation and management of these animals and their ecosystem, particularly as shark species are declining worldwide. Stable isotopes are naturally occurring biological tracers that help scientists study feeding patterns in the wild when it is not possible to observe feeding directly. Two elements – carbon and nitrogen – pass from food to consumer in predictable ways. By measuring isotopes of these elements from tissue samples, scientists are able to estimate what eats what within an ecosystem. Importantly, this estimate is complicated by migrations, feeding in multiple habitats and differences in physiology. Compound-specific stable isotope analysis of amino acids, rather than examining whole muscle tissue, shows great promise in overcoming some of these limitations.

My co-investigator, Robert Nowicki, and I aim to use the sharks and rays held in public aquariums to develop appropriate methods for calibrating this emerging tool in food web ecology for use in wild shark populations. Robert has worked closely with large sharks for four years while collecting data for his PhD dissertation, which focuses on how sharks and ecological disturbances affect one another and the broader ecosystem. We are currently collaborating with the Mystic Aquarium in Connecticut, USA, to collect samples from animals and their food items. This project is still in its infancy and we are actively seeking additional aquariums to collaborate with.




# DIANA CHURCHILL

Photo by Diana Churchill

*'The Save Our Seas Foundation (SOSF) supported me at a time when my project was severely compromised by anthropogenic development in my study area. The continuation of my acoustic telemetry project, promoted by the SOSF, not only enabled me to carry on with my PhD, but also gave a BSc student the opportunity to take part in this project and learn some valuable field skills. For this reason, I'd like to thank the SOSF for supporting scientists who are embarking on pioneer projects.'*

# FÉLICIE DHELLEMMES

Photo by Mahault Gerard

**WHO I AM**

It all began on the arid Baja California peninsula one weekend in 2012 when I met Ursula and Abraham. Ursula was the biggest animal I had ever seen. I stumbled upon her as I was taking a swim in the murky waters of the Bahia de los Angeles in the Sea of Cortez. Her skin was like a starry night and her mouth like a black hole. Abraham was a doctor who spent his free time helping the scientific team with a survey of the whale shark population in the bay. After apologising for swimming in the protected 'shark zone', I managed to persuade Abraham to let me help him for the weekend. Ursula was the first shark I had ever seen and the thought of seeing more like her was irresistible. After a few days of helping Abraham, I met the scientific team and was offered a position as a research assistant for six months on the project. That is how I got into sharks.

Before that I was studying for my Master's degree in agricultural sciences. I have been obsessed with animal behaviour and horses ever since I was a child and had envisaged that I would work with horses, cattle, big mammals in Africa, birds in the rainforest, aquaculture fishes or even insects. Never had I imagined myself working for a PhD in the big blue, especially not with juvenile lemon sharks!

**WHERE I WORK**

I remember being very intimidated the first time I entered the building of the Bimini Biological Field Station. It was so small and crowded, and yet everyone seemed to know where they were going and what they were doing – everyone except me!

The Bimini Biological Field Station, also known as the Shark Lab, studies the sharks and rays that inhabit the waters around Bimini. It benefits from the incredible diversity of habitats created by the interplay between the deep waters of the Gulf Stream and the Great Bahama Bank. Because of this diversity, at least 13 species of elasmobranchs can be found close to Bimini, creating a great scientific playground for the 'Shark Labbers'. These form a group of about 20 individuals, usually fairly young, who come from all over the world but have one common denominator: a fervent passion for sharks. Such a great mix of motivated brains and shark research opportunities is deemed to create a never-ending stream of new research ideas. Indeed, the Shark Lab always has on board three PhD students and a couple of students with independent projects, in addition to the scientists carrying out long-term research projects. There is always something to do. We work long hours and days off are scarce, but there is nothing better than working with such a great group of friends on amazing animals!

**WHAT I DO**

At the Shark Lab, I am one of three lucky PhD students – and I was one of the lucky MSc students before that. My project focuses on the personality of juvenile lemon sharks. Defined as a consistency in

Photo by Eugene Kitsios

Photo by Michael Scholl

Photo by Michael Scholl

behavioural response over time and across situations, personality is a well-documented subject in many animal taxa that range from mammals to insects. However, most studies focus on small, non-predatory animals that are easy to capture and keep in captivity. I am trying not only to fill this taxonomical gap by documenting personality in sharks, but also to understand what consequences different personality types would have in wild shark populations. Would sharks have different life-history traits depending on their personality? Would some sharks be more likely to take risks than others? These are some of the questions I am hoping to answer.

This project involves captive behaviour trials, multiple captures of the same individuals using gill nets, stable isotope sampling, active and passive telemetry and genetic sampling.

**ECOLOGICAL CONSEQUENCES OF PERSONALITY IN SHARKS**

**BIMINI, BAHAMAS**

**2016**

**BIMINI, BAHAMAS**

RESEARCH, CONSERVATION

LEMON SHARK (*NEGAPRION BREVIROSTRIS*)

Photo by Framoudou Doumbouya

# FRAMOUDOU DOUMBOUYA

**WHO I AM**

Enseignant chercheur, fonctionnaire au Ministère de la Pêche, de l'Aquaculture et de l'Economie Maritime, je suis le Chef Adjoint du Département Pêche Artisanale Maritime au Centre National des Sciences Halieutiques de Boussoura (CNSHB).

Titulaire d'un master et d'un doctorat en sciences biologiques, j'ai enseigné à l'Université de Conakry les cours de biologie marine aux étudiants de 3ème année du Département de Biologie de la Faculté des Sciences et les cours d'ichtyologie aux étudiants de la 4ème année de la même Faculté de 1983 à 1998.

**WHERE I WORK**

Depuis 1999, je travaille au CNSHB, j'ai participé à la mise en œuvre de différents projets tant au niveau national que sous-régional tels que: le Projet Pêche Ecologique en Guinée (PEG) en 2003; le Projet d'Evaluation des impacts environnementaux dans le cadre de la construction d'un port minéralier à Matakang par Rio-Tinto « Volets ressources marines de 2008 à 2011 »; le Projet Sous-Régional pour la Conservation et la Gestion Durable des Raies et Requins en Afrique de l'Ouest (PSRA-Requins) de 2004 à 2011.

**WHAT I DO**

Actuellement, je suis le Chef de Projet *Manta Trust West Africa* qui regroupe la République de Guinée, la Sierra Leone et le Libéria. Je suis consultant en conservation et gestion durable des ressources marines au CNSHB.

Au bénéfice d'appuis techniques et financiers de la *Fondation Save Our Seas* et du *Manta Trust*, je contribue et participe largement à la mise en œuvre d'activités de terrain relatives aux études sur la pêche, l'identification des espèces de Mobulidae (manta et mobula) et les circuits de commercialisation de leurs produits de pêche (viande, branchies, ossements, etc.).

**EVALUATION DE L'IMPACT DE LA PÊCHE ARTISANALE DES RAIES ET REQUINS EN AFRIQUE DE L'OUEST**
**CENTRE NATIONAL DES SCIENCES HALIEUTIQUES DE BOUSSOURA**
**2016**
**GUINEA, SIERRA LEONE & LIBERIA**
RESEARCH
*MANTA BIROSTRIS*, *MOBULA* SPP.,
*SPHYRNA LEWINI*, *RHINOBATOS CEMICULUS*

*'Working with the Save Our Seas Foundation (SOSF) has been unlike any regular funding experience. The foundation's approach is unique, being highly flexible and supportive, and its staff truly believed in the project, wanting it to succeed. Their special approach is driven by their overarching desire to protect the health of our oceans and to provide marine animals with the chance to thrive that they deserve. Ultimately, the SOSF's support has enabled us to gain unparalleled insights into the molecular drivers of the growth of virulent tumours in sea turtles and has laid the foundation for improved treatment and management strategies.'*

**WHO I AM**

My father's family are seafarers. Their lives revolve around the fishing industry and serving in the Royal National Lifeboat Institution. So when I was growing up in Dublin, Ireland, much of my childhood was spent along the coast or out on boats, and throughout my life my affinity for the ocean has endured. During my undergraduate studies in zoology I studied the marine ecosystems and wildlife around the Irish coast and took part in an island biogeography project in Indonesia, where I was first captivated by wild sea turtles.

My postgraduate studies took me to the west of Ireland to study the embryology and regenerative biology of *Hydractinia echinata*, also known as snail fur, which is a tiny marine organism related to corals and jellyfish. From there my focus moved for a time to human cancer, but I became convinced that the cutting-edge techniques I was using could be applied more broadly to problems beyond human medicine. So in 2015 I embarked on a project that brought me back to wildlife and back to the sea.

**WHERE I WORK**

My daily commute consists of a beach walk to the University of Florida's Whitney Laboratory for Marine Bioscience and the Sea Turtle Hospital, which are idyllically nestled between the Intracoastal Waterway and the Atlantic Ocean. Juvenile sea turtles enjoy the rich foraging grounds just offshore, while adults come ashore here in their thousands to nest.

Sea turtles that were injured or stranded along Florida's north-eastern coast used to be driven in relay across the state to rehabilitation hospitals for treatment. If they showed symptoms of a disease called fibropapilloma (FP) they were driven even further, to a facility equipped to deal with this disease. Our new sea turtle hospital opened in 2015 to fulfil the growing need in this part of Florida for a place to treat and rehabilitate stranded turtles and, even better, it can treat turtles with FP. The location of the laboratory and the hospital next to one another means that while conducting ground-breaking laboratory investigations with cutting-edge technology, I can also be on hand to examine turtles with FP, be present during operations and get involved with the rehabilitation process. This is my ideal working environment – getting involved directly with the animals I'm studying and seeing at first hand the impact of my research.

**WHAT I DO**

Sea turtles, particularly green turtles, have increasingly been found with large tumours that develop during their juvenile life stage inshore. When these tumours are so large that they prevent the turtle from swimming, feeding or seeing normally, they can be fatal. Fibropapilloma is a cancer that is found in all seven sea turtle species. It was first reported in the 1970s within a relatively small area, but it is spreading geographically and northern Florida has become a new FP 'hotspot'. Tumour development is thought to be linked to environmental factors that activate a herpes virus. Human-induced global warming and environmental pollution are therefore the most likely triggers of the current spread.




# DAVID DUFFY

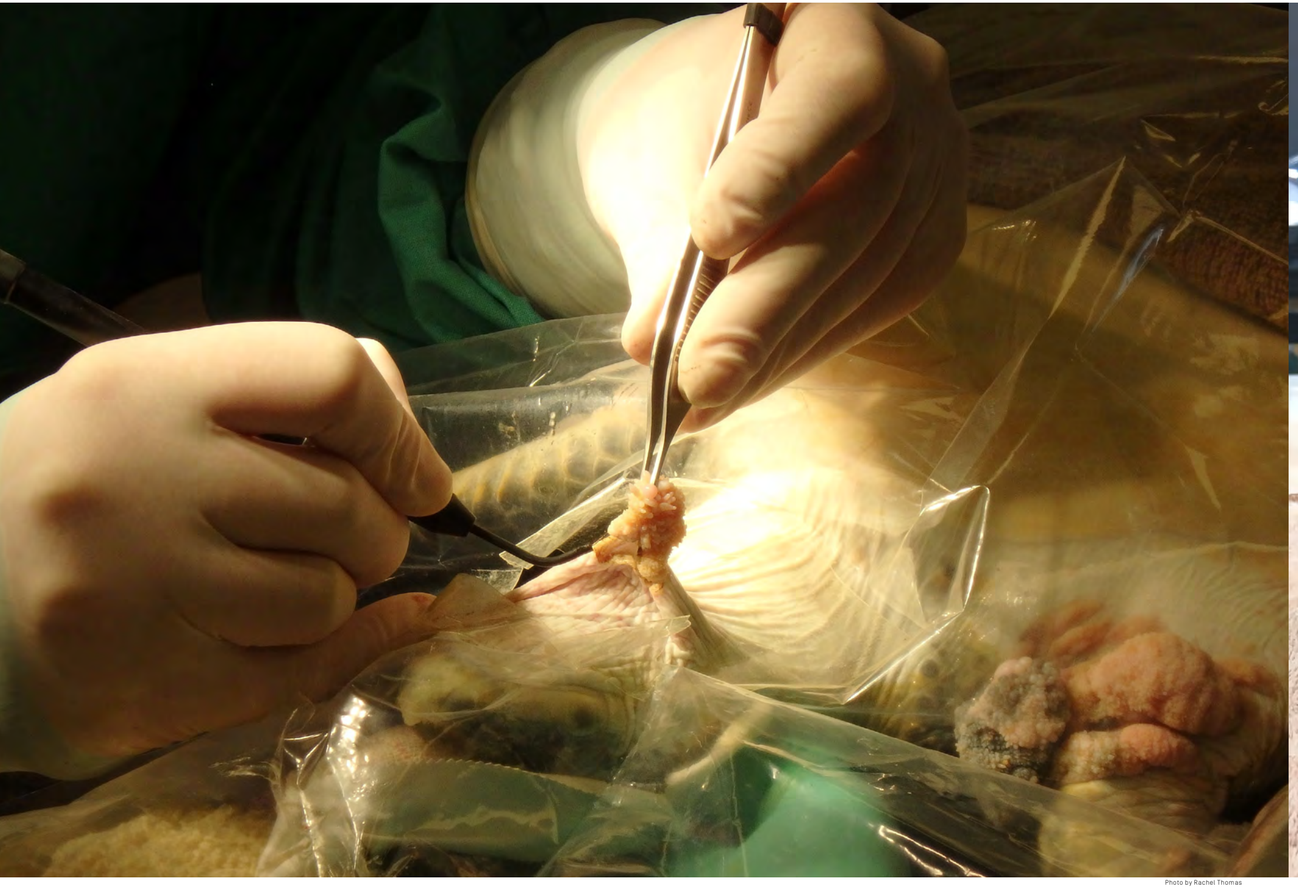


Photo by Rachel Thomas

Photo by Brooke Burkhalter

## HARNESSING ADVANCES IN HUMAN ONCOLOGY FOR SEA TURTLE CONSERVATION: NOVEL THERAPEUTIC TREATMENTS FOR FIBROPAPILLOMA TUMOURS

**SEA TURTLE HOSPITAL, THE WHITNEY LABORATORY FOR MARINE BIOSCIENCE | UNIVERSITY OF FLORIDA**

**2016**

**FLORIDA, USA**

RESEARCH

GREEN TURTLE (*CHELONIA MYDAS*), LOGGERHEAD (*CARETTA CARETTA*)

With the support of the Save Our Seas Foundation, we aim to get a clearer picture of how and why FP occurs and to develop effective ways of treating the tumours. I use techniques from human oncology to genetically profile FP tumours and identify possible drug treatments. I determine which of the turtles' more than 20,000 genes are abnormally switched on or off in the tumours, which enables me to pinpoint the genes driving tumour growth. I can then identify human anti-cancer drugs that would target these genes, preventing the tumours from growing. This will greatly improve the recovery and survival of turtles with FP, while our understanding of the genetics of tumour growth will help to determine which environmental problems in the turtles' inshore habitat trigger this disease.

# ISABEL ENDER

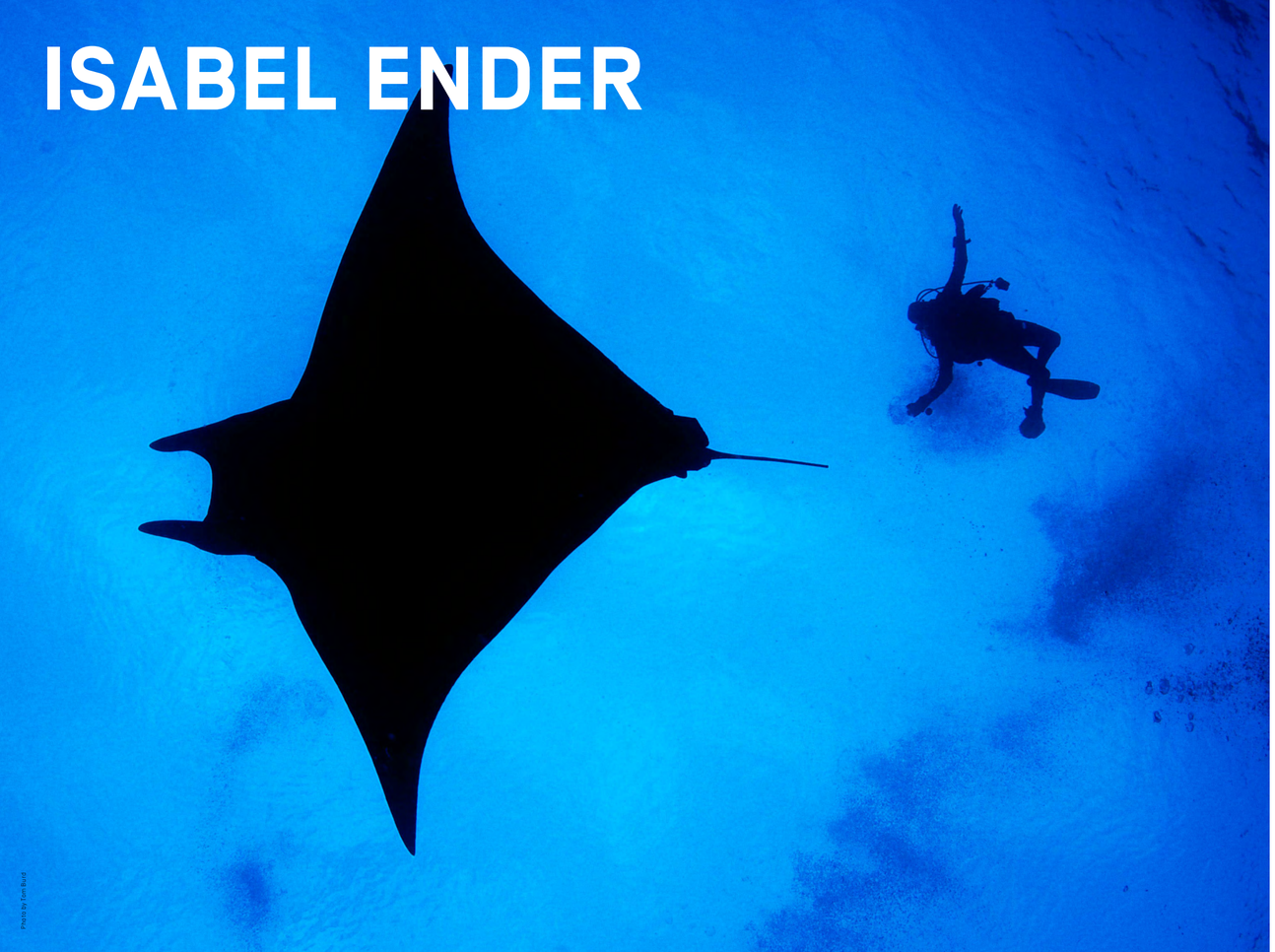


Photo by Tom Burd

*'The Save Our Seas Foundation (SOSF) has been a longstanding partner of the Manta Trust. We are incredibly grateful for its continued support, which extends beyond simply giving grants. In this particular project, the media team went out of its way to produce a video with shark advocate Achmat Hassiem, which we used to raise support for the shark and mobula ray CITES proposals at government workshops. In addition, SOSF funding enabled us to coordinate activities for the mobula proposal in the lead-up to CITES CoP17. It helped us to establish a coalition among non-governmental and inter-governmental organisations and to produce resource materials to send a clear and unified message for sharks and rays. Ultimately, it meant a successful listing of mobula rays on CITES Appendix II!'*

**WHO I AM**

Because I grew up on a beach in Senegal, Africa, some of my first memories are of falling asleep to the sound of the crashing waves of the Atlantic Ocean. It was the most beautiful and soothing sound and I am convinced that my love for the ocean began right there. Yet it took me quite some time, and a couple of fun detours in my life, until I stumbled back into the ocean to do a scuba-diving course and realised that this was what I had been looking for. I was back where I belonged.

Completing my degree in marine biology on the Great Barrier Reef in Australia felt like Christmas and birthday every day; I was fascinated. Upon graduating, I thought that only one thing could make life better and that would be to study the most incredible animals in the ocean: manta rays. I've now been working for the Manta Trust for almost three years, researching and protecting these majestic creatures, and I still want to pinch myself to believe it's true.

**WHERE I WORK**

The Manta Trust is a global network of projects and collaborations in more than 20 countries. A large proportion of our work is carried out in South and South-East Asia, where the biggest fishery for mobulid (manta and mobula) rays occurs. Targeted mobulid fishing has expanded considerably over the past decade because the rays' gill plates, used to filter plankton from the water, are increasingly sought after as ingredients in traditional Chinese medicine. The growing demand for gill plates and the international trade in them have had a devastating effect, resulting in local population declines of up to 90%. By-catch, or incidental catch, is another challenge, as about 14,000 rays are caught in tuna purse-seine fisheries every year. Mobulid rays take a long time to reach maturity and produce few offspring in their lifetime, so populations cannot recover when faced with high fishing pressure.

The Manta Trust's projects also span the Pacific and Indian oceans and are located in a number of places in Latin America, where we work to support sustainable manta tourism and study the behaviour and life history of mantas, in addition to carrying out fishery research. Did you know that manta tourism contributes US$140-million to the global economy every year? This means not only that these species are fascinating in themselves, but also that manta tourism can provide local communities with a sustainable alternative to fishing.

Photo by Tane Sinclair-Taylor

Photo by Danny Copeland




Photo by Guy Stevens

Photo by Danny Copeland


**WHAT I DO**

As the head of conservation strategy for the Manta Trust, I work closely with project leaders on the ground to achieve our research, outreach and conservation objectives. I am particularly fascinated by mobulas, or devil rays, because so little is known about them. They face the same threats as mantas, their larger cousins, but do not receive an equal level of protection. The monitoring of fisheries is sparse and the data are often poor, partly because it is so tricky to identify the different species. Understanding the scale and impact of mobula fisheries, communicating the data and advocating for enhanced protection, such as listing mobula rays on the Convention on International Trade in Endangered Species (CITES), is really important so that sustainable regulations for mobulid trade and fisheries can be established before it is too late. My work includes informing and educating decision-makers, governments and the general public about threats to these species, producing digital and printed resource materials to raise their profile and conducting training on the identification of species and gill plate to provide customs and fisheries officials with the skills to monitor trade and support enforcement measures. I also participate in key conferences to advocate for national and international protection. And whenever I can, I get back into the water to see the mantas and little devils and to remind myself why it is so worthwhile to protect them.

**PAVING THE WAY FOR DEVIL RAY PROTECTION AT THE 2016 CITES CONFERENCE OF THE PARTIES**

**THE MANTA TRUST**

**2016**

**WORLDWIDE**

CONSERVATION

MOBULA RAYS

Photo by Duncan Leadbitter

# LACHLAN FETTERPLACE

**FACILITATING LONG-TERM AERIAL MONITORING OF INSHORE SHARK DISTRIBUTION AND ABUNDANCE IN SOUTH-EASTERN AUSTRALIA**

**AUSTRALIAN AERIAL PATROL**

**2016**

**SOUTHERN NEW SOUTH WALES, AUSTRALIA**

RESEARCH

SHARKS

## WHO I AM

I grew up in south-eastern Australia and ever since I can remember I have been fascinated by the aquatic world – and by fish in particular. My dad still likes to tell people how as a child I used to run to any patch of water, whether it was a puddle or the ocean or anything in between, and shout that I could see a fish! No matter how small or insignificant that fish, I was still very excited and usually had to be carried away from the water I was looking into or I would never leave. In my early years, most of my direct interactions with aquatic ecology took place at a small creek that ran through the suburb I grew up in. For years, together with my best mate and my siblings, I watched snakes and birds and collected tadpoles, eels, invertebrates, lizards and whatever else could be found. Sadly, that little creek is now concreted over, but my love for water has remained and it eventually led me into marine research. I now spend a lot of time sharing my love for the ocean through Fish Thinkers Research.

I am currently working on my PhD, using underwater video footage to look at the ecology of fishes found on marine sand and investigate how their communities change across gradients of fishing pressure. I also use acoustic tracking to study the movement patterns of some of these fishes, both inside and outside marine protected areas.

When not busy with my PhD, I join global challenges collaborators at the University of Wollongong to crunch numbers from 70 years of shark meshing and look at alternative, non-lethal means of protecting water-users from sharks. This involvement includes an advisory role on Project Airship, a new initiative that uses lifeguards, tethered blimps and video technology to try to reduce the likelihood of shark encounters in sections of beach patrolled by lifeguards. Now, with the support of the Save Our Seas Foundation, I am working with the Australian Aerial Patrol (an organisation that makes regular shark-spotting flights over the south coast of New South Wales) to improve how it collects data of shark sightings.

## WHERE I WORK

The south-eastern coast of Australia is a beautiful stretch of coastline that is made up of starkly contrasting vistas, from the industrial waterfronts of the city of Wollongong to the beautiful and relatively pristine shores of Jervis Bay Marine Park and Batemans Marine Park. I am lucky to spend a lot of time on the water, filming the underwater world and as part of a team catching and tagging flatheads, banjo sharks and other fishes at Jervis Bay. Meanwhile, throughout the warmer months, the Australian Aerial Patrol is overhead making regular observation flights.

## WHAT I DO

Currently in Australia an intense debate is raging about the increased number of shark interactions, and reducing these incidents in a non-lethal manner has become a major conservation challenge. Several culling programmes are already in place and locally there is increasing pressure on the New South Wales government to implement greater management of shark populations. On the positive side, there are now a number of non-lethal alternatives being put forward.

The Australian Aerial Patrol has been recording shark sightings along a 200-kilometre (125-mile) stretch of coastline for the past 18 years – and creating a long-term dataset that you will rarely find elsewhere. With the support of the Save Our Seas Foundation, I will help to bring together a large team of experts to analyse these long-term data and to work on improving the collection methodology so that it is more statistically robust and therefore more useful in a scientific sense. We will then test the improved methodology during the 2016–17 flying season to see if any further changes are required.

Our main aim is to ensure that the data collected are credible from a scientific perspective and can be used by the people responsible for putting shark safety strategies in place. I believe it is imperative that these non-lethal mitigation methods have a strong scientific foundation, so that governments have the confidence to implement them. The Australian Aerial Patrol is already recording shark sightings and we can add a lot of historical data that are of great value – let's put them all to good use!

*'The resources provided by the Save Our Seas Foundation were crucial and assisted with the field component of the project and the purchase of acoustic tags.'*

**WHO I AM**

I am an avid adventurer and traveller with a love for nature and a huge concern about our planet's natural environment. Being raised in Brazil's São Paulo, one of the largest cities in the world, I didn't have many opportunities to explore and experience nature during my childhood. Travel provided the connection that I so desired. After living in England during my early teens and learning about African culture and history, my dream was to live in Africa and be a veterinarian for big animals. Luckily, I had the opportunity to spend a month in Zimbabwe when I turned 16. An elephant chasing me while I was there was the turning point, though, and I decided that working with big animals was not for me. A year later I went to the Cayman Islands and visited a manta ray foraging area, where a ray gave me a huge hickey. Fascinated by the rays' behaviour, I struck up conversations with the local marine biologists. After this trip I knew I was going to join their ranks. I moved to Australia to undertake my undergraduate degree in marine biology and environmental sciences. During my first year as an undergraduate I went back to Brazil to conduct a one-month internship at Projeto Tamar (a sea turtle group in Brazil). Since then I have been captivated by sea turtles and have been motivated to work for their conservation. In most of the places where I work I am now known as 'the turtle girl'.

**WHERE I WORK**

Explaining where I work is as difficult as saying where I am from. As sea turtles are highly migratory, so is my work. I have worked at various projects in Australia, Brazil, Madagascar, Vanuatu, Barbados and the USA, providing biological and ecological data to inform the management and conservation of sea turtles. The geographic locations of my projects are driven by the need of the research in those locations. I am extremely excited at the prospect of working at Bimini in The Bahamas. The surrounding waters provide important habitat for several species of shark and sea turtle and they are an ideal location for investigating the interaction between sharks and turtles.

**WHAT I DO**

Understanding the details and drivers of predator–prey interactions is important for predicting community dynamics and to inform the management of species and their conservation. Although there is an overlap in the distribution of shark species known to predate on sea turtles, there is limited information about the interactions between these species. There are also few insights into habitat overlap or how encounters with predators influence turtles' decisions on how they use their habitat. Our project aims to improve the understanding of how the presence of sharks influences the habitat use of sea turtles and



# MARIANA FUENTES

Photo by Camila Domit

Photo by Leonardo Mata

to elucidate whether shark behaviour is influenced by high turtle density. To explore this we will acoustically tag a number of shark and turtle species simultaneously. The results we achieve will address important ecological questions and can inform the development of effective marine protected areas and the successful management of turtles, sharks and their habitats. This is particularly important at Bimini, where widespread habitat degradation is taking place to accommodate the expansion of land-based tourism.

**PREDATOR-PREY INTERACTIONS: UNDERSTANDING HOW SHARK PRESENCE INFLUENCES SEA TURTLE HABITAT USE, DISTRIBUTION AND MOVEMENT**

**FLORIDA STATE UNIVERSITY**

**2016**

**BIMINI, BAHAMAS**

RESEARCH, CONSERVATION, EDUCATION

TIGER SHARKS (*GALEOCERDO CUVIER*), BULL SHARKS (*CARCHARHINUS LEUCAS*), GREEN TURTLE (*CHELONIA MYDAS*), LOGGERHEAD TURTLE (*CARETTA CARETTA*)



Photo by Matthew Smukall

*'With the support of the Save Our Seas Foundation, this working year has been very successful and important for our team. We have been able to establish a solid line of work with the sharks of Peninsula Valdes, especially with the sevengill shark, a species listed by the IUCN as Data Deficient and probably the most abundant and important shark in the study area's marine environment.'*

**WHO I AM**

One of my earliest memories is of catching a rainbow trout in a river in Patagonia with the help of my mom. Since then, even though most of the time I was far from fishes and the wild, some part of me was always thinking about them, mostly wondering what they do in winter and what they eat. Incredibly, the situation hasn't changed much! It was this fascination from my earliest years that prompted me to become a keen fisherman and then to specialise in diving, underwater photography and any activity that brought me closer to fishes and their environment. My concern for the welfare and the conservation of fishes and our natural heritage has always been important to me.

**WHERE I WORK**

I work at 'El Centro Patagónico', which is linked to the National Research Council of Argentina. This regional multidisciplinary institute focuses on the management of aquatic and terrestrial resources, as well as on oceanography and meteorology, social sciences, geology, palaeontology and evolution. Committed to the conservation and sustainable use of natural resources, it collaborates with research groups and offers scientific support to a wide range of governmental and non-governmental institutions.

The Valdes Peninsula, which is also defined as the 'North Patagonian Gulfs Eco-region', was designated a UNESCO Natural World Heritage Site in 1999 and is the place where I work most of the time. Because of its spectacular concentration of breeding sites for marine birds and mammals, this incredible region has been assigned the highest conservation priority among eco-regions in southern South America. A great deal is known about its seabirds and marine mammals, but there is a surprising lack of knowledge about its sharks and rays – and no ecological studies are being carried out on them at all. Hence, there is an urgent need for information so that a conservation and management agenda can be set.

**WHAT I DO**

In my position as a researcher and with the freedom to chose my line of study, I have the opportunity to bring about positive changes in shark conservation by means of scientific knowledge and educational outreach. Most of my work is focused on finding answers to ecological questions. These answers aim to be useful for the conservation and sustainable use of fishes as a resource and as part of our natural heritage. Also, and with the same objective, I dedicate part of my time to interacting with management agencies and stakeholders.



# ALEJO IRIGOYEN

Photo by Alejo Irigoyen

Photo by Noela Sanchez

Photo by Gaston Trobbiani

**SHARKS FROM PENINSULA VALDES: A RESEARCH AND CONSERVATION INITIATIVE**

**CENTRO NACIONAL PATAGONICO**

**2016**

**PENINSULA DE VALDES, ARGENTINA**

Research, Conservation, Education

*Galeorhinus galeus*,
*Notorynchus cepedianus*

**WHO I AM**

My earliest and happiest childhood memories are of being on the beach in Greece, where I grew up. I remember being fascinated by all things marine and very quickly became obsessed with sharks. It must have been a combination of watching the *Jaws* film series and often seeing sharks sold in supermarkets. But all I knew was that I wanted to learn everything about them and bought every book I could find. More than 30 years later, I am probably even more in awe of them and realise how much more we need to learn about them.

I started my path in this field by volunteering for several projects around the world, including a study focusing on great white sharks in Gansbaai, South Africa, and one on lemon sharks in Bimini, The Bahamas. Somehow this passion for sharks and rays eventually led to a PhD investigating shark fisheries in the United Arab Emirates (UAE). It has been a long and interesting journey and my work has enabled me to travel the world for research or to attend and contribute to scientific as well as management and conservation meetings. My connection with the ocean and its creatures keeps growing stronger and I hope that in the long term my work will have led to an improvement in the status and conservation of sharks and rays.

**WHERE I WORK**

I came to the UAE on vacation and have now been here for almost 10 years! I am based in Dubai but spend a lot of time travelling in the Arabian Seas region, which includes the Arabian Gulf, Arabian Sea and Red Sea. This area is known mostly for its vast desert landscapes, oil industry and mega-construction projects, but its marine biodiversity is spectacular and remains understudied. When I first moved to Dubai there was very little information about sharks and rays, although the region was known as a hub for the trade in shark fins to Hong Kong (particularly from the UAE and Yemen). Also, the neighbouring countries of India, Pakistan and Iran were considered some of the top shark-catching nations in the world. The more I read about the region and its fisheries, the more I realised that research was needed to understand what was really happening, the magnitude of the shark fisheries and their potential impact on shark and ray populations in this region.

**WHAT I DO**

Over the past decade, the core of my work has focused on trying to understand fisheries in the Arabian Seas region. My PhD research on shark populations along the UAE coast of the Arabian Gulf was the first long-term research project to be completed on sharks and rays in the region and led to the development of the Gulf Elasmo Project (*www.gulfelasmoproject.com*). My initial goal was to understand the nature of the interactions between fishers and these species. I wanted to know how many sharks and rays were being captured in the artisanal fisheries, their sizes, sex ratios, distribution and the types of gear they are most susceptible to, as well as the socio-economic aspects of the trade in marine products. I worked closely with local fisher communities and interviewed them to understand the characteristics of this fishery. I also visited landing sites and fish markets, trying to collect information about species diversity, and I measured, sexed and collected genetic samples from as many specimens as I could. Although I still visit these landing sites to collect as much fisheries-dependent data as possible, I now also work closely with governments and NGOs in the region to raise awareness of the status of sharks and rays. I have been involved in many training and capacity-building initiatives to improve the collection of fisheries data, develop tools for data collection and the identification of species (*http://www.gulfelasmoproject.com/species-information.html*), and support policy development while pushing for the conservation and management of species. Through my growing network of collaborators in the region and my role as the representative for Asia on the Advisory Committee for the Sharks MOU under the Convention on Migratory Species, I hope that I can better understand the status of sharks and rays in the region and push for change in the management of them and the implementation of meaningful measures for their protection and conservation.

The latest project I have been involved in, funded by the Save Our Seas Foundation, was to undertake a regional Red List Assessment of sharks and rays in the Arabian Seas region. The workshop associated with this assessment was held in Abu Dhabi from 5 to 9 February 2017 and was hosted by the Environment Agency Abu Dhabi in collaboration with the IUCN Shark Specialist Group. Its main aims were to gain a better understanding of the status of sharks and rays and to develop a baseline by which governments can measure the change in Red List status of species in response to improvements in management. One of the outcomes from the workshop is a final report that will be ready in June 2017. We hope that it will be the first step in the development of regional research and management priorities, and that it will support the implementation of effective conservation strategies for those species that are most threatened.




# FRANCES KINNEY

*'Ocean Connectors is developing our first shark-themed environmental education curriculum for under-served middle school students in Southern California with support from the Save Our Seas Foundation (SOSF). The grant has enabled us to expand the impact of our programmes by reaching students beyond elementary school in an especially formative childhood time – the seventh grade. The students' knowledge of marine science, shark conservation and careers in oceanography will increase as a direct result of the SOSF funding. In addition, the* Save Our Seas *magazine is a fantastic resource for helping our team learn about the latest challenges and solutions for shark conservation.'*

**WHO I AM**

Being outside in nature has always been a big part of my life. At first it didn't occur to me that not every kid catches fish, snakes and bats in their backyard. Going to the beach, camping, fishing and visiting zoos and aquariums were all a regular part of growing up for me. When I moved to the city to kick-start my career after college, I noticed that many children do not have access to coastal adventures, animal encounters and outdoor excursions like I had. If future generations are to care about and respect our environment, they need a chance to experience and discover it at first hand. They need to build a personal connection.

I was fortunate to begin my career working with incredible mentors and role models in non-profit management and sea turtle conservation, and they encouraged me to pursue my new-found passion for environmental education. I try to carry on that tradition of mentoring and offering guidance to students and aspiring conservationists. It feels like I am making a difference, one young mind at a time, by sharing with others the marvels and mysteries of the natural world found right in our own 'backyard', the Pacific Ocean.

**WHERE I WORK**

I created Ocean Connectors to spread awareness about how we can all play a role in helping to conserve wildlife. The mission of Ocean Connectors is to educate, inspire and connect under-served young people in Pacific coastal communities through the study of migratory marine life. Ocean Connectors builds a bridge between scientific experts and urban youth in San Diego, California. This unique mentorship opportunity inspires the next generation of conservation leaders.

We focus on three easy and tangible ways to help the environment:

• Reduce, Re-use, Recycle: avoid single-use products like straws and plastic bags; use a re-usable water bottle; and recycle at home and work.

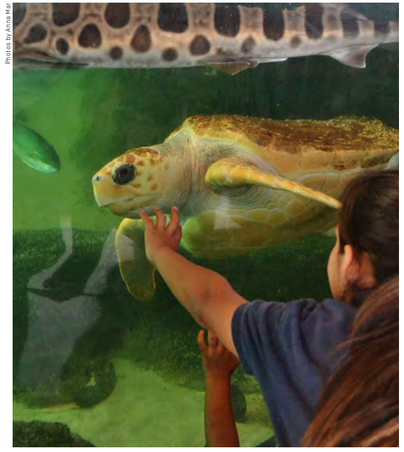
• Choose Sustainable Seafood: buy local seafood and make sure you are informed so that you do not contribute to sea turtles, dolphins and sharks being taken as by-catch.

• Protect Natural Habitats: choose native and drought-tolerant plants for your yard; use earth-friendly products; and pick up litter in your neighbourhood.

**WHAT I DO**

Ocean Connectors offers free youth education programmes and public eco-tours that focus on migratory marine species, including sea turtles, whales

Photos by Anna Mar



and birds. Participating students receive continuous year-to-year marine science programmes during a critical formative time in their childhood, when they are developing core opinions and lifelong values. With support from the Save Our Seas Foundation, we are developing a new shark education programme for middle school students. Major threats to sharks include direct exploitation for their fins and meat and being taken as by-catch in gill nets and on long lines.

Children are naturally curious about the ocean and they are motivated to take action. They are also excellent messengers for their family, friends and pen pals. Ocean Connectors provides 'knowledge exchanges', which consist of scientific communications between students in San Diego and Mexico, using artwork, letters and videos to construct a peer-to-peer dialogue in English and Spanish about protecting migratory marine life.

Working with the students in our Ocean Connectors programmes is one of the most fulfilling assignments in the world. It is wonderful to hear the sound of children's laughter and squeals as they see a wild whale for the first time, a rescued sea turtle or a flock of birds migrating south. They use microscopes, binoculars and video cameras to build real scientific skills. Each child has a chance to identify and pursue his or her own unique interests while forming a baseline understanding of marine science and conservation that will last a lifetime.

You can follow us on social media and learn more at *www.oceanconnectors.org*

**OCEAN CONNECTORS: PELAGIC THRESHER SHARK EDUCATION PROGRAMME**
**OCEAN CONNECTORS**
**2016**
**SOUTH-WEST UNITED STATES OF AMERICA**
Conservation, Education
Pelagic thresher shark
(*Alopias pelagicus*)



**WHO I AM**

Since I was little, I have been familiar with the beach and sea, as well as some of the coastal marine wildlife. My late dad would pack up the whole family and, together with family friends, we would go for seaside picnics. We seemed to do this every weekend until I was in secondary school. On at least one occasion, I remember, we went by boat to an island just off the coast. I remember, too, peeking out as the boat slowed down on its approach to the island and looking into the clear water. For the first time I saw a 'beautiful garden' under the water.

Many years later, I learnt that the 'garden' was a coral reef and that the island is now part of the Tunku Abdul Rahman Park (a marine protected area off the city of Kota Kinabalu). During the beach outings, the adults would catch all kinds of fishes in their nets for eating, and I think my interest in the diversity of fishes was sparked by looking at the different fishes they caught.

**WHERE I WORK**

In Sabah, northern Borneo, we experience two monsoon seasons a year. The weather is summery all year long, with an annual average high temperature of 31°C (89°F). The relatively calm and mild sea conditions enable us to carry out field sampling throughout the year – and commercial and subsistence fishermen to go about their business. Fishing pressure is therefore high in these coastal waters.

Sabah is an important place to be conducting research as it is located within a mega-diverse faunal region of the Coral Triangle. Moreover, in South-East Asia there are very few extensive market survey baseline datasets for elasmobranchs (sharks and rays). For Sabah, however, critical baseline information such as this goes back two decades.

**WHAT I DO**

One of the most frequent questions about sharks and rays that I am asked by the public is what their current population status is. I start by explaining that 95 known species of sharks and rays have been recorded so far from Sabah's waters alone. Of these, about 70% (66 species) are evaluated as Threatened in the IUCN's Red List of Threatened Species. Yet for a majority of them, biological and ecological data are completely lacking. In this project, we will carry out biodiversity surveys and assess the abundance of elasmobranchs in Sabah. Critically, the project will enable us to evaluate current exploitation rates and




# MABEL MATSUMOTO

Photo by Sandra Liew


Photo by Manjaji Matsumoto


Photo by Sandra Liew

**ELASMOBRANCH BIODIVERSITY MONITORING AND ASSESSMENT IN SABAH, NORTHERN BORNEO**
**UNIVERSITY MALAYSIA SABAH**
**2016**
**SABAH, MALAYSIA**
RESEARCH, CONSERVATION, EDUCATION
SHARKS AND RAYS

compare population trends with the baseline data. The field work will involve mainly monitoring surveys of fish markets, twice a week in major markets and every two months in smaller ones. Photographs will be taken during the surveys and, when necessary, specimens will be collected for further study in the laboratory. An important objective of the project is to develop practical conservation strategies for sustainable elasmobranch stocks in Sabah. This will be carried out in brainstorming sessions and workshops with stakeholders.

*'Together with ESMOI (Ecology and Sustainable Management of Oceanic Islands), we are using Baited Remote Underwater Video Stations (BRUVS) to answer questions about the sharks of Easter Island. So far we have made two BRUVS deployments, during which we recorded 11 fish species, including the Galápagos shark! Our record is the first scientific evidence of the presence of this species at the island. The Save Our Seas Foundation made this project possible.'*

Photo by Michel Garcia

# NAITI MORALES SERRANO

**LOST FISHES OF EASTER ISLAND**
**UNIVERSIDAD CATOLICA DEL NORTE**
**2016**
**EASTER ISLAND, CHILE**
RESEARCH, CONSERVATION, EDUCATION
SHARKS AND RAYS

## WHO I AM

In my early childhood I developed a strong interest in the marine ecosystem, spending much of my free time in my grandfather's library and going through every marine journal I could find there. I didn't know it at the time, but those days left a mark on me. A couple of years later, on my first diving trip in the Caribbean, I realised that I wanted to become a marine biologist. Although cephalopods were my first love, when I started working with elasmobranchs I fell in love with them too. My first experience with shark and ray research and conservation projects was as an undergraduate student, when I participated in setting up the initial basic guidelines for the development of the Shark National Action Plan in Chile. Since then I have had the opportunity to work with great researchers on different projects relating to biodiversity, reproductive biology, feeding behaviour and photo-ID. All of them were on common shark and ray species in Chile.

Currently I am doing my PhD in collaboration with the first research group on Easter Island, the Ecology and Sustainable Management of Oceanic Islands (ESMOI). My thesis will concentrate on species biodiversity, migratory patterns and population genetics of top predators in the Easter Island eco-region, including the large population of Galápagos sharks *Carcharhinus galapagensis* in the area. Working on the ESMOI project gives me the opportunity to collaborate with the local community to help protect one of the most isolated and valuable areas in the world.

## WHERE I WORK

Working on Easter Island, home to the monumental stone statues known as *moai* and beautiful landscapes protected by UNESCO as a World Heritage Site, could well make me the luckiest marine biologist in Chile.

Located in the middle of the Pacific Ocean, Easter Island – also known by its Polynesian name Rapa Nui, or Isla de Pascua in Spanish – is one of the most isolated inhabited islands in the world. It harbours the eastern coral systems of Polynesia, known for colourful fishes and high levels of endemism. However, the environmental conditions of this region make it highly susceptible to global climate change and anthropogenic activities.

Big fish assemblages are now scarce around the island. We assume that the number of fish communities were already starting to drop at the time of the ancient fishery, when the island was fully populated. Today, with modern fishing methods and an increasing number of tourists, the risk of overfishing is even higher. The big challenge facing Easter Island is to achieve sustainable fisheries but still conserve its unique marine biodiversity. Therefore, we need to acquire substantial scientific knowledge about the biology and population dynamics of the species inhabiting the area if we are to create new and effective regulations.

## WHAT I DO

Baited Remote Underwater Video Stations (BRUVS) technology enables scientists to observe fish in hard-to-reach habitats and fishing-free or even threatened areas. At these fixed stations, bait is used to attract fishes and the cameras then record not only the individuals attracted to the bait, but also those that just swim in front of the lens.

By using the BRUVS, we aim to describe the pelagic species inhabiting the waters around Easter Island, their abundance and their use of habitat, including ancestral fishing zones. Thanks to the SOSF, we will carry out the first study of top predators on Easter Island using non-destructive methodology. This project seeks to fill the gaps in our knowledge in order to create marine parks with effective boundaries and to develop realistic recommendations for the correct management and conservation of the local biodiversity. We also believe that this biodiversity can be used to enhance ecotourism and help local inhabitants to shift from non-sustainable practices (overfishing) to a broader array of sustainable activities such as community-based ecotourism.

*'Working with the Save Our Seas Foundation (SOSF) has opened up a lot of opportunities and without its support my work would not have been possible. But it's not only about the funding it provided to get our work off the ground; just as important has been the chance to share our work with a larger audience. Deep-water sharks don't usually get much attention in the media. I hope that by writing blogs and telling our story through the SOSF's social media outlets, we have helped people to get a better understanding of these species and their unique environment.'*

**WHO I AM**

Looking back at my life, it now seems to have been inevitable that one day I would study sharks. I was raised in Atlantic Canada, where one's life – social, economic and political – is defined by the ocean. Since I was a child my happy place has always been in the water. I also developed a soft spot for species that most people found frightening or unattractive. It seemed so unfair that cute and cuddly species got all the attention! It's no wonder that at 16 years old I marched home and announced that one day I would study sharks on the Great Barrier Reef. I never wavered on that dream and in 2011 I moved to Queensland, Australia, to pursue my PhD in shark ecology at James Cook University. This was the best decision I have ever made. Shark research has given me the chance to travel the world, meet brilliant people and challenge myself in ways I never thought possible.

**WHERE I WORK**

The Great Barrier Reef, where I have worked for the past five years, is one of the most iconic and complex ecosystems on the planet. It is famous for its crystal blue waters, colourful reefs and, of course, its incredible diversity of sharks. However, what many of us don't realise is that one third of the Great Barrier Reef Marine Park is actually deep-water habitat. This is an ecosystem seldom seen by the public and many of the sharks found in it are unknown even to most marine scientists.

A number of fisheries operate in these deep waters and they are expanding rapidly to keep up with our demand for seafood. Although these fisheries do not target sharks and rays, the species are caught as by-catch and there is a danger that, as we know very little about deep-water sharks and rays, they may soon be overfished. We urgently need more information about deep-water sharks in order to develop effective fisheries management.

**WHAT I DO**

Our team is using a combination of cutting-edge techniques to learn as much as we can about deep-water sharks and rays on the Great Barrier Reef. Of course, to learn more about these species, you first have to catch the animals! This was no easy task. Researchers from James Cook University travelled 200 nautical miles offshore of the reef and spent several months aboard deep-water commercial trawlers. The cooperation and help of these commercial operators was essential to our success. A total of 1,680 sharks and rays was collected from these trawls at depths of more than 200 metres (650 feet). For our project, we have decided to focus on the most commonly captured sharks and rays, such as the poorly known piked spurdog *Squalus megalops*.

Previously, members of the James Cook University shark team used ground-breaking techniques to study the growth and reproduction of these deep-water sharks. Now, with the generous support of the Save Our Seas Foundation, we are using stable isotope analysis to learn more about their diet and communities. This kind of analysis is one of the most efficient ways to investigate shark diet: stable isotopes are different forms of an element, like carbon, that differ in atomic mass, and the amount of each of these isotopes varies from one type of prey to another. By measuring the different isotopes in a small piece of shark tissue, we can determine what these sharks eat and whether their diet changes in terms of species, size or location.

By combining all our information on the growth, reproduction and diet of deep-water sharks, we can help to create a holistic picture of their ecology on the Great Barrier Reef. We hope that people will become as fascinated by these under-represented sharks as we are.

**THE DIET AND ECOLOGICAL ROLE OF DEEP-WATER SHARKS IN AUSTRALIA REVEALED USING STABLE ISOTOPE ANALYSIS**
**JAMES COOK UNIVERSITY**
**2016**
**AUSTRALIA**
RESEARCH
SHARKS




# SAMANTHA MUNROE

# PETER MUSEMBI

Photo by Allan Momba

*'Working with the Save Our Seas Foundation on elasmobranch conservation has been an eye-opener for me with regard to issues that were happening right on my doorstep. Firstly, we conducted participatory environmental education with children around Watamu Marine Park on specific topics relating to elasmobranchs and their conservation. It has been fascinating and also daunting to venture into a new area for most marine researchers and conservationists in Kenya. As we get into the next phase of underwater surveys, I believe it's going to get even more interesting and we are going to open up more shark and ray research in Kenya.'*

**WHO I AM**

I was born and grew up on Kenya's coast and have always been fascinated by how the ocean works. Where I come from, people rely on the ocean for many things, yet at the same time they fear it. There were many myths about the ocean and its creatures, and they were intended to underscore the mystery of this vast expanse of water. At an early age I was sent to school far away from the coast and found that even there they had more myths about the ocean. Some of these were really false and with all my energy I took on the responsibility of refuting these misunderstandings. But between teenage life and school my fascination for the sea almost disappeared and only occasionally would I go to the coast for a holiday.

When I took an undergraduate course in biological sciences and majored in aquatic sciences, my relationship with the sea was resuscitated. Now more curious about the ocean, I began to realise that most of the things we had been told when we were kids were false and that we need the ocean more than it needs us. I took several internship programmes with local institutions involved with marine research and conservation and became completely hooked on the ocean, especially coral reefs. My colleagues tell me I have never come out of the water since.

**WHERE I WORK**

I work for A Rocha Kenya in Watamu, a small town on the northern coast of Kenya that boasts one of the finest beaches in the country. It's a seasonal town, very busy when the tourists are here, but surprisingly quiet during low season. We are based just 50 metres from one of the oldest marine protected areas in Africa, Watamu Marine National Park, which is actually my 'office'. Although relatively small, the park has very high biodiversity, its habitats ranging from coral reefs to expansive sea-grass meadows and with an extensive mangrove forest on one side. It's not unusual to see reef sharks close to shore and big rays barely 20 metres from the beach. The marine park forms part of the Malindi-Watamu UNESCO biosphere reserve.

The marine biodiversity is, however, under threat both directly from human activities and from global phenomena such as climate change. The region is among the poorest in Kenya and people here depend too much on natural resources for their livelihoods, from fishing and tourism businesses to rain-fed subsistence agriculture. Climate change has had an impact, causing habitat degradation and irregular weather patterns. These factors are a threat not only to biodiversity, but also to people's lives. If they are not properly addressed, we are looking at the collapse of coastal systems that encompass both ecosystems and people's socio-economic and cultural values.

Photo by Lydia Kayaa


Photo by Peter Musembi

## WHAT I DO

Our work brings nature and people together. We aim to understand the role of the marine national park in aspects that have previously been overlooked, such as how it affects the protection of elasmobranchs. In the past, local communities were ignored in the management of these natural resources, which led to resentment and opposition. We build the capacity of local communities to help in the protection of important habitats and key species, and assist them in adapting to changing environmental conditions. By working with these communities, we help them appreciate different conservation tools, including marine protected areas, and encourage them to support conservation activities.

**BIODIVERSITY AND CONSERVATION OF ELASMOBRANCHS IN WATAMU MARINE NATIONAL PARK AND RESERVE, KENYA**

**A ROCHA KENYA**

**2016**

**KENYA**

RESEARCH, CONSERVATION, EDUCATION

SHARKS

**CAN THE YELLOW STINGRAY (*UROBATIS JAMAICENSIS*) DETECT AND USE GEOMAGNETIC CUES FOR ORIENTATION AND NAVIGATION?**
**FLORIDA ATLANTIC UNIVERSITY**
**2016**
**FLORIDA, USA**
RESEARCH, CONSERVATION
YELLOW STINGRAY (*UROBATIS JAMAICENSIS*)

# KYLE NEWTON

Photos by Kyle Newton

### WHO I AM

I grew up in the Pacific Northwest, where the water is way too dark and cold to even think about going for a swim. After watching a lot of documentaries about the ocean, I decided to study marine biology in Florida, which prompted me to get a scuba diving certification – in Seattle. Despite the freezing water and poor visibility, I was hooked. It seemed to me that underwater is the one place where life's cares seem to melt away and this connection to the ocean has guided my circuitous career path ever since.

My first exposure to field work came during a course in Bimini and I thought, 'This is the life: chasing fish in warm, clear water. What could be better?'It's taken me a while to translate the idea into reality, but I eventually found a way to study a fun aspect of an easily overlooked species. Yes, yellow stingrays are not terribly charismatic compared to huge pelagic sharks, but they are incredibly cute, especially the newborn pups that fit in the palm of your hand.

### WHERE I WORK

A warm climate and clear water makes South Florida a popular destination for vacation-goers and snowbirds. I enjoy the diversity of coastal elasmobranchs (sharks, rays and skates), while their close proximity to shore gives researchers like me excellent opportunities to study these species in the field and in the laboratory. The best part of being here is the field work, even though I don't get out in the field nearly enough because there is so much lab work to do!

Observing the natural migration patterns and behaviour of elasmobranchs is essential to understanding their biology, but we also need to bring animals back to the lab because we cannot control what happens in the field. Our marine science lab is right next to the Atlantic Ocean and the aquaria are supplied with sea water straight from the ocean. Furthermore, it is a great spot to maintain our elasmobranchs in a controlled environment without the stress of long-distance transportation. Here we can manipulate small variables in the geomagnetic field – no small task – and observe how the stingrays react, how they learn and what they remember. This information about the behaviour and sensory biology of elasmobranchs would be nearly impossible to achieve by field work alone.

### WHAT I DO

For more than 40 years scientists have hypothesised that elasmobranchs use the earth's magnetic field to navigate. Larger sharks, such as white sharks, basking sharks, blacktip sharks and scalloped hammerheads, are known to undertake long migrations between habitats, but the sensory cues they use to get from one place to another is a mystery. The yellow stingray serves an important biological role in the South Florida near-shore ecosystem and is an excellent laboratory model for the larger species that cannot be maintained in captivity.

We seek to understand a few general questions: how do sharks and rays perceive their environment; what sensory stimuli are essential to finding food, mates and suitable habitats, and avoiding predators; and how do sharks and rays process sensory information into appropriate behavioural responses? Specifically, my work focuses on whether elasmobranchs can use the geomagnetic field as a navigational cue. My behavioural experiments determine the types and range of magnetic stimuli that stingrays can detect and how learning and memory influence their cognitive ability. We don't know how human activities, such as land development and energy exploration, impact the sensory capabilities and behaviour of elasmobranchs, but we must fill this gap in our knowledge if we are to mitigate any potential negative effects that we may have on these species.

*'I am extremely thankful to the Save Our Seas Foundation (SOSF) for supporting my research, which would not have been possible without the small grant funding. My genetic work is starting to provide insights into the population dynamics and biology of the Nassau grouper. Although research is the foundation for protecting threatened species, sharing information about this work is equally important. I am thoroughly enjoying collaborating with the SOSF media team to raise awareness about the conservation of the Nassau grouper.'*

**WHO I AM**

The Bahamas is a subtropical archipelago comprising more than 700 islands and cays separated by stunning seascapes. I grew up on New Providence, one of the country's smaller islands and the location of its capital, Nassau. I've been enjoying the ocean since I was a baby and my fascination with marine life began after I learned to snorkel at about the age of seven. Those early experiences were transformative and ignited a passion and a curiosity that have persisted over time and led me to pursue a BSc in marine science and an MRes in ocean science. For six years I worked on conservation-related research projects in The Bahamas before leaving to begin a PhD in September 2014. Currently I am working towards a PhD in biological sciences from the University of Exeter. My research aims to assess the status, population structure and dynamics of Nassau grouper spawning aggregations in The Bahamas in order to support their conservation. In my spare time I still love snorkelling and free diving – so much so that my friends and colleagues have nicknamed me 'the mermaid'.

**WHERE I WORK**

As in other island countries, we in The Bahamas rely heavily on the ecosystem services and functions provided by the marine environment to sustain our living. The Nassau grouper is an iconic species and one of the most important marine fish species in our country. However, the abundance of this species has declined drastically not only in The Bahamas, but worldwide, leading to its classification as an Endangered species by the IUCN.

I began studying spawning aggregations of the Nassau grouper in The Bahamas in 2010, along with Dr Craig Dahlgren. For me, one of the most interesting aspects of this endangered species is its spawning behaviour and reproduction; it is a truly awe-inspiring experience to witness a spawning aggregation and be surrounded by hundreds of groupers. Unfortunately, fishing at these aggregation sites has led to the collapse of several that had existed for years. We know very little about the status of the sites that remain.

Recognising the need to address the decline of the Nassau grouper, The Bahamas government prioritised science-based adaptive management in 2013. As a result, I embarked on a multi-year collaborative project with Dr Kristine Stump and Dr Craig Dahlgren the following year to address national research priorities and to help improve conservation management for the species.

Luckily for me, all this field work is conducted in The Bahamas and most of it occurs during the reproductive season for the Nassau grouper, which coincides with winter. The grouper's reproductive season in The Bahamas extends from November until March, but most of our work is completed within one week around the full moon during the peak spawning months of December and January. From a live-aboard research vessel, *Coral Reef II*, we collect and process Nassau groupers for fin clip and blood sampling, tagging and morphometric (length and weight) data. Throughout the day and into sunset, we dive among the aggregations to collect data on the abundance, size and spawning behaviour of the species at historic sites around Long Island



# KRISTA SHERMAN

Photo by Shane Gross

Photo by Shane Gross

Photo by Shane Gross

Photo by Krista Sherman

## UNDERSTANDING GENETIC POPULATION STRUCTURE OF ENDANGERED NASSAU GROUPER TO SUPPORT ITS CONSERVATION IN THE BAHAMAS

**UNIVERSITY OF EXETER**

**2016**

**THE BAHAMAS**

RESEARCH, CONSERVATION

NASSAU GROUPER (*EPINEPHELUS STRIATUS*)

and Andros. With the support of local fishermen and NGOs, we are also expanding efforts to visit other reported spawning aggregation sites in the country.

### WHAT I DO

When I am not conducting field work in The Bahamas, I am based in England completing genetic and data analysis at the University of Exeter. Population genetics can be used to answer questions about effective population sizes, diversity and relatedness of fishes. This information is useful not only to advance scientific knowledge, but also to inform fisheries and conservation management decisions. I analyse DNA extracted from fin clip samples and use high-resolution molecular markers to better understand the health and status of Nassau grouper populations in The Bahamas.

One of the key challenges facing the Nassau grouper fishery is that there is no awareness of fishery regulations and thus no compliance with them. In The Bahamas, although regulations have been implemented to protect the species since the late 1990s, groupers are still being harvested illegally and sold during the closed season. With support from the Department of Marine Resources, the Bahamas National Trust, the Save Our Seas Foundation and local NGOs, I hope to increase public awareness about the status of the fishery and the need for compliance with science-based fishery regulations. This is a daunting task, but it is critical to prevent further collapses of the spawning aggregation sites that replenish the population.

**WHO I AM**

I grew up as a city kid from New York, far from the tropical oceans where I now work. My escape was the American Museum of Natural History, where I would spend hours in the Hall of Ocean Life staring at frozen tiger sharks chasing sea turtles or lying on the floor examining a life-size blue whale suspended from the ceiling. As a teenager, I took every available opportunity to volunteer for research and conservation projects and went swimming, diving, sailing, kayaking – anything that would get me into the water. When I started college, I enrolled in classes on fish biology and scientific diving and volunteered for every field project I could find. The programme I was part of focused heavily on underwater archaeology, so in between surveying fish biomass or coral recruitment, I was helping to excavate 17th-century shipwrecks. I'm not sure how many hours I spent underwater over those four years, but it's safe to say that salt water was coursing through my veins as I set out to start my career.

In my first year out of college I received a Rolex Scholarship that enabled me to travel around the world learning about marine conservation priorities and the many different approaches that dedicated experts are taking to improve the outlook of marine ecosystems. Of all the systems and species I worked with, I was especially taken with manta and mobula rays. These charismatic species are threatened globally by targeted fisheries and being taken as by-catch, and yet at the time we knew so little about their basic biology and ecology. Shortly after my first experience working with manta rays in the Maldives, I helped found the Manta Trust and since then I have been working to improve our understanding of the ecology and conservation status of manta and mobula rays.

**WHERE I WORK**

Pacific Mexico is home to an incredibly rich marine environment supported by high productivity. Massive schools of jacks and grouper thrive in protected areas along the coast and the region is famous for its large pelagic species. In Bahia de Banderas, lush green mountains plunge into the ocean and continue into a 2,000-metre (6,560-foot) trench within the bay. This unique bathymetry causes local upwelling of nutrient-rich waters, which in turn leads to high densities of zooplankton. Manta rays are seasonally attracted to the wild southern coast of the



# JOSH STEWART

Photo by Josh Stewart

Photos by Josh Stewart

bay. Our research programme is based in the sleepy fishing village of Yelapa, nestled in the green hills adjacent to one of the prime manta sighting locations.

**WHAT I DO**

My research in general focuses on understanding how large marine species – especially oceanic manta rays – move through and interact with their environment. This helps us determine how populations are connected, what drives the spatial patterns in abundance and distribution that we observe, and how we can design conservation and management strategies to be more effective based on this information.

Specifically in Pacific Mexico, our programme focuses on understanding what drives mantas to seasonally visit specific regions where they are most vulnerable to human-related impacts such as ship strikes and entanglement in fishing gear. We work closely with local undergraduate students and fishing communities to conduct field research such as satellite and acoustic tagging, abundance surveys, zooplankton collections and environmental monitoring. A major aspect of our programme is providing technical skills training and research experience to young scientists and exposing children in local primary and secondary schools to marine science. We train undergraduate students in field data-collection methods, provide them with logistical support for individual research projects and help place them in research- and conservation-related jobs or graduate study programmes.

**CAPACITY-BUILDING WORKSHOP FOR YOUNG ELASMOBRANCH SCIENTISTS IN PACIFIC MEXICO**
**THE MANTA TRUST | SCRIPPS INSTITUTION OF OCEANOGRAPHY**
**2016**
**MEXICO, PACIFIC COAST**
RESEARCH, EDUCATION, CONSERVATION
RAY

*'My work would not have been possible without the Save Our Seas Foundation (SOSF). The dedication and enthusiasm of the researchers at the D'Arros Research Centre who helped me during many hours of sampling and brainstorming was crucial to my project. Funding from the SOSF also covered the costs of critical equipment and the analysis of samples, which will be completed in South Africa. I look forward to returning to the Seychelles in 2017 to continue with the project.'*

**WHO I AM**

From a young age I knew that I wanted to work with marine life and do my part to protect it. I was intrigued by how everything in the ocean is so connected and, since we know so little about our oceans, I wanted to be one of 'those people' who uncover its mysteries. When I started diving at 11, my mind was blown away by the sheer beauty of the underwater world. My parents told me I would need to work really hard to do what I love, which is exactly what I did.

By the end of high school I, like many other students, started to worry about my future and I began to wonder whether marine biology really was what I should do. I applied for funding at dozens of institutions but, despite excelling academically, I had no luck. Just before the academic year was to start in 2012, I went to see some marine scientists at Nelson Mandela Metropolitan University in Port Elizabeth, South Africa. After talking to Pierre Pistorius and Ronel Nel and being absolutely captivated by their stories and passion for their work, I was certain this was what I still wanted to do. I later went to the Dean of Science's office to find out if there was any other potential funding that I could apply for. After talking to him for a while, I received a phone call in his office and was informed that I had been awarded the Vice Chancellor's Scholarship Award, which would cover my entire undergraduate degree. As soon as I left his office it hit me: I was going to be a *scientist*.

**WHERE I WORK**

I'm an MSc student at Nelson Mandela Metropolitan University and am lucky to be doing my field work in the Seychelles, where I will be studying the wedge-tailed shearwater (known locally as *fouquet*) at D'Arros Island and St Joseph Atoll. Most of the field work is carried out at night when the *fouquets* return to their burrows. Apart from almost being eaten alive by mosquitoes and getting the odd 'love bite' from the shearwaters, the field work is really exciting. If a *fouquet* doesn't find its runway (its small entry or exit point) on the island, it often crashes into a coconut tree (or your head lamp if you are not careful) and it makes the strangest *ooo-ow* calls, which keep you entertained throughout the night.

**WHAT I DO**

My study aims to investigate the foraging ecology of the wedge-tailed shearwater (focusing mainly on its trophic ecology and foraging strategies)



# DANIELLE VAN DEN HEEVER

Photos by Danielle van den Heever

by means of stable isotope analyses and by tracking the at-sea distributions of this top marine predator. The results will give us insight into what these birds are doing out at sea. From them, and the results of similar studies on other top marine predators, it will be possible to suggest to spatial planners where potentially suitable pelagic marine protected areas could be proclaimed in order to protect sea life.

To discover precisely where the *fouquets* are flying to and how deep they dive, I attach very small GPS devices and Time Depth Recorders (TDRs) to the birds. By combining the data from these devices, I will be able to determine where they are foraging in the big open ocean. I will also be collecting small amounts of blood and feathers for stable isotope analysis to establish the trophic ecology of the *fouquet*.

Although the worldwide population of wedge-tailed shearwaters stands at more than 5.2 million, several studies have shown that it is currently decreasing due to predation by invasive species and unsustainable levels of exploitation. It is therefore important to monitor the species' population status. The last census of the D'Arros and St Joseph population was conducted in September and October 2009 by means of direct counts and area-based estimates. It found that there were 254 breeding pairs on D'Arros and 28 909 pairs in St Joseph Atoll. Since the global population is said to be declining, I am conducting a census on D'Arros in 2016 and in St Joseph Atoll in 2017. I'm making use of similar methods as the previous study did, but am also using technology to help me out in the form of an endoscope attached to a laptop or cell phone to inspect the burrows visually. In addition, I'm playing the shearwater's call at the burrow entrance and if it responds I know that there is a bird in the burrow even if I can't see it.

**FORAGING ECOLOGY OF WEDGE-TAILED SHEARWATERS (*ARDENNA PACIFICUS*) BREEDING AT ST JOSEPH ATOLL, SEYCHELLES**
**NELSON MANDELA METROPOLITAN UNIVERSITY**
**2016**
**ST JOSEPH ATOLL, SEYCHELLES**
RESEARCH
*ARDENNA PACIFICUS*

# PROJECT LEADER PROFILES - SUMMARY

AN INTRODUCTION TO OUR PROJECT LEADERS WHOSE PROJECTS ARE A CONTINUATION FROM THE PREVIOUS YEAR(S) AND WERE FUNDED DURING 2016.
THEIR COMPLETE PROFILES ARE AVAILABLE IN THE PRECEDING EDITIONS OF OUR ANNUAL REPORT AS WELL AS ON OUR WEBSITE.

## MOHAMMED ABUDAYA

**ASSESSMENT OF THE GAZA FISHERY OF THE GIANT DEVIL RAY**
**AL-AZHAR UNIVERSITY – INSTITUTE OF WATER AND ENVIRONMENT**
**2014–2016**
**GAZA, PALESTINE**
RESEARCH, CONSERVATION
GIANT DEVIL RAYS (*MOBULA* SPP)

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.

Photo by Wisam Nassar

## IVY BAREMORE

**CHARACTERISING THE EMERGING DEEP-WATER SHARK FISHERIES IN BELIZE**
**MARALLIANCE**
**2015, 2016**
**BELIZE, CENTRAL AMERICA**
RESEARCH, CONSERVATION
*HEXANCHUS GRISEUS, H. NAKAMURAI, HEPTRANCHIAS PERLO, CARCHARHINUS SIGNATUS*

As pressure on marine resources increases, fishers have to explore deeper and deeper waters to make a living. What does this mean for Belize's deep-sea sharks? Ivy aims to understand the threat to these animals before it is too late.

## DIANA CHAN

**GREAT BEAR LIVE: USING REMOTE CAMERA TECHNOLOGY AS A MARINE MAMMAL CONSERVATION TOOL**
**PACIFIC WILD ALLIANCE**
**2015, 2016**
**BRITISH COLUMBIA, CANADA**
RESEARCH, CONSERVATION, EDUCATION
KILLER WHALE (*ORCINUS ORCA*), HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*)

The Great Bear Rainforest, one of the planet's few remaining wilderness areas, is frequented by an abundance of marine mammals. Diana wants to share this unique place with the world by live-streaming video from underwater cameras.

## LAUREN DE VOS

**OPTIMISING THE EFFECTIVENESS OF MARINE BIODIVERSITY MONITORING AND CONSERVATION PLANNING IN FALSE BAY, SOUTH AFRICA**
**UNIVERSITY OF CAPE TOWN**
**2014–2016**
**FALSE BAY, WESTERN CAPE PROVINCE, SOUTH AFRICA**

RESEARCH, CONSERVATION
CHONDRICHTHYANS (SHARKS, RAYS & SKATES) AND TELEOSTS

Lauren has already spent a year spying on False Bay's 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.

## DEAN GRUBBS

**HABITAT USE, RESIDENCY AND POPULATION GENETICS OF THE ENDANGERED SMALLTOOTH SAWFISH OFF ANDROS ISLAND**
**FLORIDA STATE UNIVERSITY RESEARCH FOUNDATION**
**2015, 2016**
**ANDROS, BAHAMAS**

RESEARCH, CONSERVATION
SMALLTOOTH SAWFISH (*PRISTIS PECTINATA*)

Sawfishes are rapidly disappearing from our seas, so when a healthy population was discovered off Andros Island in The Bahamas, the area became a very important place. Dean aims to understand this rare community of sawfishes in order to protect them.

Photo by Dean Grubbs

## CHANTEL ELSTON

**THE ECOLOGY OF STINGRAYS IN ST JOSEPH ATOLL, SEYCHELLES**
**SOSF D'ARROS RESEARCH CENTRE**
**2014–2016**
**ST JOSEPH ATOLL, SEYCHELLES**

RESEARCH
MANGROVE STINGRAY (*HIMANTURA GRANULATA*), COWTAIL STINGRAY (*PASTINACHUS SEPHEN*), PORCUPINE STINGRAY (*UROGYMNUS ASPERRIMUS*)

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.

## NEIL HAMMERSCHLAG

**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, 2016**
**FLORIDA, USA**
RESEARCH, CONSERVATION
SHARKS

Have you ever imagined a shark swimming through downtown? Biologists have found at least five species of sharks in Miami's waterways. Neil hopes to learn how they use this space and how well they are coping with their urban lifestyles.

Photo by Robbie Roemer



## EUAN HARVEY

**THE GALAPAGOS MARINE RESERVE: PROVIDING A MODEL FOR A SUSTAINABLE COEXISTENCE BETWEEN HUMANS AND SHARKS**
**CURTIN UNIVERSITY**
**2015, 2016**
**GALAPAGOS ISLANDS, ECUADOR**
RESEARCH, CONSERVATION, EDUCATION
SHARKS

Nearly 200 years after Darwin arrived at Galápagos, Euan and his team are exploring the shark communities of this fabled archipelago. They are also running programmes to inspire local communities to protect sharks within the islands' marine reserve.

## ALISON KOCK

**SHARK RESEARCH COMPONENT OF THE SHARK SPOTTERS PROGRAMME**
**SHARK SPOTTERS**
**2015, 2016**
**FALSE BAY, CAPE TOWN, SOUTH AFRICA**
RESEARCH, CONSERVATION, EDUCATION
WHITE SHARK (*CARCHARODON CARCHARIAS*)

False Bay is home to one of the world's largest white shark populations and a growing human community. This creates a number of challenges for both people and sharks. Alison is finding out how these apex predators shape the bay and what would happen if they disappeared.

Photo by Morné Vandenberg

A white shark breaches out of the water after a Cape fur seal at Seal Island, False Bay.

## RUTH LEENEY

**DOCUMENTING AND PROTECTING CRITICALLY ENDANGERED SAWFISHES IN MADAGASCAR**
**BENGUELA RESEARCH & TRAINING**
**2015, 2016**
**WESTERN MADAGASCAR**
RESEARCH, CONSERVATION
GREEN SAWFISH (*PRISTIS ZIJSRON*),
FRESHWATER SAWFISH (*P. PRISTIS*)

Based in one of the world's most unusual and unexplored ecosystems, Ruth aims to unravel the mystery of Madagascar's sawfishes. Which species are present? What threats do they face? Can communities be convinced to protect them?

## EVA MEYERS

**DISCOVERY OF AN ANGEL SHARK (*SQUATINA SQUATINA*) NURSERY AREA IN THE CANARY ISLANDS**
**BIODIVERSITY AND CONSERVATION RESEARCH UNIT, UNIVERSITY OF LAS PALMAS DE GRAN CANARIA**
**2015, 2016**
**CANARY ISLANDS, SPAIN**
RESEARCH, CONSERVATION
ANGEL SHARK (*SQUATINA SQUATINA*)

Although they grow to be 2.5 metres long, angel sharks are notoriously difficult to spot. They are flat, perfectly camouflaged – and also rare. Eva aims to learn about one of the few remaining populations of these enigmatic creatures.

Photo by Michael Sealey

## JEANNE MORTIMER

**COMMUNITY MONITORING OF NESTING SEA TURTLES AT D'ARROS AND ST JOSEPH, SEYCHELLES**
**SOSF D'ARROS RESEARCH CENTRE**
**2013–2016**
**D'ARROS ISLAND AND ST JOSEPH ATOLL, SEYCHELLES**
RESEARCH, CONSERVATION, EDUCATION
TURTLES

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.


Photo by Donald Bason

## EMILY MOXHAM & PAUL COWLEY

**BEHAVIOURAL ECOLOGY OF BONEFISH AND PERMIT AT ST JOSEPH ATOLL, REPUBLIC OF SEYCHELLES**
**SOUTH AFRICAN INSTITUTE FOR AQUATIC BIODIVERSITY**
**2015, 2016**
**ST JOSEPH ATOLL, SEYCHELLES**

RESEARCH, CONSERVATION, EDUCATION
BONEFISH (*ALBULA OLIGOLEPIS*)
AND PERMIT (*TRACHINOTUS BLOCHII*)

Bonefish and permit fish, prized by recreational fly fishermen, are abundant at St Joseph lagoon in the Seychelles. Using acoustic telemetry, Emily is investigating their role in the ecosystem and whether they recover after catch-and-release.



## LAUREN PEEL & GUY STEVENS

**MOVEMENT PATTERNS, TROPHIC ROLE AND ECOLOGY OF REEF MANTAS IN THE D'ARROS MARINE PROTECTED AREA**
**AUSTRALIAN INSTITUTE OF MARINE SCIENCE | SOSF D'ARROS RESEARCH CENTRE | THE MANTA TRUST**
**2013–2016**
**D'ARROS ISLAND AND ST JOSEPH ATOLL, SEYCHELLES**

RESEARCH
REEF MANTA RAY (*MANTA ALFREDI*)

There is a very lucky population of manta rays that lives at D'Arros Island in the Seychelles. These mantas not only live in a relatively pristine habitat, but are also safe from fishing. This gives researchers a unique opportunity to learn about how these intriguing animals live when they are free from human influence.

Photo by Guy Stevens © Manta Trust

## DAVID SIMS

**TRACKING TRANS-ATLANTIC MOVEMENTS, HABITAT PREFERENCES AND FISHERIES OVERLAP OF THE SHORTFIN MAKO SHARK**
**MARINE BIOLOGICAL ASSOCIATION OF THE UK**
**2015, 2016**
**NORTH ATLANTIC OCEAN**

Research

Shortfin mako shark (*Isurus oxyrinchus*)

Shortfin makos are the gold medallists of the shark world. They jump the highest, swim the fastest and cover marathon distances in the open ocean. David is exploring how their Olympian lifestyles overlap with commercial fishing fleets.

## ORNELLA WEIDELI

**HABITAT AND RESOURCE PARTITIONING OF JUVENILE SHARKS AND THEIR ROLES IN REMOTE COASTAL ECOSYSTEMS**
**SOSF D'ARROS RESEARCH CENTRE I CRIOBE I EPHE**
**2014–2016**
**ST JOSEPH ATOLL, SEYCHELLES**

Research

Blacktip reef shark (*Carcharhinus melanopterus*), sicklefin lemon shark (*Negaprion acutidens*)

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.

Photo by Rainer von Brandis

## BARBARA WUERINGER

**TROPHIC POSITION AND ECOLOGICAL ROLES OF EURYHALINE ELASMOBRANCH PREDATORS**
**SHARKS AND RAYS AUSTRALIA PTY LDT**
**2015, 2016**
**CAPE YORK PENINSULA, NORTH QUEENSLAND, AUSTRALIA**

Research, Education

Sawfish

Northern Australia is one of the last strongholds for largetooth sawfish and it is an important home for other endangered species too. Barbara is investigating the role of sawfish within the ecosystem and working with citizen scientists to raise awareness about this critical habitat.

Photo by David Doubilet © National Geographic Creative

## SCHOLL MICHAEL | CHIEF EXECUTIVE OFFICER

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* Magazine 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 | SCIENTIFIC ADVISOR

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 vice-chair 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.

SOSF STAFF

## 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. He 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.

## 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.

SOSF STAFF

## SOSF CONSERVATION MEDIA UNIT | KALK BAY | WESTERN CAPE | SOUTH AFRICA

### 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.

### EHRLICH PHILIPPA | CONSERVATION JOURNALIST

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 | CONTENT MARKETER AND SOCIAL MEDIA MANAGER

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, Jade understands that the media is extremely powerful when it comes to spreading a message and raising awareness – and, in fact, 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.



## SOSF D'ARROS RESEARCH CENTRE | D'ARROS ISLAND AND ST JOSEPH ATOLL | AMIRANTES | SEYCHELLES

### 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 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 stayed 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.

### DALY RYAN | LAB MANAGER

As a child growing up along the coast of South Africa, Ryan spent every spare moment surfing, diving and exploring the shoreline and rock pools of South Africa. After gaining a Bachelor's degree in zoology and ocean and atmosphere science from the University of Cape Town, he completed his Master's degree in marine biology at Rhodes University, South Africa. Between 2010 and 2015 he led studies on the ecology and migration dynamics of bull sharks and tiger sharks in southern Mozambique. The work on bull sharks earned him his PhD from Rhodes University in South Africa in 2014. Ryan's current research interests include marine conservation, shark ecology, migration and behavioural patterns, predator–prey interactions and the habitat use and aggregation dynamics of keystone teleost species.

## KEATING DALY CLARE | LAB MANAGER

Clare's affinity for the ocean comes as a surprise to some people. She spent her childhood exploring forests and streams in her native Minnesota in the USA, far from the tide pools and ocean creatures that usually draw people to the ocean. But soon after her first scuba dives in the shallow waters of the Caribbean, she realised that salt water was indeed the cure for anything. Before her starter career as a scuba instructor, Clare completed a Bachelor's degree in business and economics at Colorado College in the USA. She then went on to teach diving in Thailand and the Philippines before moving to Mozambique to embark on a research project studying bull sharks and later tiger sharks. While working as a shark research assistant, Clare also conducted research on the sustainable financing of marine protected areas in southern Mozambique, which earned her a Master's degree in commerce from Rhodes University. Her current research interests include marine protected areas, conservation finance and seabirds, as well as the migration and behavioural patterns of marine species.

## BULLOCK KERRYN | 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 has just 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.



SOSF STAFF

## MILLAR PAUL JAMES | EDUCATOR

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.

## METCALF CLAIRE | FACILITIES ADMINISTRATOR

Raised in various small West Coast fishing and mining towns of South Africa and Namibia, with parents whose free-range approach to parenting meant lots of time outside exploring beaches, Claire is a firm believer in the power of experiential education in moulding future generations to become effective conservationists.

Claire joined the Save Our Seas Foundation Shark Education Centre in May 2016 after almost eight years with Liberty Life Financial Services as a franchise business support administrator. With a diploma in administration and legal studies from Montrose Business College in Cape Town, in her role as the facilities administrator she brings a high level of organisation and structure to the dynamic working environment that is the Shark Education Centre. She is enjoying every minute of the varied opportunities this role brings and, in addition to seeing to facilities maintenance and administration, she has become a vital part of the team, joining school groups as they learn about, explore and appreciate the ocean. She has also made it her personal mission to convince the education centre's resident puffadder shysharks to eat their food.

With a family that has earned – and continues to earn – its income almost entirely from the sea, Claire has a vested interest in the conservation of the oceans for current and future generations. She believes that she is in exactly the right place to be able to contribute to this.

## 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 SHARK RESEARCH CENTER | NOVA SOUTHEASTERN UNIVERSITY, OCEANOGRAPHIC CENTER, FLORIDA, USA

### 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.

SOSF STAFF

## SOSF ISLAND SCHOOL SEYCHELLES MAHÉ, SEYCHELLES

### VEL TERENCE | PROJECT ADVISOR AND EDUCATOR

Before joining University of Seychelles in 2015 as a science laboratory technician and a field lecturer for BSc environmental science students, Terence Vel spent 16 years as a laboratory technician in various secondary schools. Twenty-one years ago he became a founder of Wildlife Clubs of Seychelles and during this time has managed the organisation's projects and coordinated environmental programmes in 40 schools on Mahé, Praslin and La Digue.

In 2000 he worked as a technician on a project called 'Avian ecosystems in Seychelles', which was funded by the Global Environment Facility and implemented by the former BirdLife Seychelles. The project involved two distinct phases: in the first, ecological research was carried out on a number of the Seychelles' Inner Islands to investigate their biology and conservation potential; during the second, endemic Seychellois birds were translocated from certain islands to others that were more suitable.

In 2008 Terence embarked on studies for a diploma in environmental education and social marketing at the University of Kent's School of Anthropology and Conservation. This led him to The Darwin Initiative Rare Pride Campaign to work on a project called 'Investing in island biodiversity: restoring the Seychelles paradise flycatcher'. The project was based on La Digue Island and aimed to translocate a small population of birds on Denis Island.

Terence also conducts outreach programmes that focus on marine education for youth groups from the community.

### FLEISCHMANN KARL | PROJECT SUPERVISOR

Dr Karl Fleischmann joined University of Seychelles in 2014 as a senior lecturer in environmental science. Earlier in his career he had spent two years at Seychelles Polytechnic as an instructor in A-level biology; later he returned to the Seychelles to undertake field work for his doctoral research. His long and varied career in education at secondary and tertiary level includes periods in Tanzania as well as in his home country of Switzerland. In 1988 he embarked on Master's studies in environmental sciences and geobotany at the Swiss Federal Institute of Technology (ETH) and at the University of Zurich. He followed these with studies, also in Zurich, on the subject of problems with invasive alien plants in the Seychelles, which led to his PhD. Since 1997 Karl has been coordinating research projects in the field of vegetation rehabilitation and nature conservation in the Seychelles. His work has been published in numerous academic journals and his research reputation has led to invitations to lecture to scientific audiences in both German and English. For five years he edited an international journal, *Perspectives*, a source of articles about the ecology, evolution and systematics of plants. Between 2008 and 2011 Karl was the deputy dean of the faculty of science and a member of the academic board at the Mwenge University College of Education in Moshi, Tanzania. The Ministry of Education, St Gallen, has awarded him the title of professor.

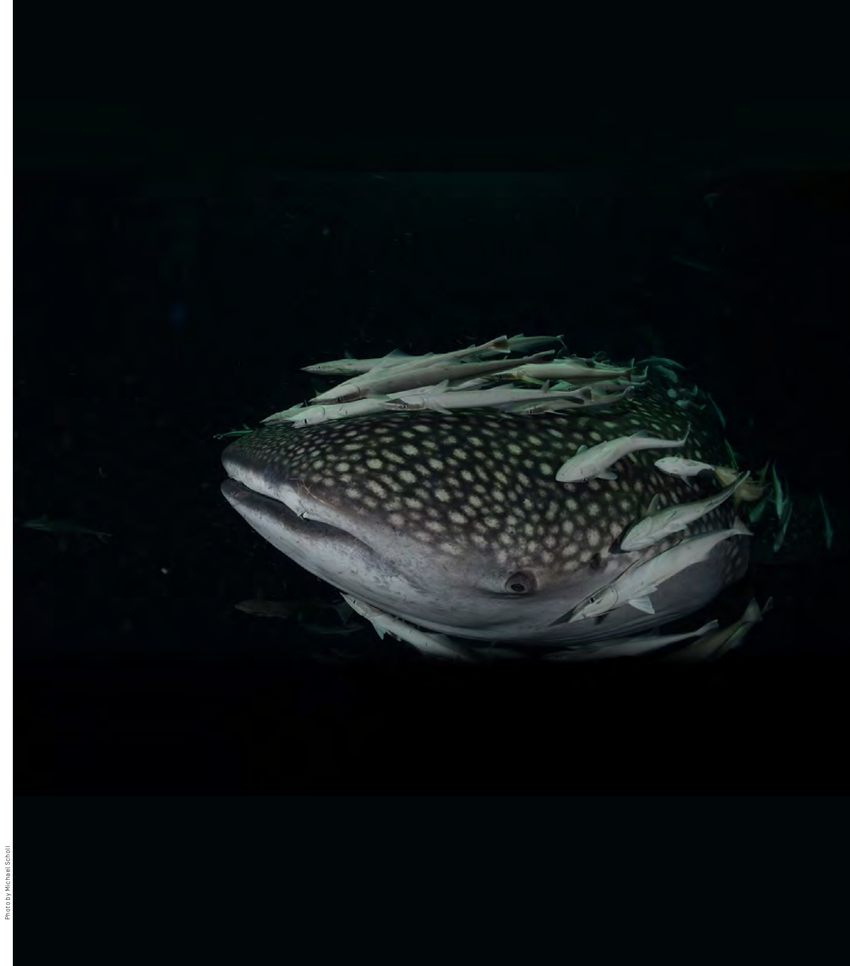


Photo by Michael Scholl

## SOSF CENTRES

SOSF Headquarters - Geneva, Switzerland | Scholl Michael

SOSF D'Arros Research Centre - D'Arros Island and St Joseph Atoll, Les Amirantes, Seychelles (328) | Von Brandis Rainer

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 PARTNERS

Shark Spotters - Finding a balance between recreational water-user safety and white shark conservation (149) | Waries Sarah, Kock Alison & Sikweyiya Monwabisi

Cetacea Lab - Identifying critical habitat for killer whales in northern British Columbia (217) | Wray Janie & Meuter Hermann

The Acoustic Tracking Array Platform ATAP - A nationwide marine science platform (227) | Cowley Paul

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, *Report written by Isabel Ender*

## SOSF SPONSORSHIPS

SOSF marine photography grant 2016 (339) | Peschak Thomas

Award - Eugénie Clark Award at the American Elasmobranch Society (AES) Scientific Conference - July 2016 | New Orleans, Louisiana USA (335) | Grubbs Dean

International League of Conservation Photographers (iLPC) (329)

*National Geographic* Magazine NGM | Galápagos (368)

Student Travel Grant and Keynote Speakers - European Elasmobranch Association (EEA) Scientific Conference - October 2016 | Bristol, UK (228) | Hood Ali

Student Travel Grant - American Elasmobranch Society (AES) Scientific Conference - July 2016 | New Orleans, Louisiana USA (229) | Grubbs Dean

Student Travel Grant - Oceania Chondrichthyan Society (OCS) Scientific Conference 2016 - September 2016 | Hobart, Australia (255) | Chin Andrew

Symposium - Biology and Ecology of Sawfishes - American Elasmobranch Society (AES) Scientific Conference - July 2016 | New Orleans, Louisiana USA (342) | Grubbs Dean

Sponsorship - University of Seychelles | Seychelles (338) | Fleischmann Karl & Vel Terence

WaveScape - December 2016 | Clifton Beach, Cape Town, Western Cape, South Africa (334) | Frylinck Ross



# FUNDED PROJECTS

## A: ALL SOSF PROJECTS FUNDED IN 2016
### IN ALPHABETICAL ORDER OF THE PROJECT TITLE

An analysis of oceanographic factors at D'Arros and St Joseph Special Reserve (349) Phil Hosegood

Assessment of the Gaza fishery of the giant devil ray *Mobula mobular* (265) Mohammed Abudaya

Behavioural ecology of bonefish and giant trevally at St Joseph Atoll, Republic of Seychelles (312) Paul Cowley & Emily Moxham

Behavioural patterns of lemon sharks in St Joseph Atoll using daily diary tags (348) Ryan Daly

Biodiversity and conservation of elasmobranchs in Watamu Marine National Park and Reserve, Kenya (363) Peter Musembi

Calibrating an emerging trophic ecology tool for wild elasmobranch populations using aquarium-held animals (355) Diana Churchill

Can the yellow stingray detect and use geomagnetic cues for orientation and navigation? (364) Kyle Newton

Capacity-building workshop for young elasmobranch scientists in Pacific Mexico (366) Josh Stewart

Characterising the emerging deep-water shark fisheries in Belize (299) Ivy Baremore

Community monitoring of nesting sea turtles at D'Arros Island and St Joseph Atoll, Seychelles (256) Jeanne Mortimer

Discovery of an angel shark (*Squatina squatina*) nursery area in the Canary Islands (344) Eva Meyers

Documenting and protecting critically endangered sawfishes in Madagascar (307) Ruth Leeney

Ecological consequences of personality in sharks (367) Félicie Dhellemmes

Elasmobranch biodiversity monitoring and assessment in Sabah, northern Borneo (343) Mabel Manjaji Matsumoto

Evaluation de l'impact de la pêche artisanale des raies et requins en Afrique de l'Ouest (340) Framoudou Doumbouya

Facilitating long-term aerial monitoring of inshore shark distribution and abundance in south-eastern Australia (357) Lachlan Fetterplace

Feasibility of a novel, low-cost tracking system to monitor the movements of marine turtles (354) Giulia Cerritelli

Finprinting: an international white shark photographic identification catalogue system (310) Michael Scholl

Foraging ecology of Wedge-tailed Shearwaters breeding at St Joseph Atoll, Seychelles (352) Danielle van den Heever

Great Bear LIVE (300) Diana Chan

Habitat and resource partitioning of juvenile sharks and their roles in remote coastal ecosystems (290) Ornella Weideli

Habitat use, residency and population genetics of endangered smalltooth sawfish off Andros Island (302) Dean Grubbs

Harnessing advances in human oncology for sea turtle conservation: novel therapeutic treatments for fibropapilloma tumours (356) David Duffy

Lost fishes of Easter Island (361) Naiti Morales Serrano

Magnitude of elasmobranch exploitation and by-catch in artisanal fisheries of Colombia using fishers' knowledge (353) Camila Caceres

Movement patterns, trophic role and ecology of reef mantas in the D'Arros Marine Protected Area (230) Lauren Peel & Guy Stevens

Ocean Connectors: pelagic thresher shark education programme (360) Frances Kinney

Optimising the effectiveness of marine biodiversity monitoring and conservation planning in False Bay, South Africa (292) Lauren De Vos

Paving the way for devil ray protection at the 2016 CITES Conference of the Parties (341) Isabel Ender

Predator-prey interactions: understanding how shark presence influences sea turtle habitat use, distribution and movement (358) Mariana Fuentes

Sawfish children's book (369) Ruth Leeney

Sharks from Peninsula Valdes: a research and conservation initiative (359) Alejo Irigoyen

Sharks on the urban edge: shark research component of the Shark Spotters programme (306) Alison Kock

The diet and ecological role of deep-water sharks in Australia revealed using stable isotope analysis (362) Samantha Munroe

The ecology of stingrays in St Joseph Atoll, Seychelles (288) Chantel Elston

The Galápagos Marine Reserve: providing a model for a sustainable coexistence between humans and sharks (304) Euan Harvey

Tracking trans-Atlantic movements, habitat preferences and fisheries overlap of the shortfin mako shark (308) David Sims

Trophic position and ecological roles of euryhaline elasmobranch predators (309) Barbara Wueringer

Understanding genetic population structure of endangered Nassau grouper to support its conservation in The Bahamas (365) Krista Sherman

Urban shark: the effects of human-induced stressors on the ecology of sharks occupying urbanised landscapes (303) Neil Hammerschlag

Workshop: IUCN Red List assessment of sharks, rays and chimaeras in the Arabian Sea (370) Rima Jabado

## B: ALL SOSF PROJECTS FUNDED IN 2016

SORTED BY CATEGORY AND IN ALPHABETICAL ORDER OF THE PROJECT TITLE

### KEYSTONE GRANTS – CONTINUATION

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SOSF team at the annual meeting of the scientific advisors in September 2016 in Florida, USA (from left to right): Thomas Peschak, Dean Grubbs, Michael Scholl, Sarah Fowler and Nadia Bruyndonckx.

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