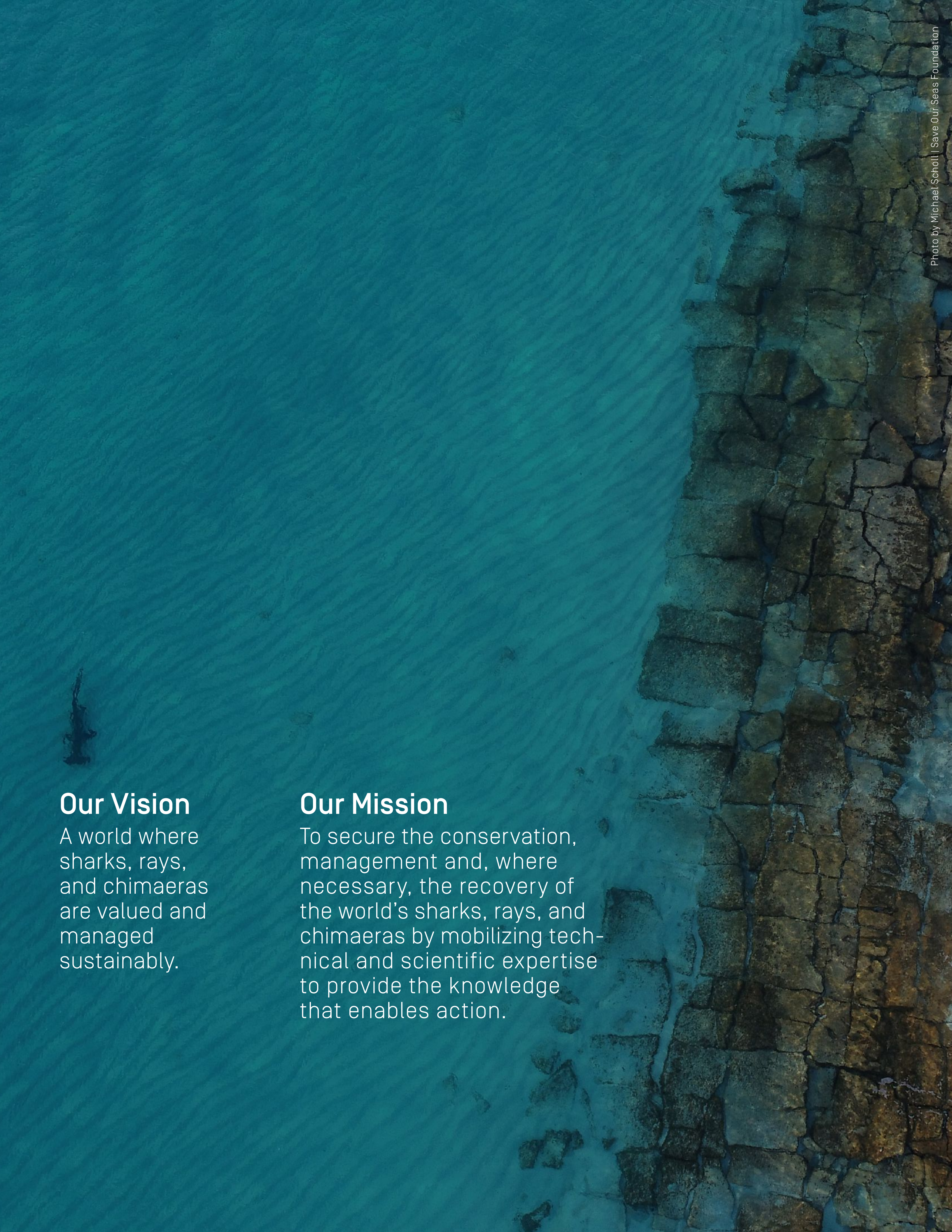
SHARK NEWS

Newsletter
of the IUCN SSC Shark
Specialist Group
#3/2021

IUCN SSC
Shark Specialist Group



Our Vision

A world where sharks, rays, and chimaeras are valued and managed sustainably.

Our Mission

To secure the conservation, management and, where necessary, the recovery of the world's sharks, rays, and chimaeras by mobilizing technical and scientific expertise to provide the knowledge that enables action.

Photo by Michael Scholl | Save Our Seas Foundation

Photo by Kelvin Aitken

Covers: These images of an Elephant Fish *(Callorhinchus milii)* were taken in late summer, when they move from the edge of the continental shelf, from 300m deep, to shallow sheltered bays to mate and lay their eggs. Westernport Bay near Melbourne, Australia, is a perfect place for this to occur, being shallow, silty and with a good supply of marine worms, crabs and small molluscs. This male was photographed near the entry to the bay, where clear water is briefly pushed in on the rising tide.

Cover photos by Kelvin Aitken | Marine Themes Pty Ltd | marinethemes.com

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Published by the IUCN SSC Shark Specialist Group (SSG)
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Editorial

A note from the Chair Rima Jabado

Artwork by Keith Witmer

Dear readers,

I have just returned from my first large international event since the COVID-19 pandemic began, the World Conservation Congress (WCC) in Marseille, France. It's not often that you find yourself at an event with almost 6,000 people (despite COVID restrictions!), with most participants working on or at least involved in one aspect of conservation. The passion, the drive, the hope for change is tangible at each of the events attended and across all conversations. So many people striving to make a difference in a range of fauna, flora, and funga including, of course, sharks. The meeting was a wake-up call in some sense for many, but there was also a lot of hope and optimism. The conversation around extinction was often shifting towards resilience, recovery, and solutions to the challenges we face when working in this field. Sadly, this is where we also announced the results of the last global assessment for chondrichthyans. In the new paper titled 'Overfishing drives over one-third of all sharks and rays towards a global extinction crisis', we report that it is now estimated that 37% of sharks, rays, and chimaeras are threatened with extinction, according to the IUCN Red List of Threatened Species Categories and Criteria. With that, we now also have the first three species of sharks and rays that are flagged as Critically Endangered – Possibly Extinct because they have not been recorded in decades even though survey efforts have been undertaken across their known range. Despite this grim outlook, one key thing discussed at WCC is the concept of species recovery and the Reverse the Red campaign – the global movement to ensure the survival of wild species. We now know conservation works, which is a cause for optimism and incentive for more action for many species. And even though threats to sharks, rays, and chimaeras continue unabated, in this third issue of Shark News, we wanted to share some good news stories from around the world. You can read about how scientists and government entities in Indonesia have mobilized very quickly to understand and improve the status of rhino rays (sawfishes, wedgefishes, giant guitarfishes, and guitarfishes); how in Brazil, what started as a small project is making waves with coastal fishing communities who are now voluntarily releasing a Critically Endangered species of guitarfish; and how in Belize, fishers are currently working with scientists to provide information on their catches and inform policy. With this, we delve into IUCN's 'Green Status of Species', a new global standard to measure how close a species is to be fully ecologically functional across its range and how much it has recovered due to conservation action. We have examples from three species of sharks. Once this tool is integrated as a complement to the IUCN Red List of Threatened Species, we will have a fuller picture of species' conservation status in terms of their extinction risk and progress towards their recovery. Along with other stories from fieldwork in Ghana, Greece, and Malaysia, we have more good news from Australia, where only 12% of species are considered threatened, showcasing how fisheries management can work. Finally, the WCC is also when all IUCN Specialist Groups are dissolved and re-established and where so many decisions related to the functioning and program priorities of the IUCN are finalized. I have tried to provide a summary of some of the highlights from the Congress and some of the changes to the Shark Specialist Group in terms of membership. Once again, thank you to all members and non-members that have contributed to this issue. And of course, special thanks to Michael Scholl for coordinating all the contributions and design of Shark News. Rima

‘The time for action is now.’

Photo by Rima Jabado

Written by Dr Rima Jabado
IUCN SSC Shark Specialist Group | Chair

An update from the World Conservation Congress – Marseille 2021

The International Union for Conservation of Nature (IUCN) World Conservation Congress usually takes place around the world once every four years. It was originally planned for June 2020, and after several postponements due to the COVID-19 pandemic, the 7th IUCN Congress finally took place between September 3–10 in Marseille, France. It’s one of those unique events that brings together people from all walks of life -- thousands of leaders and decision-makers from governments, civil society, academia and conservationists from around the world to discuss solutions to the growing challenges facing nature and biodiversity as well as form new partnerships.

In a world still slowly emerging from the pandemic, the Congress was the first global major environmental event to be held in hybrid format. This allowed those unable to physically attend the event to follow and participate in some parts of the Congress remotely. Overall, it attracted over 6,000 in-person participants as well as about 3,500 online registrations. It drew strong political attention with an opening ceremony which included speeches by French President Emmanuel Macron, the President of the European Central Bank Christine Lagarde, the Greek Prime Minister Kyriakos Mitsotakis, the famous Brazilian photographer Sebastiao Salgado, and the actor and Vice-Chair of Conservation International’s Board of Directors Harrison Ford (amongst many others), all recognizing that now is the time for action and making a strong commitment to conservation.

The IUCN Congress agenda consisted of three main components: the Members’ Assembly, the IUCN’s highest decision-making body where IUCN Members (governments and non-governmental organizations) jointly vote on priority actions for conservation and sustainability; the Forum, a hub of conservation science and innovation with over 600 sessions organized through different types of events from high-level dialogues to training workshops; and the Exhibition, where exhibitors can showcase their work to Congress participants and the public. The Congress was structured around the themes of Landscapes, Freshwater, Oceans, Climate change, Rights and Governance, Economic and Financial Systems, and Knowledge, Innovation and Technology. However, to me at least, the recurring themes across exhibition stands, panel discussions, and even side-bar conversations were the state of biodiversity and its collapse, as well as the growing threat of climate change.

Some key outcomes were:

- the approval of the IUCN programme for 2021–2024 – Nature 2030: Union in Action

- the election of IUCN’s officials for the next four years, notably, the new IUCN President, Razan Al Mubarak from the United Arab Emirates (the first woman from the Arab world to hold this role) as well as the re-election of Dr Jon Paul Rodriguez from Venezuela as the Chair of the Species Survival Commission;

- the Marseille Manifesto highlighting that ‘*Humanity has reached a tipping point. Our window of opportunity to respond to these interlinked emergencies and share planetary resources equitably is narrowing quickly. Our existing systems do not work. Economic “success” can no longer come at nature’s expense. We urgently need systemic reform.*’;

Photos by Rima Jabado

- the adoption of 28 motions on a range of conservation and sustainable development issues, including urgent motions that had been tabled in the last month. These included motions on the Protection of deep-ocean ecosystems and biodiversity through a moratorium on seabed mining (#069) and the Controlling and monitoring trade in croaker swim bladders to protect target croakers and reducing incidental catches of marine megafauna (#132);

- the adoption of 109 resolutions and recommendations including those (relevant to sharks and rays) on: Aquatic biodiversity conservation of shallow marine and freshwater systems (#012), Reducing impacts of incidental capture on threatened marine species (#023), For an improved management of drifting fish aggregating devices (FADs) in purse seine fisheries (#024), Implementing international efforts to combat the sale of illegal wildlife products online (#040), Guidance to identify industrial fishing incompatible with protected areas (#055), Global Conservation of rhino rays (Rhinidae, Glaucostegidae, Rhinobatidae) (#91), and Reducing the impact of fisheries on marine biodiversity (#107); and

- the **re-establishment of the IUCN SSC Shark Specialist Group and its members for the next four years.**

There were a number of conservation success stories that were highlighted throughout the Congress. Notably, for marine species, the focus was on signs of recovery of four tuna species due to the enforcement of sustainable fishing quotas and work to reduce illegal fishing. However, for sharks, rays, and chimaeras, the news was rather grim. On September 4th, a press conference was held to announce the results of the latest IUCN Red List of Threatened Species assessments. We announced that 32–37.5% (estimate depending on whether Data Deficient species are assumed to be threatened in the same proportion as assessed species) of sharks, rays, and chimaeras are now considered threatened (Critically Endangered, Endangered, or Vulnerable) according to IUCN Red List criteria. These species now rank second among vertebrates (after amphibians) in terms of extinction threat. They are threatened primarily due to overfishing, compounded by loss and degradation of habitat and climate change. The complete study can be found here.

IUCN Congress in numbers

Source: IUCN newsletter – September 11th, 2021

Attendance
- **9,200 participants in Marseille and online**
- **25,000 visits by the general public to the Exhibition and Nature Generation Areas**

Virtual participation
- **50,000+ views of online sessions**
- **4,730 individual connections**
- **19,000+ hours viewed**

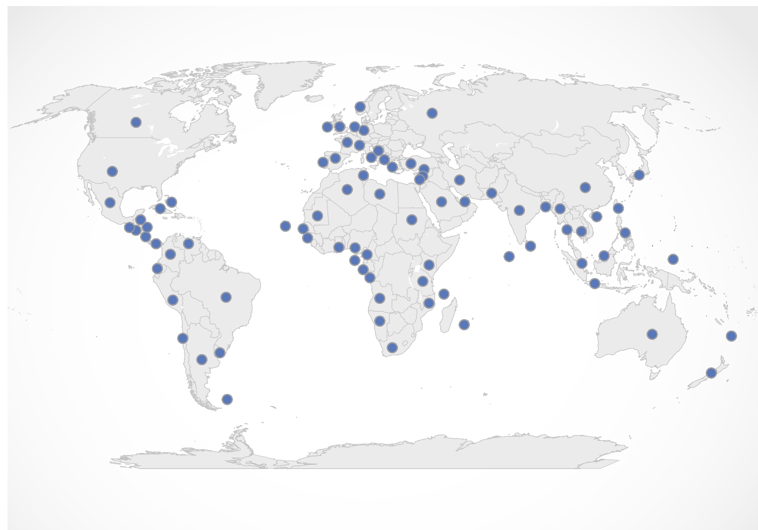
Media
- **10,000 news stories**
- **140 countries covered the Congress**

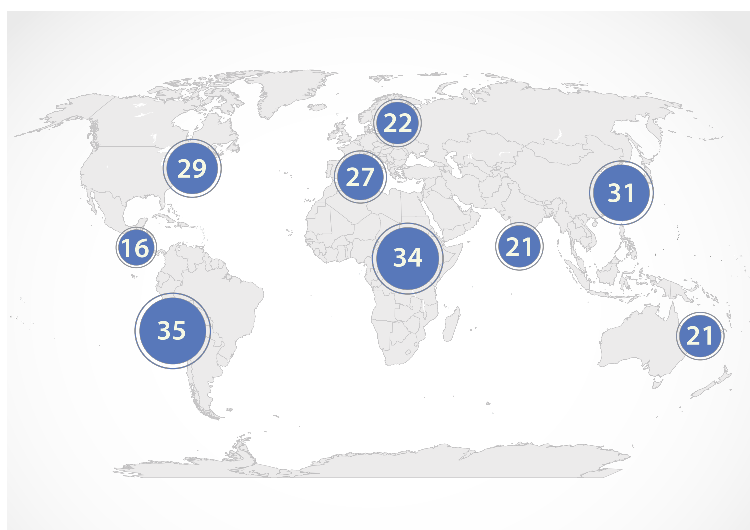
Social media
- **54 million people reached per day with #IUCNcongress**
- **567% increase in engagement over August 2021**

Update on the IUCN SSC Shark Specialist Group

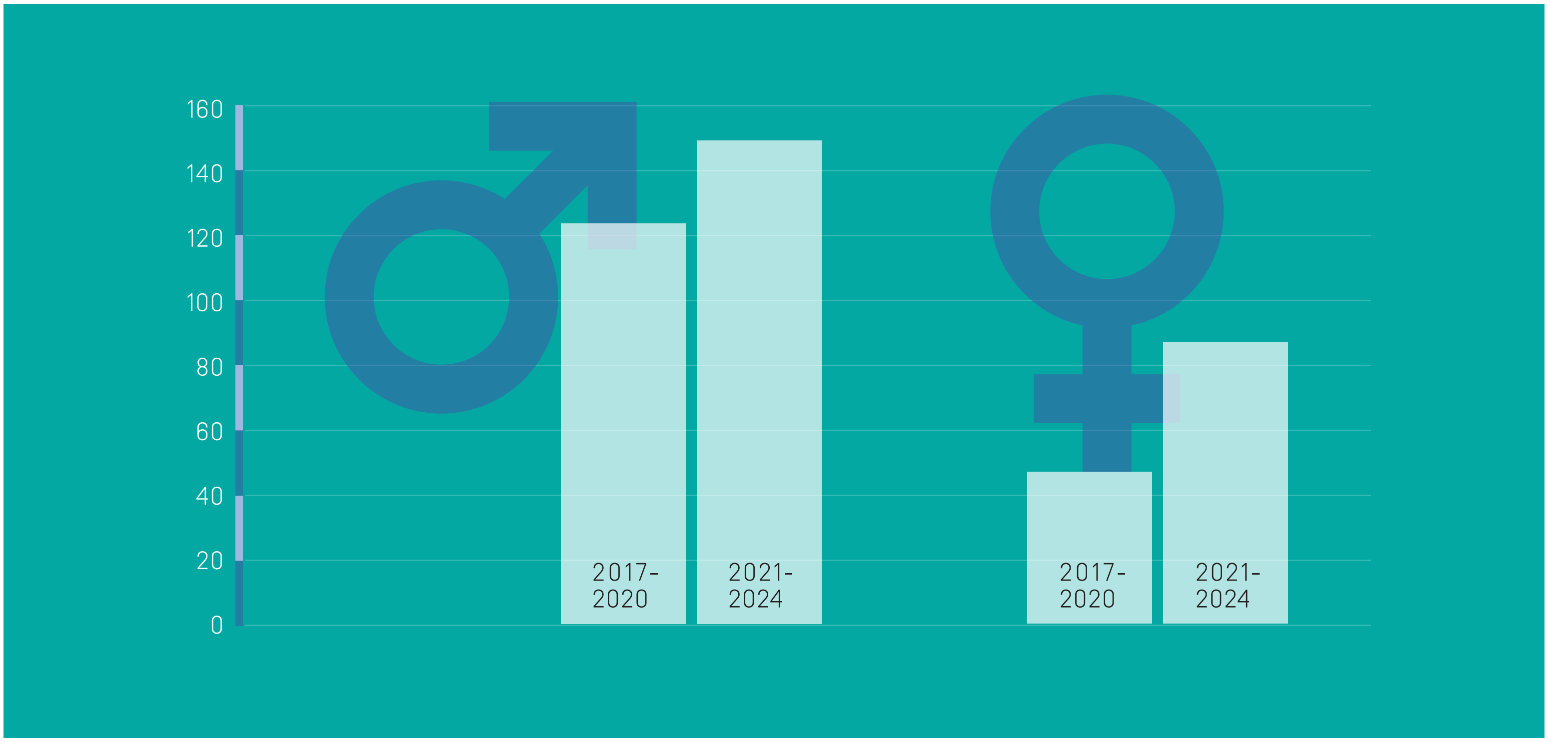
With the new quadrennium officially upon us, I also wanted to take the time to provide an update on the IUCN SSC Shark Specialist Group network. Our membership increased by 38.5% since 2017, from 171 members during the 2017–2020 quadrennium to 237 members in 2021. We renewed memberships for 108 of the 171 members from the previous quadrennium and invited 129 new members to join our group.

We now have members from 82 countries compared to 51 countries previously. We have done our best to build a diverse network in terms of gender, age and geographic distribution, and expertise. Our members are spread out across nine regions: North America (12.2%), Central America and the Caribbean (6.8%), South America (14.8%), Northern Europe (9.3%), Mediterranean (11.4%), Africa (13.1%), Indian Ocean (9.2%), Asia (13.1%), and Oceania (8.9%).





Geographic distribution of IUCN SSC Shark Specialist Group members by countries and territories (n=82) and by the nine regions (numbers indicate the total number of members in each region)

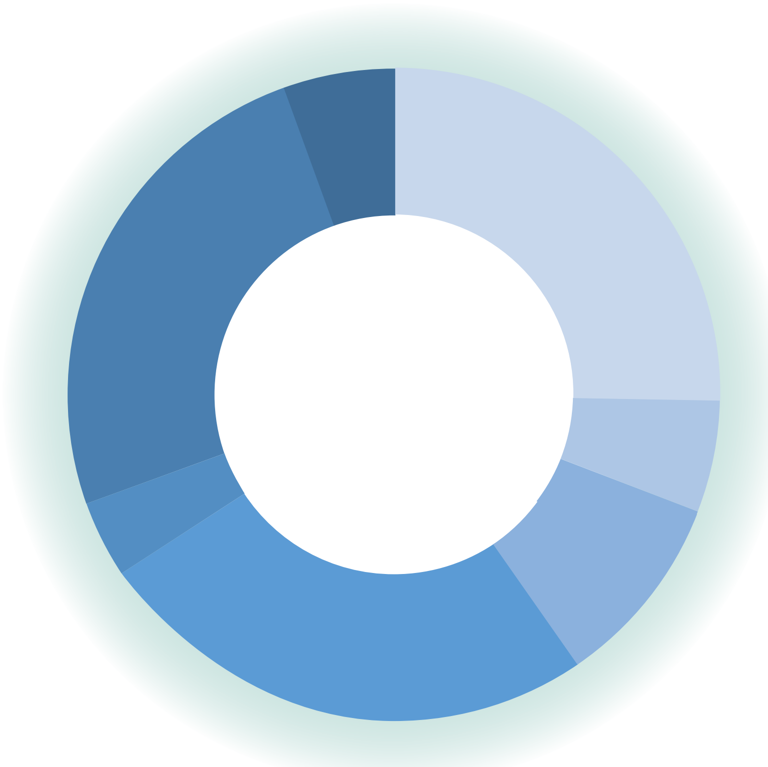


Comparison of gender distribution of IUCN SSC Shark Specialist Group members for the previous quadrennium (2017–2020) and the current quadrennium (2021–2024)

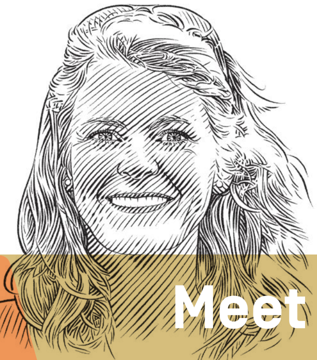
We still have some work to do regarding gender representation, but overall we have also increased our percentage of male to female members from 72.5% and 27.5% respectively in 2017–2020 to 63.3% and 36.7% in 2021–2024.

Finally, we have tried to diversify our expertise so that not all members are shark, ray, and chimaera scientists but are also working on policy, advocacy, conservation planning, ex-situ conservation, and education. We have tried to engage and have relatively equal representation from members in academia (25.3% - both university staff and students), research institutes (24.9%) and non-governmental organizations (23.5%) but also broadened our membership to those working in governmental organizations (9.7%), aquariums (5.5%) and those in other fields such as arts and communications (3.8%).

IUCN WORLD CONSERVATION CONGRESS Marseille 2020



Distribution of IUCN SSC Shark Specialist Group members in terms of affiliation.



Artwork by Keith Witmer

Q&A

Meet one of the founding members of the IUCN SSC Shark Specialist Group: Sarah Fowler

Sarah discusses her long and diverse career in shark conservation

By Dr Rima Jabado
IUCN SSC Shark Specialist Group | Chair

"I was always destined to be a marine biologist from my early days as a child. I went to university to do marine biology and then decided to take an MSc course on Nature Conservation in London. I was one of the few people in the UK to have a marine conservation qualification back then," said Sarah Fowler, an independent consultant, one that has made an immense contribution to shark and ray conservation over the last three decades.

During this time, Sarah has worn many hats. She started her career working at the Nature Conservancy Council as a government advisor on biodiversity conservation. Back then, her role meant she had to work on anything conservation related along the coast of the UK – from seaweeds and invertebrates to unmanaged fish species such as Basking Sharks *(Cetorhinus maximus)*, the Common Skate *(Dipturus batis)* and the Angelshark *(Squatina squatina)*. She continued working on these issues when she left that job, including drafting some of the first UK Species Action Plans and advocating for UK species protection. Sarah also became familiar with International Union for Conservation of Nature (IUCN) Action Plans and the IUCN Red List of Threatened Species. Despite her earlier work on sharks, it was by chance that she got involved in shark conservation. "Over coffee with a friend, I was complaining and saying: 'you know, there is a real problem with shark conservation, sharks are in so much trouble, nobody cares, no one has noticed, something needs to be done about it.' My colleague dashed off a fax to IUCN, and a few hours later my phone rang – it was Dr Simon Stuart (then Director of the IUCN Species Programme; later Chair of the Species Survival Commission), saying that a Shark Specialist Group was being set up, that Dr Samuel Gruber (Sonny) would be Chair and that I would be Deputy Chair. That was it – changed my life," she recalls.

And so, in 1991, Sarah became one of the founding members of the SSG and entered a leadership role for 18 years as Deputy Chair, Acting Chair, and then Co-Chair. Her role was diverse, and she initially spent a substantial amount of time just setting up group administration, fundraising to launch Shark News -- the official SSG newsletter, asking a friend to design an SSG logo, creating letterheads, developing a database of members, and inviting contributions for an IUCN shark status report. "Everyone else in the group was an eminent shark researcher including Sonny, Malcolm Francis, Leonard Compagno, John Stevens and many many great researchers, but very few were actually professional marine conservationists, and I guess that's where I fitted in," she said.

At that time, shark conservation was in its infancy, and one of the first issues the SSG had to address was the practice of finning. There were already shark fisheries in the 1930s and 1940s for several species like the Porbeagle Shark *(Lamna nasus)* for its meat and even the Basking Shark for its liver oil. But in the 1980s, the demand for shark fins from China exploded and with that came an increase in fisheries targeting sharks for their fins. "This is really why the SSG was established. It was at that time that Sonny Gruber had realized that his study animals [Lemon Sharks, *Negaprion brevirostris*] were disappearing or were not as abundant as they used to be in Florida. Sid Cook wrote an article in his newsletter *Chondros* about the impact of shark finning on the increasing mortality of many species. The founding members of the SSG were still struggling to convince fisheries managers that sharks were wildlife and needed to be conserved. Actually, it was difficult to address the impact of fisheries on sharks, but finning (and discarding the carcasses) was a different story because no one could say it was good practice, and it was an easy concept for people to grasp. That was the issue that put sharks on the map as a major biodiversity conservation challenge," she said. Even with all the efforts of the SSG, its members, and countless other organizations, addressing finning took a long time. "It was a struggle from the beginning. We had to work through the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES) (see below), the United Nations Food and Agriculture Organization (FAO), Regional Fisheries Management Organizations, and developed a particular focus on Europe, because of the huge impact of European Union fishing fleets. The debate on the impact of these fleets on shark mortality led to the establishment of the Shark Alliance, which was a hugely successful campaign that led to

Q&A

First IUCN Shark Specialist Group (SSG) Meeting during Sharks Down Under – International Conference on Shark Biology and Conservation | Taronga Zoo, Sydney, Australia | February 25 - March 1, 1991

Photos from the personal collection of Samuel and Marie Gruber an EU finning ban and the adoption of the EU Shark Plan," Sarah stated.

The SSG had also become involved early on with debates on sharks at CITES, when Dr Gruber went to the 9th Conference of Parties in Fort Lauderdale, Florida, in 1994. "Sonny made a passionate intervention on the problems of shark conservation and the fin trade driving unsustainable fisheries. It was absolutely groundbreaking! As a result, CITES adopted a Resolution on Sharks, which was the first time a Resolution had addressed international trade concerns for taxa not already listed in the CITES Appendices. This asked the CITES Animals Committee to review all information concerning the biological status of sharks and the effects of international trade and submit their findings to the next Conference of Parties, in 1997," she added. As a result, countries started to consider proposing shark species to be listed on CITES Appendix II, with the White Shark *(Carcharodon carcharias)*, Basking Shark, and Whale Shark *(Rhincodon typus)*, first proposed (unsuccessfully) in 2000. It took almost 10 years (until 2003) for any shark species to be listed on CITES. Still, these early actions put sharks on the political agenda, prompted the FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) and encouraged the collection and sharing of fisheries and trade data. "These initial listings were really big. Sometimes it took three meetings of the Conference of Parties before we could achieve an objective, but they brought so much attention to shark conservation. By the time the first species were listed, the Basking Shark-targeted fisheries were nearly finished, Whale Shark fisheries had been reduced worldwide, and White Shark trade was mostly from trophy hunting. But regulating trade in these few species allowed us to get into promoting regulation for the commercially-important species that were increasingly threatened by trade," she said. Since these initial listings, proposals to list sharks and rays on CITES have continued to pass at meetings of the Conference of Parties, with 46 species currently listed on Appendix I and II of the Convention. One way or another, Sarah has been involved in supporting these proposals and/or providing the scientific basis for their development.

Another big challenge facing the SSG was to understand the status of the over 1,000 species of sharks, rays, and chimaeras around the world. "Red List assessments are the building blocks of conservation work, and this was one of the first things I pushed the SSG to do. We needed to fundraise, hold lots of meetings, and it took forever. It stopped us from doing other proactive work for several years, but it is one of the things I am the most proud of, it was an amazing time," Sarah revealed. She had, by then, a team of volunteers and staff pushing through the assessments but says "I still don't know how we got so much done, although Rachel [Cavanagh], who was hired as the Programme Officer, did so much work and she achieved a phenomenal amount. Also, the volunteers gave up their time, their holidays, and they travelled around the world just to talk about assessments. It has been such an enormous privilege to work with so many dedicated people." Sarah also recognized that those first assessments were very different because each status assigned to a species was agreed by consensus of the entire Specialist Group. "I felt it was important that people owned it. But it was so difficult to get some fisheries people to admit that there was any extinction risk for many species. Now the SSG has new tools it can use, like the JARA method (Just Another Red List Assessment), which applies models to show that the status of species is actually bad. This evolution is great because we can now use quantitative data to base the assessments on rather than just relying on expert opinion and consensus," she added.

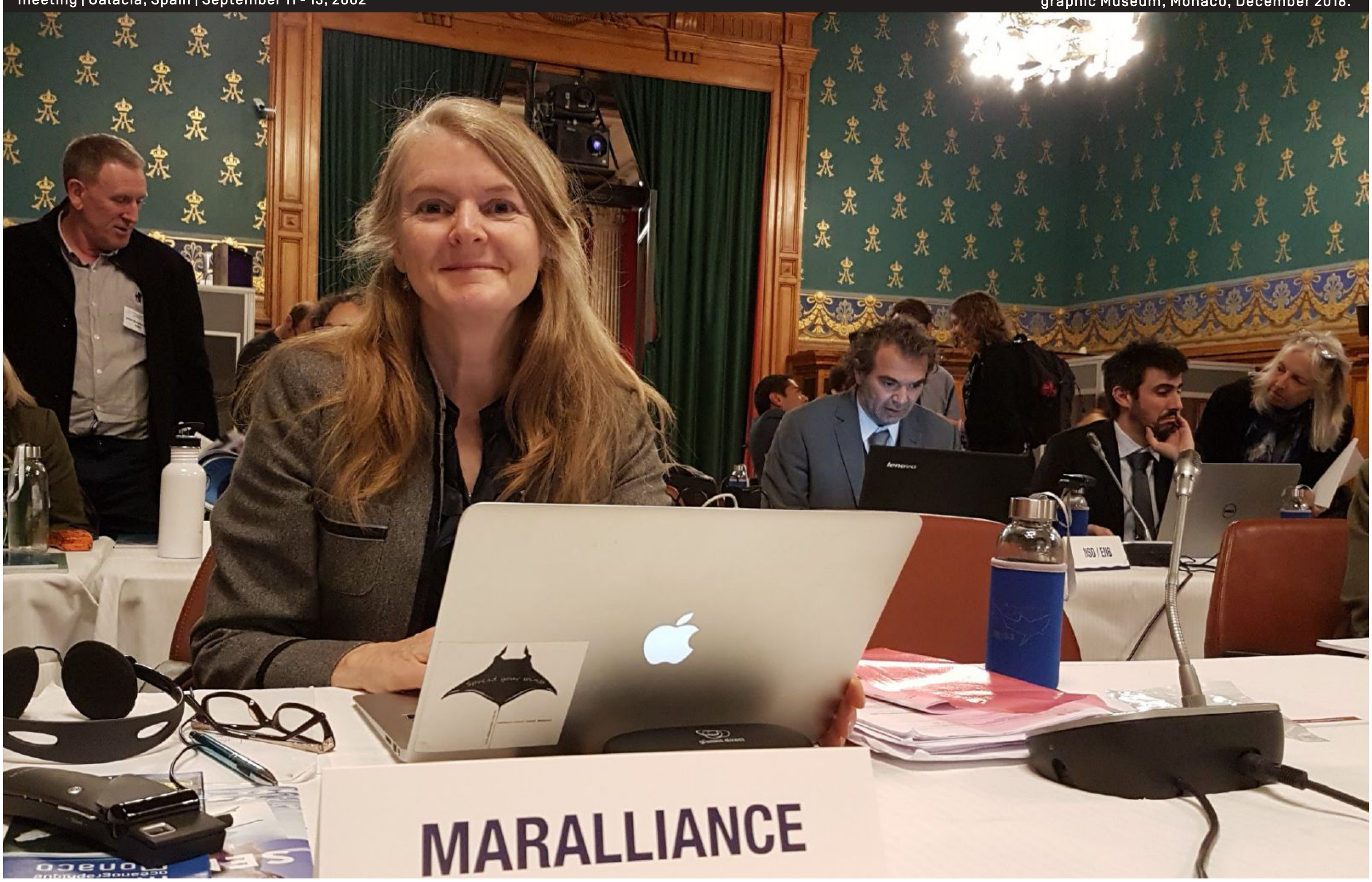
There were also many other monumental achievements that Sarah was involved in while leading the SSG, including the listing of sharks and rays on the Convention on Migratory Species (CMS) and the development of the CMS Sharks Memorandum of Understanding (Sharks MoU). And, even while she was supporting these large global campaigns and facilitating a network of over 150 SSG members, Sarah had kept very busy on the side. "There was huge interest from students and researchers in joining the SSG. So many people wanted to feel that they were engaged in a shark network and belonged to a shark community. But we couldn't invite everyone to be part of the SSG. Instead, similar to what already existed in the United States and Japan, we eventually founded the European Elasmobranch Association and its UK member, the Shark Trust," she said. In recognition of her work, Sarah was appointed Officer of the Order of the British Empire for services to marine conservation in 2004 and awarded a Pew Fellowship in Marine Conservation to build on the international shark policy work she had started through the SSG.

Sarah stepped down as Chair of the SSG in 2009. "We had finished all the assessments, even though some people were still busy describing new species. But I think 8 to 10 years is long enough for a person to do one thing, and I had been driving or involved with the SSG for far longer," she said. Her work on sharks, however, did not stop there. Sarah has also held a role as one of the Save Our Seas Foundation's Scientific Advisors since 2011, sits on the Expert Advisory Panel of the Shark Conservation Fund, and continues to be active on shark and ray conservation policy in CITES, CMS and other fora. "I haven't been as closely involved in the SSG work over the last 10–15 years, but the great thing about the SSG now is that so many more people are involved, it's so much more professional than it used to be, and there are more funds coming in to support with conservation work," Sarah said. But more than anything, moving forward, she is most excited by how many people are now working on shark conservation. "I want to see more people doing what I used to do. When I started out, there was no one else representing shark conservation, and now it's fantastic. I love to see so many delegates advocating for shark conservation at international meetings. I would like to continue to see people implement what we have achieved already and I encourage more people to do so."

Photos from the personal collection of Samuel and Marie Gruber

↑ Sarah Fowler, Jack Musick and Rachel Cavanagh at the Northwest Atlantic Fisheries Organization's 24th annual meeting | Galacia, Spain | September 11 - 13, 2002

↓ Observer delegate to the Third Meeting of Signatories to the CMS Sharks MOU, Oceanographic Museum, Monaco, December 2018.



Convention on Migratory Species Sharks MOU and Sharks*

* The term ‘sharks’ refers to all species of sharks, rays, and chimaeras.

Text by Jennifer Pytka and Andrea Pauly
Convention on Migratory Species

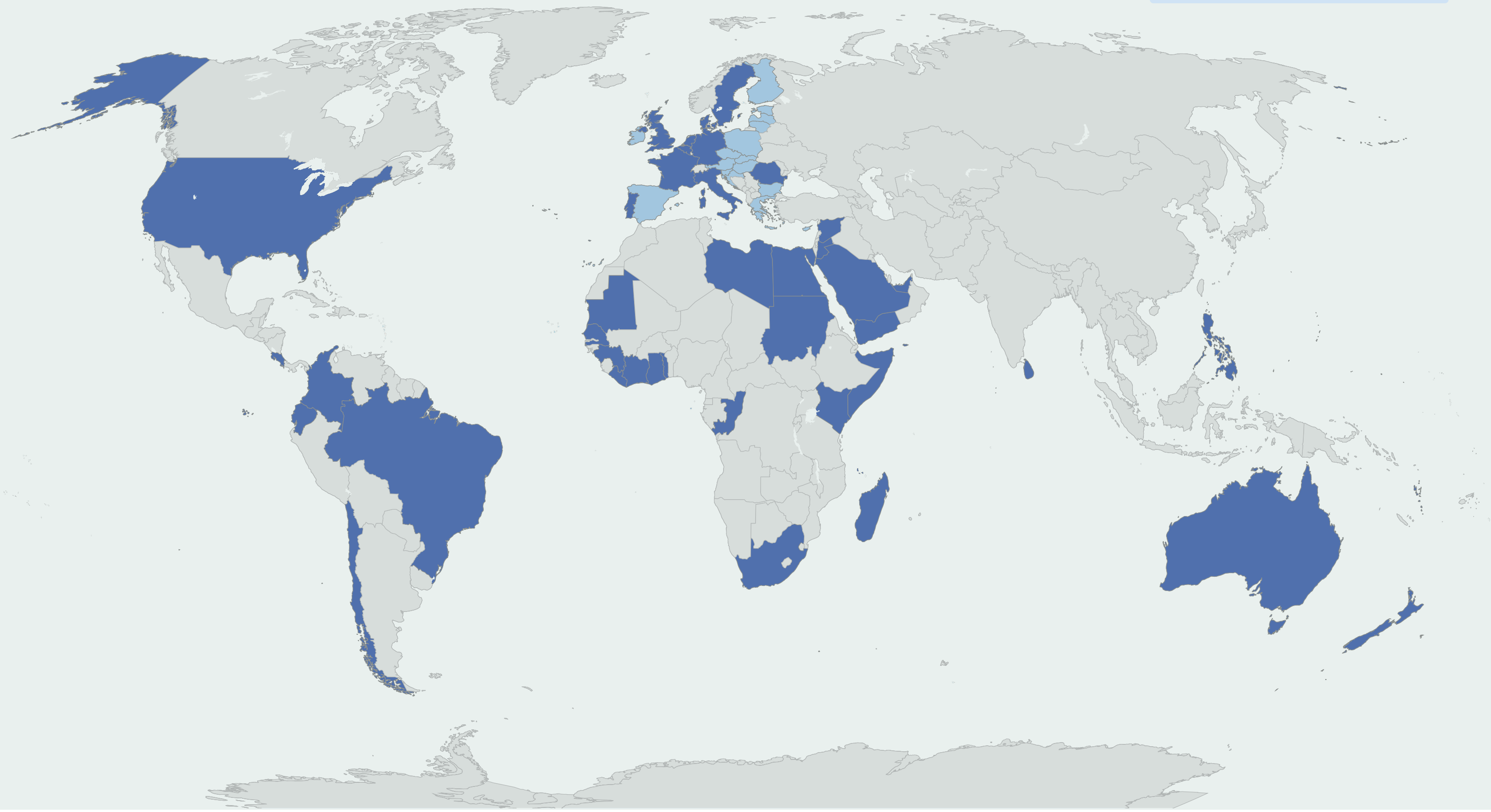
What is the CMS Sharks MOU?

The Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MOU) is a daughter agreement under the Convention on the Conservation of Migratory Species of Wild Animals (CMS). It represents the only global instrument specifically dedicated to the conservation of migratory species of sharks. The MOU was concluded in 2010 and is **legally non-binding;** rather, Signatories have **committed politically** to its implementation. As of June 2021, the Sharks MOU has been signed by 48 States, the European Union (EU), and 15 cooperating partners.

The **main objective** of the Sharks MOU is to “achieve and maintain a **favourable conservation status** for migratory sharks included in its **Annex 1** based on the best available scientific information, taking into account the socio-economic value of these species for the people of the Signatories”.

As a framework Convention, CMS operates through specialized **daughter agreements** established for species included in Appendix II of the Convention.

There are three Annexes under the Sharks MOU:
Annex 1 Species covered by the Sharks MOU
Annex 2 Regions and Advisory Committee representation
Annex 3 Conservation Plan



Map showing all Signatories to the CMS Sharks MOU. Dark blue ● indicates countries that have individually signed the agreement, light blue ● indicates member states of the EU, which signed the agreement as a block (as of June 2021). Source: CMS Sharks MOU Secretariat

World with Countries - Blue (WRLD-EPS-02-4006) basemap – Copyright © Free Vector Maps | Striped Candy LLC

What are the criteria for listing species on the Sharks MOU?

Sharks listed on Appendices I and II of the mother Convention, CMS, **are not** automatically included in Annex 1 of the Sharks MOU. Still, they will be automatically **considered by the Sharks MOU Signatories for inclusion at their meetings.** However, Signatories **should prohibit the taking** of CMS Appendix I-listed species.

Taking refers to taking, hunting, fishing, capturing, harassing, deliberate killing, or attempting to engage in any of the stated conducts.

In line with the criteria for the inclusion of species in CMS Appendix II *(see Shark News Issue #2)*, Annex 1 of the Sharks MOU shall list **migratory species** which have **unfavourable conservation status** and which require international agreements for their conservation and management, as well as those which have a conservation status which would significantly benefit from the international cooperation that an international agreement could achieve.

Further to the definition of "migratory" under CMS, the Sharks MOU identifies four different categories of migratory behaviour, from wide-ranging migration to short distances:

a) **Large scale migration (or highly migratory):** Those species whose migrations extend over the scale of oceanic basins, encompassing national waters and high seas.
b) **Regional migration:** Those species whose migrations extend over the scale of regional (often shelf) seas, although a small proportion of the population may make longer distance movements, including excursions into oceanic basins.
c) **Sub-regional migration:** Those species that migrate over smaller spatial scales but with clear evidence of cyclical and predictable migrations across jurisdictional boundaries.
d) **Smaller scale coastal migration (or non-migratory):** Those species that are generally site specific or make only shorter migrations.

Amendments to Annex 1 should be assessed by the Signatories at each Meeting of the Signatories (usually every three years), where decisions are made by consensus on whether to include new species or remove species from Annex 1.

How are species protected under the Sharks MOU?

Finning: Practice of removing any of the fins of a shark (including the tail) while at sea and discarding the remainder of the shark at sea.

Provisions of the Sharks MOU apply to all species listed in **Annex 1.** The Sharks MOU requires that sharks be managed to allow for sustainable harvest where appropriate through conservation and management mea-sures based on the best available scientific information. Signatories should also consider enacting legislation to prohibit shark **finning**.

Signatories have decided that the Sharks MOU **shall not** manage fisheries but should instead collaborate with and work through competent fisheries bodies. Recognizing this, Signatories should promote cooperation and information-sharing and engagement with relevant stakeholders, including Regional Fisheries Management Organizations (RFMO) and the United Nations Food and Agriculture Organization (FAO). This includes sharing technical and scientific information to develop best practice guidelines for stock assessments, monitoring and enforcement, and bycatch mitigation measures.

Signatories should record species-specific data, including catches and discards, and are encouraged to implement conservation measures such as the FAO International Plan of Action for Conservation and Management of Sharks (IPOA-Sharks). Signatories are encouraged to develop their own National Plan (NPOA-Sharks) and encourage other States to sign the Sharks MOU.

As set out in **Annex 2,** representatives from various regions (Africa: 2; Asia: 2; North America: 1; Europe: 2; Oceania: 1; South, Central America & the Caribbean: 2) form the **Advisory Committee.** These representatives provide expert advice to the Secretariat and Signatories concerning the implementation of the Sharks MOU, analysis of scientific assessments, and recommendations on the conservation status of **Annex 1**-listed species.

Signatories have also agreed a comprehensive Conservation Plan (**Annex 3**) for **Annex 1**-listed migratory sharks, which is based on **five main objectives:**

a) Improving the understanding of migratory shark populations through **research, monitoring** and **information exchange;**
b) Ensuring that directed and non-directed fisheries for sharks are **sustainable;**
c) Ensuring to the extent practicable the protection of **critical habitats** and migratory corridors and critical life stages of sharks;
d) Increasing **public awareness** of threats to sharks and their habitats, and enhancing public participation in conservation activities; and
e) Enhancing national, regional, and international **cooperation.**

In implementing the measures given in the **Conservation Plan**, the Signatories should apply widely, both an ecosystem and a precautionary approach. Lack of scientific certainty should not be used as a reason for postponing measures to enhance the conservation status of sharks.

Further reading:
CMS, Convention Text, 23 June 1979, available at cms.int/en/convention-text

CMS, *Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)*, 22 May 2020, cms.int/en/species/appendix-i-ii-cms

CMS Sharks MOU Website, available at cms.int/sharks/

CMS Sharks MOU, *Modifying the Species List (Annex 1) of the MOU*, 14 December 2018, CMS/Sharks/Outcome 3.2, available at cms.int/sharks/en/document/modifying-species-list-annex-1-mou-3

CMS Sharks MOU, MOU Text, December 2019, available at cms.int/sharks/en/page/sharks-mou-text

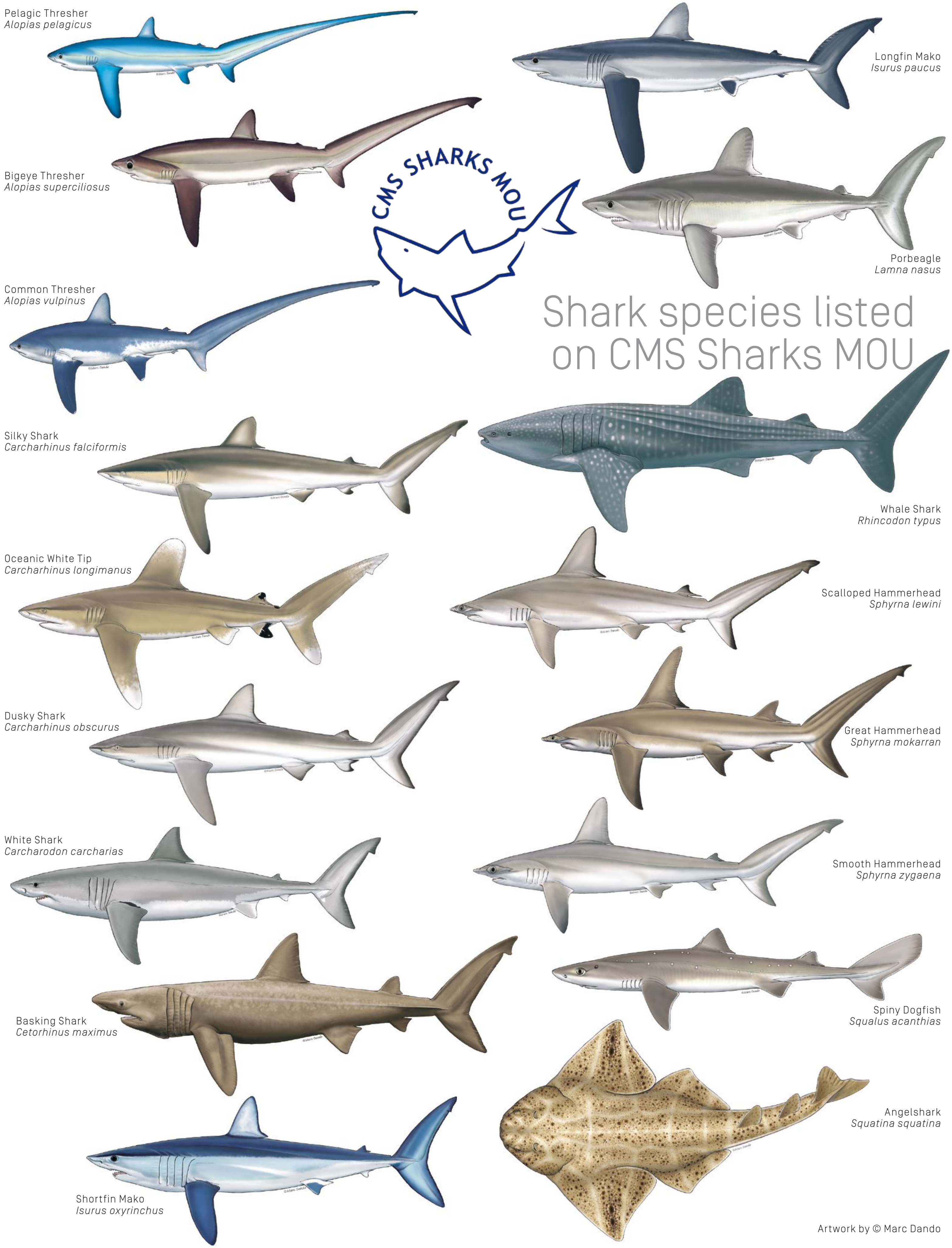
FAO, *The International Plan of Action for the Conservation and Management of Sharks, 1999*, Food and Agricultural Organisation, Rome, available at fao.org/3/x3170e/x3170e.pdf

Which species are covered by the Sharks MOU?

There are currently 37 shark species listed on the CMS Sharks MOU. The following table provides information on each of these species along with the year of listing in Annex 1.
[1] indicates that the taxonomy of these species has changed since they were listed, and changes have been made to their scientific names. For example, the genus *Manta* is no longer considered valid and has changed to *Mobula; Mobula japanica* is a synonym of *Mobula mobular; Mobula eregoodootenke* is now known as *Mobula eregoodoo*; and *Mobula rochebrunei* is believed to be an invalid species.

Order and Family	Species	Common Name	Year Listed
SHARKS			
Order Orectolobiformes			
Rhincodontidae	*Rhincodon typus*	Whale Shark	2010
Order Lamniformes			
Lamnidae	*Carcharodon carcharias*	White Shark	2010
	Isurus oxyrinchus	Shortfin Mako	2010
	Isurus paucus	Longfin Mako	2010
	Lamna nasus	Porbeagle	2010
Cetorhinidae	*Cetorhinus maximus*	Basking Shark	2010
Alopiidae	*Alopias pelagicus*	Pelagic Thresher	2016
	Alopias superciliosus	Bigeye Thresher	2016
	Alopias vulpinus	Common Thresher	2016
Order Carcharhiniformes			
Carcharhinidae	*Carcharhinus falciformis*	Silky Shark	2016
	Carcharhinus longimanus	Oceanic White Tip	2018
	Carcharhinus obscurus	Dusky Shark	2018
Sphyrnidae	*Sphyrna lewini*	Scalloped Hammerhead	2016
	Sphyrna mokarran	Great Hammerhead	2016
	Sphyrna zygaena	Smooth Hammerhead	2018
Order Squaliformes			
Squalidae	*Squalus acanthias*	Spiny Dogfish	2010
Order Squatiniformes			
Squatinidae	*Squatina squatina*	Angelshark	2018
RAYS			
Order Rhinopristiformes			
Rhinidae	*Rhynchobatus australiae*	Bottlenose Wedgefish	2018
	Rhynchobatus djiddensis	Whitespotted Wedgefish	2018
	Rhynchobatus laevis	Smoothnose Wedgefish	2018
Rhinobatidae	*Rhinobatos rhinobatos*	Common Guitarfish	2018
Pristidae	*Anoxypristis cuspidata*	Narrow Sawfish	2016
	Pristis clavata	Dwarf Sawfish	2016
	Pristis pectinata	Smalltooth Sawfish	2016
	Pristis pristis	Largetooth Sawfish	2016
	Pristis zijsron	Green Sawfish	2016
Order Myliobatiformes			
Mobulidae	*Mobula alfredi*[1]	Reef Manta Ray	2016
	Mobula birostris[1]	Manta Ray	2016
	Mobula eregoodoo[1]	Pygmy Devilray	2016
	Mobula hypostoma	Atlantic Devilray	2016
	Mobula japanica[1]	Spinetail Devilray	2016
	Mobula kuhlii	Shortfin Devilray	2016
	Mobula mobular	Giant Devilray	2016
	Mobula munkiana	Munk's Devilray	2016
	Mobula rochebrunei[1]	Lesser Guinean Devilray	2016
	Mobula tarapacana	Sicklefin Devilray	2016
	Mobula thurstoni	Bentfin Devilray	2016

Shark species listed on CMS Sharks MOU



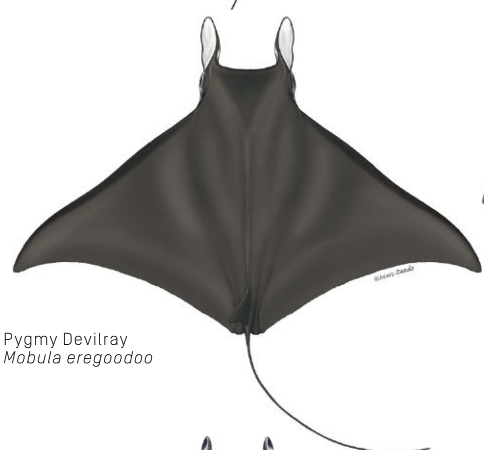
Artwork by © Marc Dando

Artwork by © Marc Dando

Ray species listed on CMS Sharks MOU

Reef Manta Ray
Mobula alfredi

Giant Manta Ray
Mobula birostris



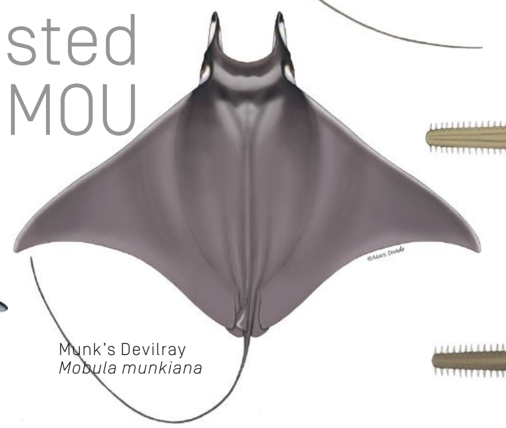
Pygmy Devilray
Mobula eregoodoo

Atlantic Devilray
Mobula hypostoma

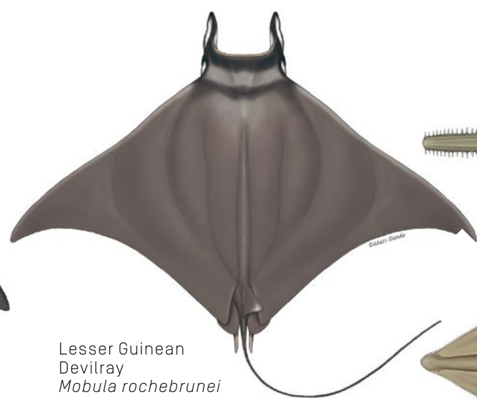
Giant Devilray
Mobula mobular

Spinetail Devilray
Mobula japanica

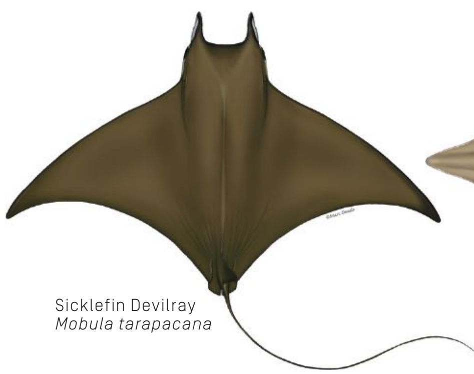
Shortfin Devilray
Mobula kuhlii



Munk's Devilray
Mobula munkiana

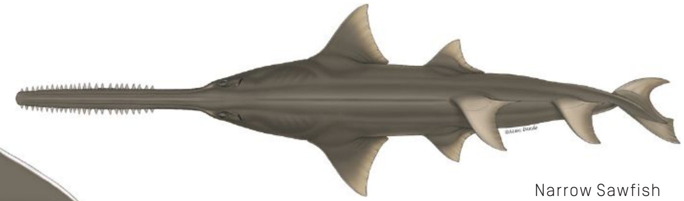


Lesser Guinean Devilray
Mobula rochebrunei

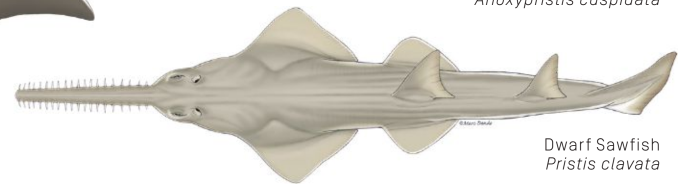


Sicklefin Devilray
Mobula tarapacana

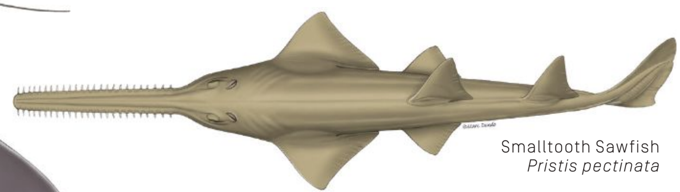
Bentfin Devilray
Mobula thurstoni



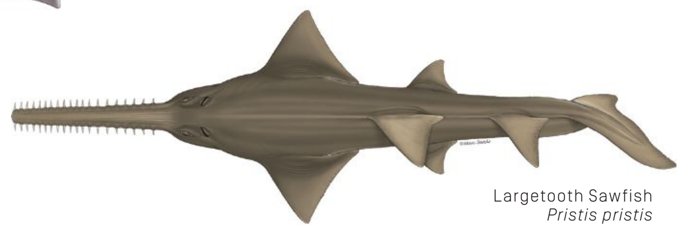
Narrow Sawfish
Anoxypristis cuspidata



Dwarf Sawfish
Pristis clavata

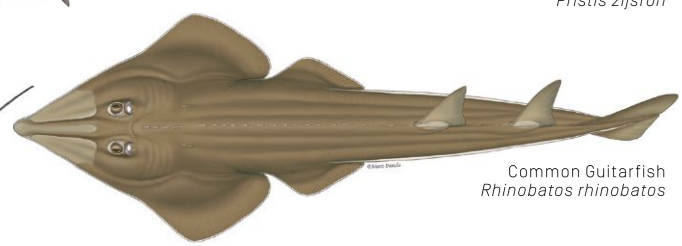


Smalltooth Sawfish
Pristis pectinata

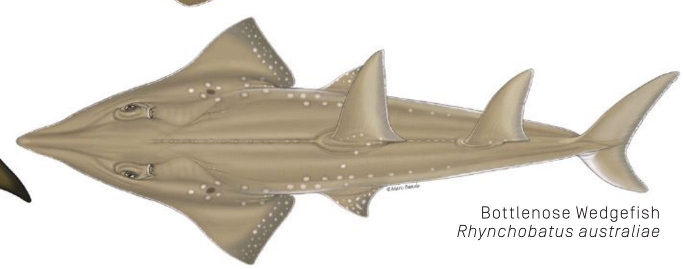


Largetooth Sawfish
Pristis pristis

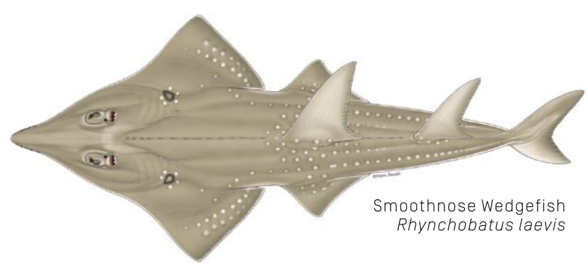
Green Sawfish
Pristis zijsron



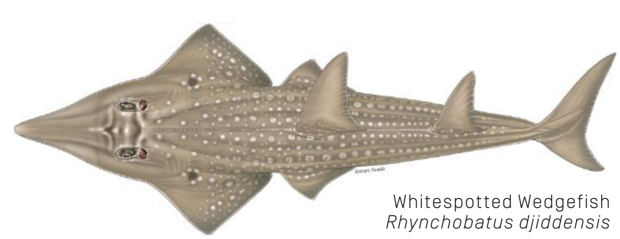
Common Guitarfish
Rhinobatos rhinobatos



Bottlenose Wedgefish
Rhynchobatus australiae



Smoothnose Wedgefish
Rhynchobatus laevis



Whitespotted Wedgefish
Rhynchobatus djiddensis

Shark Spotlight

Written by Michelle Scott

Jordan's Chimaera

Taxonomy

The Order Chimaeriformes (subclass Holocephali) includes 53 species from six genera and three families. The long-nosed chimaeras (family Rhinochimaeridae) contain eight species from three genera. The short-nosed chimaera (family Chimaeridae) includes 42 species from two genera, and the plow-nosed (family Callorhinchidae) has three species from one genus. Chimaeras are also often referred to as 'ghost shark', 'rabbitfish', 'ratfish', and 'spookfish'. The taxonomy of the Chimaeriformes is not well understood, mainly due to the high levels of endemism, offshore distributions of many species, and the fact that many inhabit deep waters, meaning they are rarely encountered and hence challenging to sample.

Morphology

In Greek mythology, the Chimaera was a terrifying creature. Depicted with the body and head of a lion, the head of a goat protruding out of its back and the tail of a serpent or dragon, the Chimaera was a fanciful creature of the imagination. It is therefore clear to see how the Chimaeriformes were named. Their morphology is as fanciful as the mythical Chimaera. The Chimaeriformes are characterised by long tapering bodies leading to 'rat-like' tails. The group is recognisable for the incisor-like anterior tooth plates and large nostrils, which give the appearance of a rabbitlike mouth. The common name "rabbitfish" is often applied to members of this family. They range in total length from 0.6 – 1.5 m. Adult chimaeras are scaleless.

Jordan's Chimaera (*Chimaera jordani*, Tanaka, 1905) belongs to the family Chimaeridae. The species is even brown to dark black in colour. It has a blunt, fleshy snout that is slightly pointed at the tip. Its body tapers down to a whiplike tail. An anal fin is present in this species, separated from the ventral caudal fin by a notch. It reaches a maximum size of at least 93 cm total length. Like other chimaeras, it is oviparous and lays eggs. The lateral line of Jordan's Chimaera is straight with very little sinuation along its length.

Range and Distribution

Chimaeras tend to be deepwater fishes generally inhabiting the shelves and slopes off continental landmasses. They typically occur at depths of 500 m or deeper. Jordan's Chimaera has been recorded at depths of 716–780 m, but its full depth range remains uncertain. Its known deep distribution beyond the reach of most regional fishing activities has resulted in it being rarely encountered. The species is known from only a limited number of specimens collected from eastern Honshu, Japan, in the Northwest Pacific Ocean. Surveys of deepwater chondrichthyans from 2000–2002 and 2005–2008 from the region and surrounding areas failed to find additional specimens.

Conservation measures and IUCN Red List status

Jordan's Chimaera has been assessed as Data Deficient on the IUCN Red List of Threatened Species. The distribution and depth range of the species mean it is only known from a few specimens. The limited data available makes it difficult to assess the species beyond Data Deficient. With a large proportion of chimaeras being assessed as Least Concern (69%), it would be easy to assume that there is no urgent need for action regarding Data Deficient species. However, the high levels of endemism displayed by species like Jordan's Chimaera and the lack of data from dedicated deepwater chondrichthyan surveys indicate a need to assess the current status of the population in order to monitor and manage the species. There are no known commercial uses for Jordan's Chimaera, though it may be consumed locally. For most chimaera species, there is a lack of catch reporting as most species are caught as bycatch and discarded, not reported at the species level, or not reported at all. More data are required regarding species abundance and population as well as the effects of fishing and incidence of bycatch to determine if fishing is causing population reductions.

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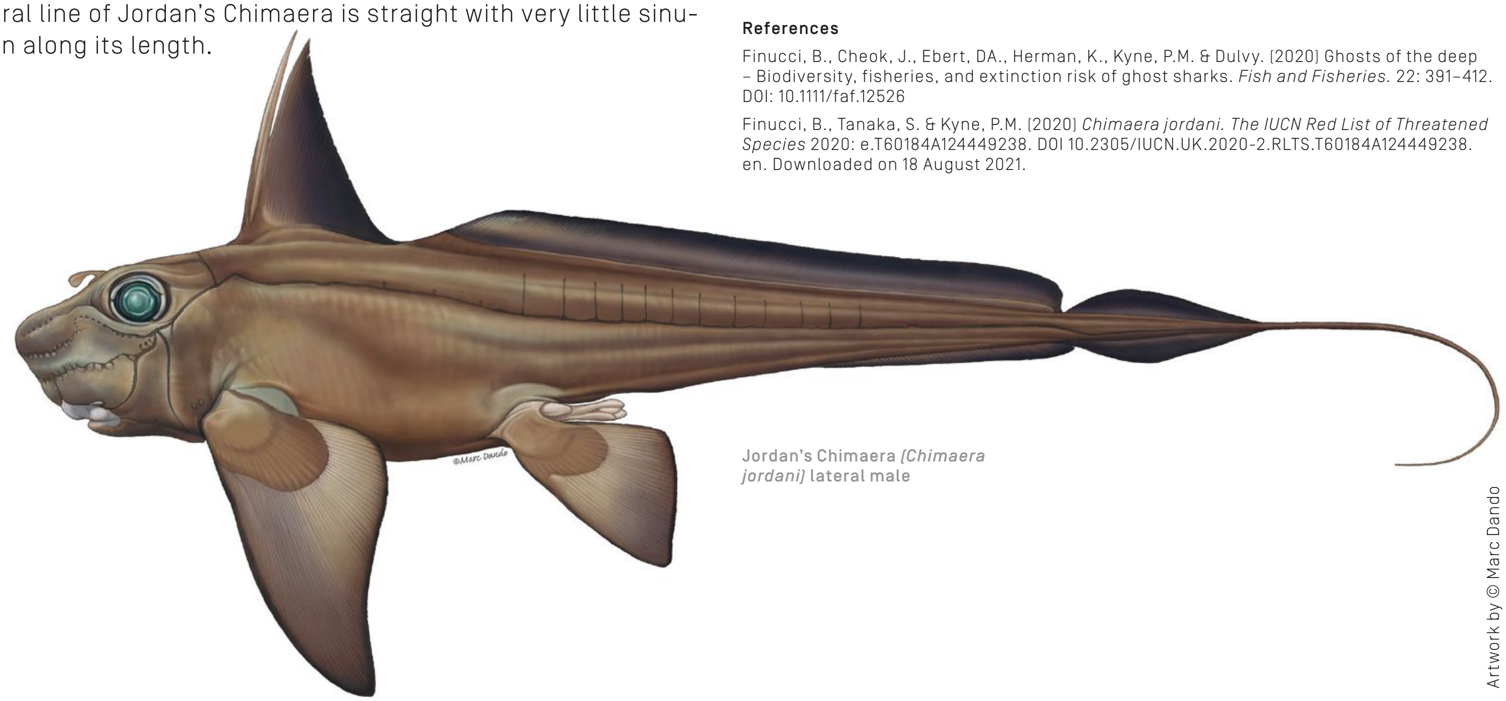

Jordan's Chimaera *(Chimaera jordani)* lateral male

Artwork by © Marc Dando

News

Hong Kong takes a lead: Recognizing wildlife crimes as organized and serious crimes in one of the world's top shark fin trade hubs

Photo by Stan Shea | BLOOM Association Hong Kong | bloomassociation.org

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The Global Initiative to End Wildlife Crime | Steering Group Member

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BLOOM Association | Hong Kong | Marine Programme Director

Photos by ADM Capital Foundation (ADMCF)

On August 18th 2021, the Hong Kong government quietly made a decision that likely has global repercussions for the wildlife trade, including the illegal trade in shark products. Lawmakers voted to add wildlife crime to the Organized and Serious Crimes Ordinance (OSCO), the primary legislation for providing powers of investigation into organized crimes and providing a legal basis for the confiscation of proceeds and enhancement of sentencing. This legislation could have a significant impact on fighting wildlife crime, not just in Hong Kong but regionally and globally.

Hong Kong's port and airport are among the busiest and largest globally and serve as a gateway to growing Asian markets in wildlife products, including shark fins. The city has long been recognized as one of the world's leading importers of shark fin. Although imports have decreased by two thirds over the last decade, the city is still estimated to receive approximately 40% of all global imports. The decline has occurred in tandem with increasing public awareness of and movement against the unsustainable shark fin trade. At first glance, this provided some hope that Asia's ubiquitous shark fin trade was on the way to being a distant tradition. Further, the listing of multiple shark species at recent Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Conference of the Parties (in 2013, 2016, and 2019) was good news for sharks and related species.

However, Hong Kong is also a wildlife trafficking hub, and its shark fin seizures tell a different story. Relatively few shark product seizures were made between 2014 – 2018. But, in 2019, seizures of shark fins ominously jumped to around 6,500kg, five times the average for the previous five years. In 2020, the number skyrocketed to at least 21,580kg (86% were CITES-listed species) and in the first six months of 2021, were at 22,505kg (78% were CITES-listed species).

It's not surprising that seizures have increased since more species have been listed, and traders are looking to circumvent the new regulations. The seizures, most notably those in the last eighteen months, have been few in number, but large in volume, contrasting with previous years, such as in 2019 where 28 seizures accounted for the total volume seized. The implication is that some level of organization is needed to traffic such large volumes, and Organized Crime Groups (OCGs) are thus likely involved. Despite this, prosecution has consistently been low, and so far, only three cases involving shark fin seizures have been prosecuted.

This is why Hong Kong's recent decision is important. Until now, Hong Kong's enforcement authorities tasked with combatting wildlife crime have focused on prosecuting carriers and mules caught red-handed at the airport. Those OCGs behind the trafficking have been conspicuously absent from the courts. Indeed, the authorities have repeatedly failed to gather sufficient evidence to prosecute the most significant seizures, usually where contraband is smuggled in shipping containers or air cargo. The recent shark seizures are indeed significant, and enforcement agencies may, looking forward, invoke the full powers of OSCO in pursuing perpetrators. As such, when shipping containers and air cargo loaded with contraband such as pangolin scales, shark fins, ivory tusks, rhino horns are seized, robust investigations should follow, with sufficient evidence gathered to prosecute at the highest level.

How did Hong Kong make such a momentous move when its administration would not even acknowledge the city as one of the global wildlife trafficking hubs only five years ago?

In 2018, though not convinced on the question of organized gangs perpetrating wildlife trafficking, the Hong Kong administration steered a landmark piece of legislation phasing out the ivory trade and raising penalties for wildlife crimes. The penalty rise did little to deter traffickers because of the continued focus on carriers and mules; nevertheless, it shone a much-needed light on the wildlife trade.

Meanwhile, since 2015 Hong Kong's Wildlife Trade Working Group (a coalition of Non-Governmental Organizations, academics and legal experts convened by the ADM Capital Foundation) had spoken with a unified voice on the need to address the persistent trafficking. They developed an enhanced enforcement strategy outlining the OSCO amendment requirements, feasibility, and mechanisms. Lawmaker Elizabeth Quat, a supporter of the ivory legislation, became a proponent of the strategy and, in early 2021, submitted a private members' Bill and garnered sufficient support for its passage.

In the run-up to the Bill's development and its subsequent passage, much work was done, with research published, legal reviews undertaken, a white paper drafted and, importantly, public engagement to educate the community and raise awareness of the issues. The support of the Shark Conservation Fund (SCF) was integral to much of this work. It facilitated the research, drafting and publication of reports and a white paper. It allowed for CITES implementation training workshops for relevant departments in the local government on how to visually identify shark fins related to CITES species, including the creation of identification guides, to increase inspection and implementation capacity. These training workshops no doubt played a part in the increasing success of seizures at Hong Kong's ports, as officers become more equipped to recognize fins of regulated species.

Furthermore, research studies enabled the development of a baseline for the local shark fin retail market, furthering understanding of the effectiveness of CITES implementations and making available information that can potentially help future investigations of illegal trade under OSCO. The support also provided the capacity to develop and implement innovative videos and a street art campaign coupled with augmented reality that captured the public's attention. But mostly, SCF's forward thinking since the passage of the Bill could not have been more timely - coinciding with an unprecedented rise in shark fin seizures in one of the world's leading trafficking hubs.

The world is now watching, and it remains to be seen if Hong Kong can stem the illegal trade in shark fins, whether it can detect, disrupt, and deter shark fin traffickers once and for all. We believe it can.

Across Hong Kong, campaigns to educate the community and raise awareness of wildlife crime were implemented

Photos by ADM Capital Foundation (ADMCF)

Photos by ADM Capital Foundation (ADMCF)

Bringing Science to Management and Promoting Rhino Ray Conservation in Indonesia

Benaya Simeon
IUCN SSC Shark Specialist Group | Asia Regional Group | Member
Wildlife Conservation Society (WCS) | Fisheries Resource Center of Indonesia

Een Irawan Putra
Rekam Nusantara Foundation

Photo by Guy Stevens | Manta Trust

Small Footprints of Rhino Ray* Conservation in Indonesia

**in this context, the term 'Rhino Rays' refers to the family Rhinidae (wedgefishes) and Glaucostegidae (giant guitarfishes)*

Indonesia has historically been known as the largest chondrichthyan (sharks, rays, and chimaeras) fishing nation in the world. Its location in the core of Indo-Pacific waters makes Indonesia one of the most important global shark and ray diversity hotspots. Despite continuing to be the highest contributor of shark and ray captures from 2005 to 2015, Indonesia's wedgefish (family Rhinidae) capture production data decreased by 80% during this period. When we started investigating why these data showed this steep decline within the span of 10 years, we had no idea what it might be attributed to. But we immediately realized that this was likely because Rhino Rays had not been prioritized as a fish group in terms of monitoring and management actions and that immediate action was needed!

Until 2017, conservation efforts in Indonesia had mainly been focused on species such as the Silky Shark *(Carcharhinus falciformis)*, Hammerhead sharks *(Sphyrna* spp.*)*, and other oceanic shark and ray species that had been listed on the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) Appendix II to regulate the trade in their products. Rhino Rays had not been noticed by fisheries managers or even researchers across the country as a conservation priority species group. Two things also compounded this lack of prioritization for these species. First, shark and ray landings monitoring data indicate that until 2017, surveys in Indonesia mainly were conducted at landing sites located at the edge of the Indian Ocean with a lot less focus on the areas of the Java Sea, Banda Sea, Molucca Sea, and the Arafura Sea. Although there are some data available on Rhino Ray landings, considering the scale of the exploitation, it is almost impossible to use these as a baseline to inform management across the whole country when large areas had not been surveyed. Second, since Indonesia consists of a large number of islands with diverse tribes and cultures, many local names were used across the country to refer to Rhino Rays including as "pandrung", "nunang", "kio-kio", "baji", "kupu-kupu", and "liongbun". And yet in the national statistics database, there is only one category for this species group that is related to wedgefishes and referred to as "Pari Kekeh". There is a high likelihood that these variations in common names across locations could have created confusion for some port/fisheries data collectors. Considering the low species resolution of the available data, many individuals questioned the validity of data collected on this species group from many fishing ports across the country.

In 2018, when the global and regional conservation status of Rhino Rays started getting highlighted due to the CITES proposals and associated awareness campaigns, it was even difficult to get good pictures or scientific information about the species that occurred in Indonesia. This was because few researchers had even documented them despite monitoring of landing sites. This lack of information made Rhino Ray conservation almost impossible to initiate, especially since other priority species had more data in comparison. Questions from fisheries stakeholders included: "What is a wedgefish?"; "What is a giant guitarfish?"; "Is that a shark or a ray?"; and "What is the difference?". Unfortunately, back then, we did not realize that the thousands of wedgefish, guitarfish (family Rhinobatidae), and giant guitarfish (family Glaucostegidae) that were being caught and landed at several fishing ports across Indonesia were already almost gone from many areas of the world with many of them considered Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Even though we are located at the core of a hotspot for Rhino Ray species diversity, we had not realized that we, as a country, should be leading global conservation efforts into the foreseeable future to make sure these species don't go extinct.

Trends in targeted and non-targeted Rhino Ray fisheries in Indonesia

Indonesia has two wide shallow seas – the Java Sea and the Arafura Sea – with average depths of approximately 50–80 m. Both these bodies of water provide suitable habitats for demersal fishes, including Rhino Rays. Recent research has shown that wedgefishes and giant guitarfishes have long been considered targeted and non-targeted valuable commodities across the country and in various communities. Without baseline information, it's difficult to attribute the reported declines in captures to specific events or fishing behaviour. However, it is important to note that there have been significant shifts in effort and gear used in these areas over the years that have also likely altered the impact of fisheries on Rhino Rays.

Wedgefishes have historically been targeted in gillnet fisheries with nets characterized by large mesh (30-40 cm) sizes called "Gillnet Liongbun". In fact, giant guitarfishes and other guitarfishes were also caught in these fishing operations because of an overlap in habitat preferences. However, after reaching its peak popularity in the 2000s in the Java Sea, the "Gillnet Liongbun" fleet shifted into other more profitable fisheries such as squid fisheries in the 2010s.

Since the numbers of "Gillnet Liongbun" operating in the Java Sea have decreased, Rhino Rays are now dominantly caught by boat-seine nets as secondary catches. In fact, since 2019, fisheries data indicate that at least 4,000 Rhino Ray individuals have been caught and landed each year from the Java Sea in boat seine nets. Catches have consisted of the Bowmouth Guitarfish *(Rhina ancylostoma)*, Bottlenose Wedgefish *(Rhynchobatus australiae)*, Broadnose Wedgefish *(R. springeri)*, Smoothnose Wedgefish *(R. laevis)*, Giant Guitarfish *(Glaucostegus typus)*, and Clubnose Guitarfish *(G. thouin)* and included juvenile and mature individuals without any apparent gear selectivity. In addition to

Photo by Giyanto

←Identifying wedgefish captured in the Java Sea

Basket of guitarfishes captured in the Java Sea

Photo by Khairul Abdi | Rekam Nusantara Foundation this, since trawl vessels were banned in the Arafura Sea in 2015, the number of gillnets have significantly increased. This has not been good news for Rhino Rays in this region because the shift from trawl nets to gillnets appears to have also increased captures.

Rhino Rays in local to international markets

Some species of Rhino Rays, especially wedgefishes and giant guitarfishes, present a high demand for their very large fins and therefore garner high prices on the international market. Some studies in Hong Kong have shown that dried fins from wedgefishes can sell for over 900 USD$ per kg. Since these species were listed on Appendix II of CITES, Indonesia has imposed an export ban on products originating from wedgefishes and giant guitarfishes. Indeed, a listing on CITES triggers a ban on all international trade in that species until traceability mechanisms can be implemented to enable trade controls. The large fins of these Rhino Ray species were a priority commodity to be traded. This trade ban has likely impacted profits across different levels in the distribution chain, from fishers, boat owners, middlemen, to traders and export companies.

The other common product within Indonesia is Rhino Ray meat, usually smoked and considered a popular traditional dish on Java Island. It is a cheap source of protein on the most densely populated island in Indonesia. When the domestic market cannot absorb Rhino Ray meat, it is exported to other countries such as Singapore, Malaysia, and Sri Lanka. Rhino Ray cartilage and skins are also sold as export commodities to various countries across Asia. On the other hand, the internal organs are used locally as forage food for farmed animals.

Conservation efforts through a collaborative scientific approach

Rhino Rays are considered the most threatened marine taxa in the world. Some local extinctions have already been reported in various regions. Along with the race to prevent Rhino Ray extinction, we are also faced with the challenges of habitat loss and degradation as well as the socio-economic complexities of working on fisheries conservation. The known Rhino Ray habitats in Indonesia are located in coastal waters that are directly affected by the daily activities of the communities that reside alongside the coast. To ensure that conservation efforts and management measures were based on scientific evidence and could be implemented, robust data were needed. Several research projects were quickly elaborated and conducted across Indonesia by several institutions and universities. These projects mainly focused on understanding the impact of fisheries, species biology, critical habitat mapping, genetics, socio-economics, and gathering information on the perspectives of key stakeholders. Overall, by taking action for Rhino Rays, we have found that massive collaborative research efforts can be highly effective in supporting the progress of conservation actions. Indeed, compared with other shark and ray species, the improvement in research and conservation efforts for Rhino Rays was rapid and efficient.

First, species identification has been a critical challenge due to the complexity and uncertainty of Rhino Ray taxonomy. The genus *Rhynchobatus* is extremely difficult to identify in the field due to the variations in the spot patterns used for the identification of most species. On the other hand, juvenile giant guitarfishes are often misidentified and confused with other species of guitarfish. Identification training and refresher courses for shark enumerators were conducted at a large scale across Indonesia. Some identification doubts were then verified by using genetic barcoding methods. The lessons learnt at each site were then exchanged from one landing site to other landing sites to improve the identification of Rhino Rays.

Second, surveys have also allowed two critical habitat areas for wedgefishes to be identified in Aceh Province and West Nusa Tenggara Province. Over the years, juvenile wedgefishes were frequently caught in association with juvenile Scalloped Hammerheads *(Sphyrna lewini)* in muddy, shallow, and estuarine waters. Based on scientific evidence, local stakeholders with local universities wrote scientific papers to propose a protection status for these two locations. Furthermore, local communities in both provinces have now established a local agreement to release juvenile wedgefishes accidentally caught in their fishing gear. The wedgefish critical habitat identified in Aceh has been proclaimed and ratified based on Ministerial Decree No 76/2020 by the Minister of Marine Affairs and Fisheries. Meanwhile, the provincial government has accepted the critical habitat in West Nusa Tenggara and is being ratified at the national level.

Third, various actions and measures were also established based on other research results within a short time frame. These included developing a wedgefish non-detriment finding (NDF -- a CITES requirement to allow for export permits to be issued), catch quota calculation and evaluation, and legal trade through the development of a traceability system. Despite glaucostegids also being listed on CITES, enough data was not available to develop an NDF for these species.

Challenges working with coastal fishing communities in Indonesia

One of the flagship projects promoting the conservation of Rhino Rays is currently being conducted in the Java Sea. The Java Sea is a shallow and muddy sea located in the core of the Indo-Pacific. It has a long history of fishery-related economic activities. It is commonly known as the oldest fishing ground for commercial fisheries in Indonesia, with more than 200,000 fishers estimated to actively fish in these waters in 2020. In fact, in 2019, the annual fisheries value recorded was at over 250 million USD, highlighting the importance of this region for the country as a whole.

The North Coast Java is the most sensitive coastal fishing community. This community can get easily triggered by issues; for example, even little triggers can lead to hundreds of people from coastal communities initiating large demonstrations and protests in Indonesia and creating political disruptions across the nation. Therefore, the socio-economic aspects of Rhino Ray conservation are the most important thing to address if conservationists want to work in the North Coast Java. Working in this location can be very challenging and has raised many questions when considering launching the project, such as “Are we sure we want to work in this area?”, “Is it possible?”, “Can conservationists be brave enough to promote conservation in the oldest fishery in Indonesia while working with communities with traditional mindsets?”.

Based on the results of the collaborative research that has been conducted, step by step Rhino Ray conservation actions are being introduced to local governments and stakeholders.

Photos by Rifky | Rekam Nusantara Foundation

Juvenile of *Rhynchobatus australiae* caught by seine net with other demersal fish of the same size

→ Catches of wedgefishes at the auction house

Photo by Khairul Abdi | Rekam Nusantara Foundation

Promoting how threatened and how important the Java Sea is to the existence of Rhino Rays was challenging in communities that have been surrounded by commercial fisheries for decades. Proper communication tools were needed to deliver the messages on point without touching other sensitive issues. Considering the literacy rates in some of these communities, the most effective strategies used were creating films and short videos that could be distributed and made available online.

To work in the North Coast Java, we also needed strong collaborations with partners due to the dynamic situations. Building collaboration was key to understanding and creating perspectives. This led to significant progress in our conservation efforts in a short amount of time. Beyond that, we also needed the legal framework to develop our collaborative work. After years of establishing collaborations, in 2021, the local government established a Working Group by Governor Decree of Central Java No 523/18 for demersal fisheries. Rhino Rays were listed as priority species to be managed under the mandate of this Working Group. This work is ongoing with solid collaboration between the Ministry of Marine Affairs, Central Java Provincial Government, IPB University, Diponegoro University, The Indonesia Institute of Science, and other non-governmental organizations working on fisheries conservation.

One of the key lessons learnt is that conservationists need to have a precautionary approach when working with coastal communities. They should have scientific evidence to support their recommendations and, most importantly, not take rash steps, which could lead to non-cooperation from locals. One example was when the government banned trawlers in the Java Sea. The North Coast Java fishers resisted the move, and their actions led to large political uproars in the country. It was the same issue when it came to Rhino Ray management considerations. It was critical to consider promoting conservation using the appropriate sentiment and effective communication with grassroot communities. This is the most important step to ensure our efforts are effective and lead to a conservation success story in the future.

Implementation is still a big task for Indonesia

Rhino Ray research and conservation efforts in Indonesia have significantly increased since 2019. In only three years, we have developed and implemented new management measures and are using our baseline research results as a baseline to inform immediate policy updates. On the other hand, we cannot deny that Rhino Rays still mean big money and substantial additions to their monthly income for most fishers. This means that implementing new decisions and policies will require a lot of work within communities to ensure livelihoods are considered. The complexity of working on fisheries and combining socio-economic considerations of coastal communities requires some real conservation steps which consider the status of fish populations and their conservation without forgetting a human approach. Simultaneously, the Indonesian situation of cultural diversity within and between islands demands a dynamic implementation approach. Considering the IUCN Red List Critically Endangered status of most Rhino Ray species, conservation efforts need to be scaled up and actions implemented as soon as possible.

Photo by Khairul Abdi | Rekam Nusantara Foundation

Diverse species of wedgefishes caught and landed in the same size range

Photo by Benaya Simeon | Wildlife Conservation Society

Diverse species of rays from the Java Sea

←Identifying wedgefishes caught and landed from the Java Sea

Photos by Yudi Herdiana

Bottlenose Wedgefish *(Rhynchobatus australiae)* in Daravandhoo Thila, Baa Atoll, Maldives

Photo by Guy Stevens | Manta Trust

A bottlenose wedgefish *(Rhynchobatus australiae)* prowls over the sandy bottom at twilight, North Male Atoll, Republic of Maldives

Photo by Sirachai (Shin) Arunrugstichai | www.shinsphoto.com | @shinalodon

The IUCN Green Status of Species: Tracking the recovery of sharks, rays, and ghost sharks

Adult Whale Shark and diver in the Galapagos Islands

Photo by Simon Lorenz | WWF-Hong Kong

Whale sharks at St Helena Island

Photo by Simon Pierce | Marine Megafauna Foundation

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Whale Shark suction-feeding in Mexico

Photo by Simon Pierce | Marine Megafauna Foundation

IUCN SSC Species Survival Commission

Green Status of Species

Preventing extinction is always a win for conservation. However, there is a big difference between a species that is 'not going extinct' and a species that has fully recovered and is actively fulfilling its ecological role.

Quantifying a species' recovery, however, has traditionally been a challenge. A species that improves its status on the IUCN Red List of Threatened Species, such as moving from a threatened category – Vulnerable, Endangered, or Critically Endangered – to Least Concern, certainly has an improved outlook, but has it fully recovered? Not necessarily. The status of a Least Concern species can still be somewhat concerning. Saltwater crocodiles *(Crocodylus porosus)*, for example, are listed as Least Concern globally due to successful conservation initiatives in Australia. However, the species is no longer found in several countries within its natural range. Clearly, they haven't fully recovered, as they are not fulfilling their ecological role as an apex predator across their broad historical (pre-human impact) distribution throughout the Indo-Pacific.

With that in mind, what tool can we use to monitor the progress of a species towards full recovery – not just a reduced extinction risk, but regaining their place in the ecosystem?

Spoiler alert:

The IUCN Green Status of Species

The Green Status has been developed to formalise how we track species recovery, to ensure that "species are not just surviving, but thriving." The Green Status is a new addition to the Red List assessment that provides a complementary evaluation of status, reporting progress toward recovery, alongside extinction risk, to track the success of conservation efforts.

The Green Status is NOT a list of species that are no longer at risk. The "Green List" was the working name for a while – the IUCN membership called for three "Green Lists" of species, ecosystems, and protected areas in 2012 – but was changed when the potential for confusion on this point was recognised.

Several of us (Brit and Charlie) contributed assessments to Molly et al.'s recent paper in *Conservation Biology* that formally introduced the Green Status. Meanwhile, Simon and Gonzalo worked with Molly, the Task Force Coordinator for the IUCN Green Status, to assess whale sharks. Fresh from that process, we can provide a few case studies on how the Green Status process is applied.

How Does the Assessment Process Work?

The Green Status assesses species against three essential aspects of recovery: representation, viability, and functionality. A species can be considered *fully recovered* if:

1. ***It is present in all parts of its range, including those that are no longer occupied but where the species lived prior to major human impacts/disruption.*** If we don't know precisely when human impacts began, the range can be described at the 'default' year of 1750. This indigenous range is then divided into spatial units that represent variation in species biology, ecology, and/or geography;
2. ***The species is viable (i.e., not threatened with extinction) in each spatial unit;*** and
3. ***The species is performing its ecological functions in each spatial unit.***

Within each spatial unit, assessors determine if the species is:

1. Absent: does not occur but did historically.
2. Present: occurs but is not at a Viable or Functional level.
3. Viable: low risk of regional extinction (i.e., a Red List assessment of Least Concern, or Near Threatened and not declining), but not Functional.
4. Functional: population size, density, and structure allow for full ecological function and/or roles. A species must qualify as Viable for the Functional label to be assigned (with rare exceptions).

These designations contribute towards a Green Score ranging from 0% (Absent in every spatial unit, i.e. Extinct or Extinct in the Wild) to 100% (every spatial unit is Functional, so the species is fully recovered). The full details for calculations are in the IUCN's online resources, provided below (and see the summary in the explainer figure). At the time of assessment, the species' Green Score is called the Species Recovery Score (SRS), which provides the core metric for tracking progress toward recovery.

Conservation Impact Metrics

The Green Score can also be used to (a) retrospectively evaluate past actions and (b) project the impact of future conservation initiatives. The differences between these estimated Green Scores and the contemporary SRS produce four *Conservation Impact Metrics.*

- *Conservation Legacy:* the effect of past conservation interventions on species recovery. A high Legacy value indicates that prior conservation actions have substantially improved the species' status. A low Legacy reflects a situation where conservation efforts have not been needed, have not been attempted, have been ineffective, or have not yet started to show clear gains.

- *Conservation Gain:* the improvement in score expected to occur in the next ten years as a result of ongoing or planned conservation actions.

- *Conservation Dependence:* the reliance of the species on current conservation efforts to maintain the SRS over the next ten years.

- *Recovery Potential:* the difference between the SRS and the expected score under the most ambitious recovery outcome that could be achieved within 100 years. This assumes that biological and ecological constraints are still present, but financial constraints are lifted. In many cases, the best-case outcome for a species will not be a restoration to 100%, as it may be unrealistic for a species to re-establish its full prior range or functionality.

Have you got that? Fantastic.
Let's look at the case studies.

Whale Shark *(Rhincodon typus)*

Recent decades have been bleak for Whale Sharks. The current Red List assessment, from 2016, classed the species as globally Endangered, primarily due to targeted fisheries in the Indo-Pacific, and Vulnerable in the Atlantic. Dealing with the entire Indian and Pacific Oceans as one continuous unit might make biological sense in this species. Still, the threats and current status of Whale Sharks vary widely across this vast area. We further split the Indo-Pacific subpopulation (as defined by genetic studies) into four spatial units that can be considered separately for management purposes for the Green Status assessment. We then applied the IUCN's Regional Red List criteria to each spatial unit, explicitly acknowledging where there was uncertainty in these assessments. For example, we assessed the Arabian Sea unit as Endangered, with a lower bound of Critically Endangered, because few trend data are available.

Whale Sharks mass-murder zooplankton and small fishes, but, even with the evilest intent, they're not going to have much influence on prey dynamics. However, full-grown Whale Sharks are really, really big, and highly mobile. Whale Sharks transport considerable biomass from productive areas, such as coastal upwellings and oceanic fronts, to the nutrient-poor open ocean, which they fertilise via poop. Similarly, Whale Sharks feed at depth in low-productivity surface waters, bringing nutrients up to the surface. When Whale Sharks die, their bodies are a boon for deep-sea organisms. We made some inferences here from better-studied 'whale falls.' Whale carcasses can go through progressive decomposition for decades, sustaining hundreds of species across time. Whale falls are an essential habitat for >60 species of deep-sea macrofauna, and numerous other species associated with cold seeps and hydrothermal vents have also been found.

We assessed each spatial unit as 'Present' for the Whale Shark, though uncertainty in the Atlantic and Eastern Pacific suggested a potential upper bound (most optimistic interpretation) of 'Viable'. The SRS for the Whale Shark is estimated to be 29% – Largely Depleted. The Conservation Legacy for the Whale Shark was ranked as Low (4%). Many conservation actions have been enacted to secure the species' recovery, but the species is still near its lowest ebb at this point. Conservation Gain was also rated as Low (8%). As Whale Sharks have an extremely slow biological recovery rate (with female maturity estimated at 30–40 years), even in the best-case scenario, it's going to take a long time to demonstrate population-level recovery.

Over the longer Recovery Potential timespan (100 years), though, Whale Sharks were rated as High (71%). The good news is that people have, for the most part, stopped intentionally killing Whale Sharks. These oversized oceanic Orectolobiformes are now one of the best-known and well-protected sharks. With continuing effort to expand and improve the effectiveness of conservation efforts, they can still bounce back.

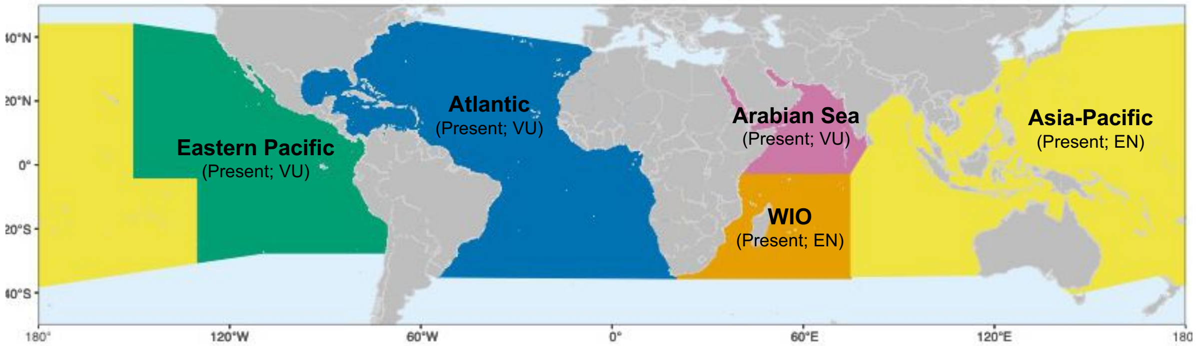
Photo by Simon Pierce | Marine Megafauna Foundation

Stella Diamant with whale shark in Madagascar

Simplified Green Status process for the whale shark. Modified from Grace et al. (2021): conbio.onlinelibrary.wiley.com/doi/10.1111/cobi.13756

1 Define Species' Range

The ***indigenous range*** is the known or inferred range of the species before major impacts limited the species distribution (1750 is the default year).



2 Identity Spatial Units

Spacial units (SUs) are revelant biological, ecological, or management-based subdivisions of the species' range. Five SUs were identified for the Whale Shark: Atlantic, Arabian Sea, Western Indian Ocean (WIO), Asia-Pacific and the Eastern Pacific (see above).

3 Calculate Green Score *(G)*

$$G = \frac{\sum_s W_s}{W_F \times N} \times 100$$

s = spacial unit
W_S = weight of the state in the spatial unit
W_S = weight of the functional state
N = number of indigenous spatial units

Assign state to each SU: Absent, Present or Functional. See map above for whale sharks.
Contemporary whale shark
G = 29% (25–37%)

4 Estimate *G* under different scenarios to calculate the conservation impact metrics

	Current without Conservation	Future with Conservation (10 yrs)	Future without Conservation (10 yrs)	Long-Term Potential
Atlantic	Present (VU)	Viable (NT)	Present (VU)	Functional (LC)
WIO	Present (EN)	Present (EN)	Present (EN)	Functional (LC)
Arabian Sea	Present (CR)	Present (EN)	Present (EN)	Functional (LC)
Asia-Pacific	Present (CR)	Present (EN)	Present (CR)	Functional (LC)
Eastern Pacific	Present (VU)	Viable (NT)	Present (VU)	Functional (LC)
G	25%	37%	27%	100%
Difference from SRS	**4%**	**8%**	**2%**	**71%**
Conservation Impact Metric	**Conservation Legacy**	**Conservation Gain**	**Conservation Dependence**	**Recovery Potential**

Pale Ghost Shark *(Hydrolagus bemisi)*

The Pale Ghost Shark is a New Zealand (NZ) endemic. Still, within this large Exclusive Economic Zone (EEZ), the chimaera has a wide distribution along the continental slope and oceanic plateaus between depths of 400–1100 m. There was no deep-sea fishing in NZ before the 1950s, so the population is assumed to have been in a near-pristine state prior to that.

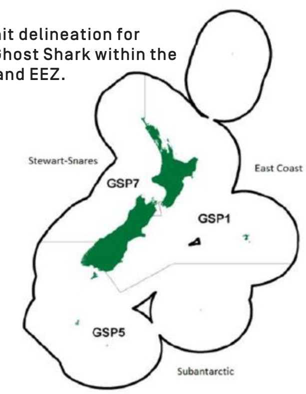
Pale Ghost Sharks are thought to maintain a large population size in these waters and, as a common predator, are likely to play an essential role in the deep-sea ecosystem. They prey on many benthic species, and their ability to consume hard prey items means they may have a role in nutrient cycling. They are also a source of prey themselves (as egg capsules, juveniles, and adults) for other fishes, including other chondrichthyan species. Pale Ghost Sharks are known to aggregate in large numbers, but their population ecology is little known at this point.

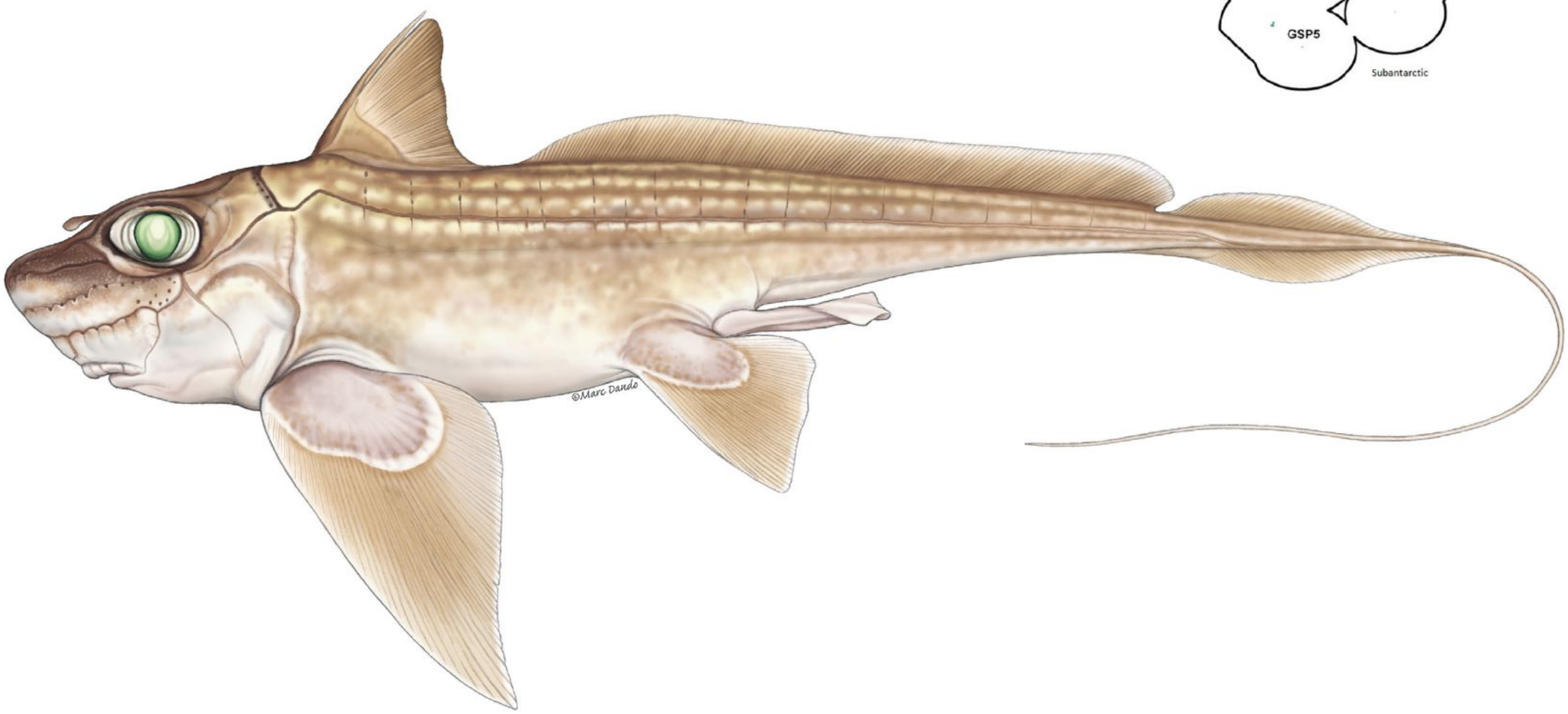
Pale Ghost Sharks are caught almost exclusively as bycatch of deep trawl fisheries. New Zealand has relatively strong fisheries management and monitoring in place, with time-series catch data for this and related species available back to the 1980s (though these data were aggregated, as the Pale Ghost Shark was not described until 2002). The species has been managed in the country's Quota Management System (QMS) since 1998, meaning that there are species-level catch quotas in place.

The Pale Ghost Shark's distribution was split into three spatial units for the Green Status assessment, based on NZ fisheries management divisions rather than known stock structure within the species. There is no evidence of an overall population decline across NZ, and the species was assessed as globally Least Concern on the IUCN Red List in 2018. Recent biomass estimates from trawl surveys on the Chatham Rise (part of the East Coast unit, GSP 1) have fluctuated over time, with some decline in trend since 2001. However, this may relate to improved species-level identification following its formal description. Trawl survey indices of Pale Ghost Sharks are considered stable in the Subantarctic (GSP 5).

The species was assessed as Functional in all three spatial units, with an SRS of 100%. Without management, this species may have been subject to unsustainable fishing practices and, thus, population decline. Conservation Legacy was 33%, demonstrating the benefit of bycatch management to the species. With ongoing management, the pale ghost shark will retain full ecological functionality across its natural distribution.

Spatial unit delineation for the Pale Ghost Shark within the New Zealand EEZ.





Artwork by © Marc Dando

Banded Wobbegong *(Orectolobus halei)*

The Banded Wobbegong is a reef-associated, coastal Australian endemic found from southern Queensland to subtropical Western Australia. These sharks, which grow to over 2 m, are ambush predators that feed on cephalopods and large fishes, including small sharks and rays.

The Banded Wobbegong was previously a target of commercial fisheries in New South Wales. Following a >50% decline in catches between 1997–98 and 2007–08, fisheries management regulations were introduced in 2007 to include both catch limits and size restrictions on retained wobbegongs. This led to less targeting of the species, and the Banded Wobbegong was downlisted from Near Threatened globally and Vulnerable in NSW (in 2009) to Least Concern (2015) on the IUCN Red List. They are still caught within commercial fisheries, generally as bycatch, and post-release survival is believed to be high.

For the Green Status assessment, the species Australian distribution was split into five spatial units, including a unit for Tasmania, outside its current range, as the species has already been recorded off Flinders Island and might expand to Tasmania with current ocean warming trends.

As large predators, the Banded Wobbegong's functional role is most likely to be through top-down pressure and controlling the abundance of its main prey species. With the reduced targeted fishing since the new fishing regulations, the Banded Wobbegong is considered to play its functional role throughout its indigenous range (it has not yet been recorded from Tasmania). Therefore, the Species Recovery Score is 100%, with a Conservation Legacy of 33%, as conservation actions have helped Banded Wobbegong maintain its functional role throughout its range.

Banded Wobbegong on sand in Byron Bay, Australia

Photo by Simon Pierce | Marine Megafauna Foundation

Photo by Simon Pierce | Marine Megafauna Foundation

General Observations

- We've considered three different species here: the widely distributed and Endangered Whale Shark; the deep-sea Pale Ghost Shark that, thanks to catch quotas, has maintained its ecosystem role; and a large coastal wobbegong that has recovered from prior overfishing.

- The 10-yr timeframe for Conservation Gain is short, in terms of the biological capacity for a population-level increase in long-lived species. However, it's an appropriate timeframe for evaluation and allows for future projection with a reasonable confidence level.

- The Green Status explicitly considers historical baselines; not just historical numbers and range, although those are key, but also – is full recovery still possible? For instance, habitat degradation affects many density-dependent elasmobranchs that use freshwater systems or coastal nurseries. Restoring these ecosystems can result in a quantified benefit to the Recovery Potential of these species.

- The increased focus on understanding the ecosystem roles of sharks and their relatives – for instance, the important contribution of coastal stingrays to sediment turnover and habitat creation – is a good opportunity to point to the importance of some less well-known species and to highlight the importance of ecological work on these animals. Our understanding of the contribution of this diverse group to ecosystem function and resilience is still at an early stage, and the extent of functional redundancy is still being debated.

- A general complaint in chondrichthyan conservation assessment is the lack of long-term trend data. We still need to emphasise the importance of such work. For the Pale Ghost Shark and Banded Wobbegong, where commercial fisheries were the clear and primary threat, the introduction of management measures obliges us to assume subsequent population recovery. There's still a need for more fisheries-independent monitoring data across ecosystems to understand and confirm that these species are fulfilling their ecological roles.

Getting Involved with the Green Status

If you're interested in learning more about the Green Status process, particularly contributing to assessments yourself, the IUCN Red List website includes links to assessment resources. We've also twisted Molly's arm to give a webinar on the Green Status and its application, especially for the IUCN SSC Shark Specialist Group. Stay tuned for the timing on that.

Australia releases its first Shark Action Plan

Photo by Ian Shaw

The Melbourne Skate *Spiniraja whitleyi*, an Australian endemic ray assessed as Vulnerable.

Written by Peter Kyne | Charles Darwin University

The Australian National Environmental Science Program (NESP) Marine Biodiversity Hub has released *The Action Plan for Australian Sharks and Rays 2021*. This book provides a comprehensive and standardised review of the extinction risk of all 328 cartilaginous fishes occurring in Australian waters, including Sub-Antarctic and Antarctic waters. The IUCN Red List Categories and Criteria were applied at the *national* level to undertake this extinction risk assessment.

This Action Plan represents the largest extinction risk assessment of chondrichthyans at the national or regional level, representing 26% of the global fauna. Overall status is characterised by a relatively low level of extinction risk: 12% of species are threatened in Australian waters compared with 37% globally. Furthermore, 70% of the fauna is considered secure (Least Concern). Australia also constitutes a 'lifeboat' for 45 globally threatened species assessed nationally as Least Concern or Near Threatened.

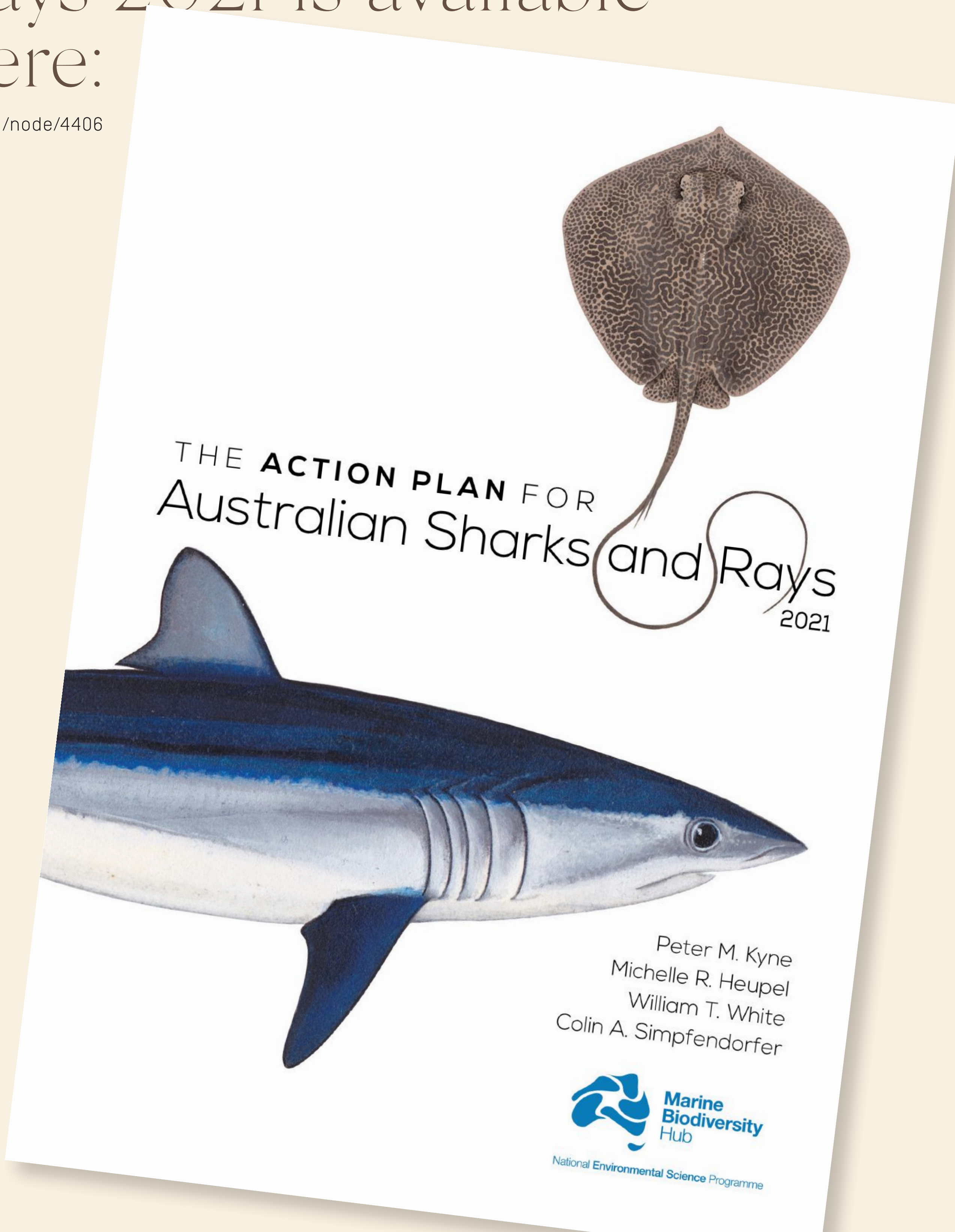
The species assessments inform actions required for each shark, ray, and ghost shark (chimaera) in the form of actions to address knowledge gaps and measures to maintain, secure, and, if necessary, recover the population. Additionally, recommendations are provided for each of the 39 threatened species. This includes recommending that five species (Greeneye Spurdog *(Squalus chloroculus)*, Eastern Angelshark *(Squatina albipunctata)*, Whitefin Swellshark *(Cephaloscyllium albipinnum)*, Narrow Sawfish *(Anoxypristis cuspidata)*, and Australian Longnose Skate *(Dentiraja confusa)* be considered for listing on Australia's national environmental legislation, the Environment Protection and Biodiversity Conservation Act (EPBC Act), three species (Dwarf Sawfish *(Pristis clavata)*, Largetooth Sawfish *(Pristis pristis)*, Green Sawfish *(Pristis zijsron)*) be considered for up-listing, and two species (Northern River Shark *(Glyphis garricki)*, Speartooth Shark *(Glyphis glyphis)*) be considered for down-listing.

Implementing the recommendations and actions in the Action Plan will require an ongoing and enhanced investment in science and management which will help secure the future of Australia's sharks, rays, and ghost sharks.

The book was authored by Peter Kyne of Charles Darwin University, Michelle Heupel of the Australian Institute of Marine Science (AIMS), William White of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and Colin Simpfendorfer of James Cook University.

The Action Plan for Australian Sharks and Rays 2021 is available here:

nespmarine.edu.au/node/4406



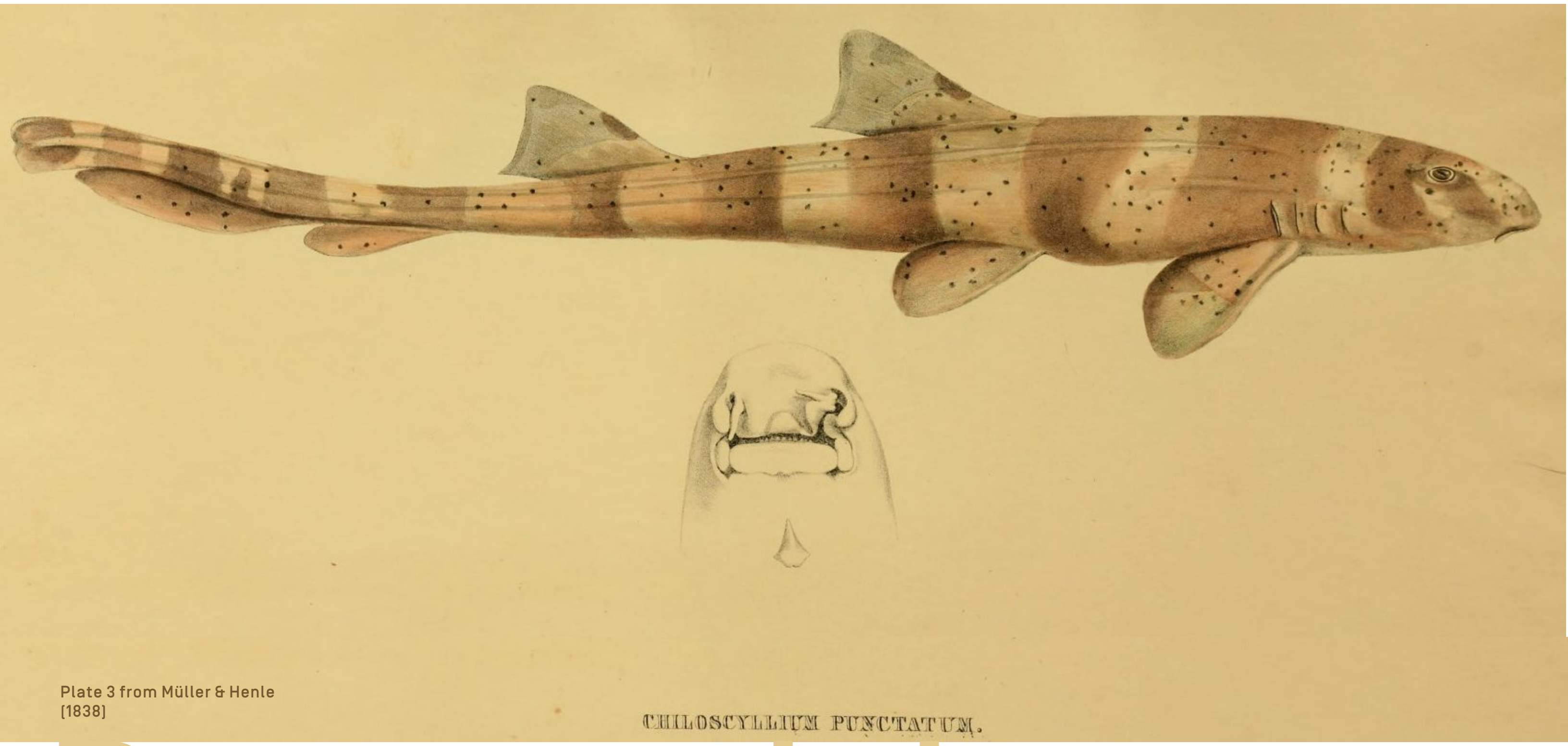


Plate 3 from Müller & Henle [1838]

Re-examining the status of *Chiloscyllium punctatum*, a Near Threatened bambooshark.

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Ecology

The Brownbanded Bambooshark *Chiloscyllium punctatum* Müller & Henle was described in 1838 from a specimen collected in Jakarta, Indonesia. Adults are light brown and usually without a colour pattern, but the young may have broad dark transverse bars with a scattering of small blackish spots. The species is distributed across the Indian and Western Pacific oceans and is strongly associated with soft muddy bottoms in nearshore intertidal and subtidal habitats. They live either solitarily or in small groups and appear to be highly territorial. This relatively fast-growing species can grow up to 18 cm year[1], mature at 6–5 years, and live for up to 14 years (Fahmi et al., 2021a). However, their mobility is likely very restricted due to their oviparous and sedentary nature, rendering them highly susceptible to local extinction.

Fishery threats

Analysis of landing statistics and published reports indicate that *C. punctatum* is the most common shark caught in commercial fisheries throughout Southeast Asia. In Malaysia, this species is often viewed as bycatch but makes up almost half of all shark individuals caught in bottom trawlers, and about 40% of landed Bambooshark are immature. The fins are categorized as black shark fins, which are sold for domestic consumption for a lower value as opposed to white shark fins. Anecdotal information from Clarke-Shen et al. (2021) suggests that this species is commonly reported in Singapore imports (whole animals) from Malaysia. Based on interviews with local fishers, this species was historically discarded by fishers or sold at low prices but is gaining popularity for meat consumption.

IUCN assessment and genetic insights

The last IUCN Red List of Threatened Species assessment of the species prioritized clarifying the population substructure due to concerns of population fragmentation (Dudgeon et al., 2016). Two recently published studies used different molecular markers and independently showed both high genetic diversity and genetic structure of *C. punctatum* in the Southeast Asian waters with limited gene flow between the different populations (Lim et al., 2021; Fahmi et al., 2021b). High fishing pressure and genetically distinct populations of *C. punctatum* provide compelling reasons to support the uplisting of this species to Vulnerable in Southeast Asia and to push for tailored fishery management locally and regionally.

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Kota Kinabalu, Sabah
Fisheries landing port, 2016

Photo by Loh Kar Hoe | Universiti Malaya

Taking morphometric measurements of *C. punctatum*

Photo by Loh Kar Hoe | Universiti Malaya

Photo by Amanda Leung | Universiti Malaya

Photos by Loh Kar Hoe | Universiti Malaya

Photos by Loh Kar Hoe | Universiti Malaya

Juvenile brownbanded bamboo shark *(Chiloscyllium punctatum)*, These sharks have barbels, which are sensory organs that look like whiskers. Hence the common name for these sharks is "Cat Sharks."

Photo by Simon Lorenz | WWF-Hong Kong

JOURNAL OF ICHTHYOLOGY

Special Issue on "Primitive Fishes"

Photo by Bernard Seret

Presented by
Bernard Seret and Alexei Orlov
IUCN SSC Shark Specialist Group |
Northern Europe Regional Group | Members

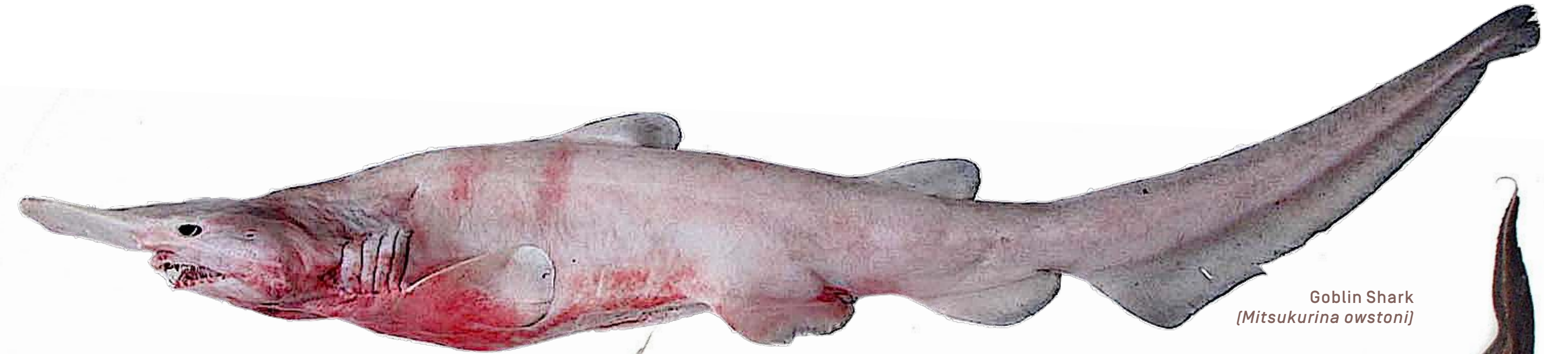
Frilled Shark
(Chlamydoselachus anguineus)

The *Journal of Ichthyology* is preparing a Special Issue on "Primitive fishes: scientific, cultural and commercial importance". The living representatives of ancient lineages of teleost fishes are often qualified as "primitive fishes" or "living fossils". However, these terms are not entirely accurate in terms of vertebrate evolution. These ancient "primitive" fishes include the following groups: hagfishes (Myxini), lampreys (Petromyzontiformes), sharks and skates/rays (Elasmobranchii), ratfishes/chimaeras (Holocephali), coelacanths (Coelacanthi), lungfishes and tetrapods (Dipneusti), bichirs/reedfishes (Cladistii), sturgeons (Acipenseridae) and paddlefishes (Polyodontidae), gars (Lepisosteidae), bowfins (Amiidae), and others.

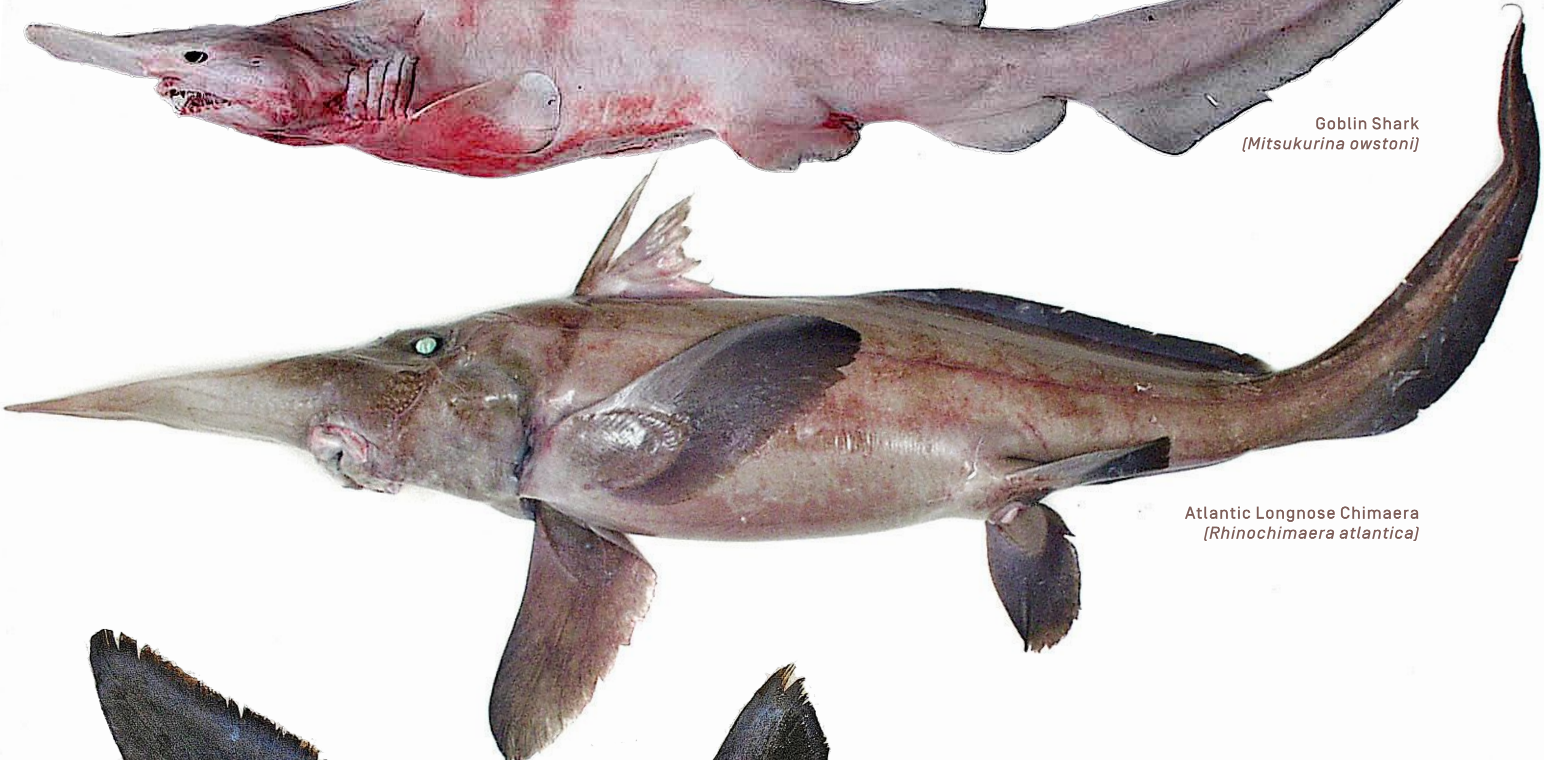
This Special Issue aims to provide an overview of the current knowledge of primitive fishes concerning: evolution, phylogeny, phylogeography, and molecular biology, taxonomy and zoogeography, ecology and life history, harvesting, stock assessment, and fisheries management, physiology, artificial propagation and aquaculture, conservation and stock rebuilding. This Special Issue is edited by Dr Alexei Orlov and the following guest editors: B. Clemens (for manuscripts on lampreys), G. Ruban (for manuscripts on sturgeons and paddlefishes); B. Séret (for manuscripts on Chondrichthyes).

Potential authors are invited to submit their manuscripts (research papers, reviews, short communications) before the 1st of May 2022 at: *publish.sciencejournals.ru/login*
The instructions for authors are available at:
pleiades.online/ru/journal/ichth/authos-instructions

All accepted papers will be published "Online first" and in the Special Issue free of charge. Please contact Dr Alexei Orlov (orlov@vniro.ru) to express your intention to submit your works or for more information.



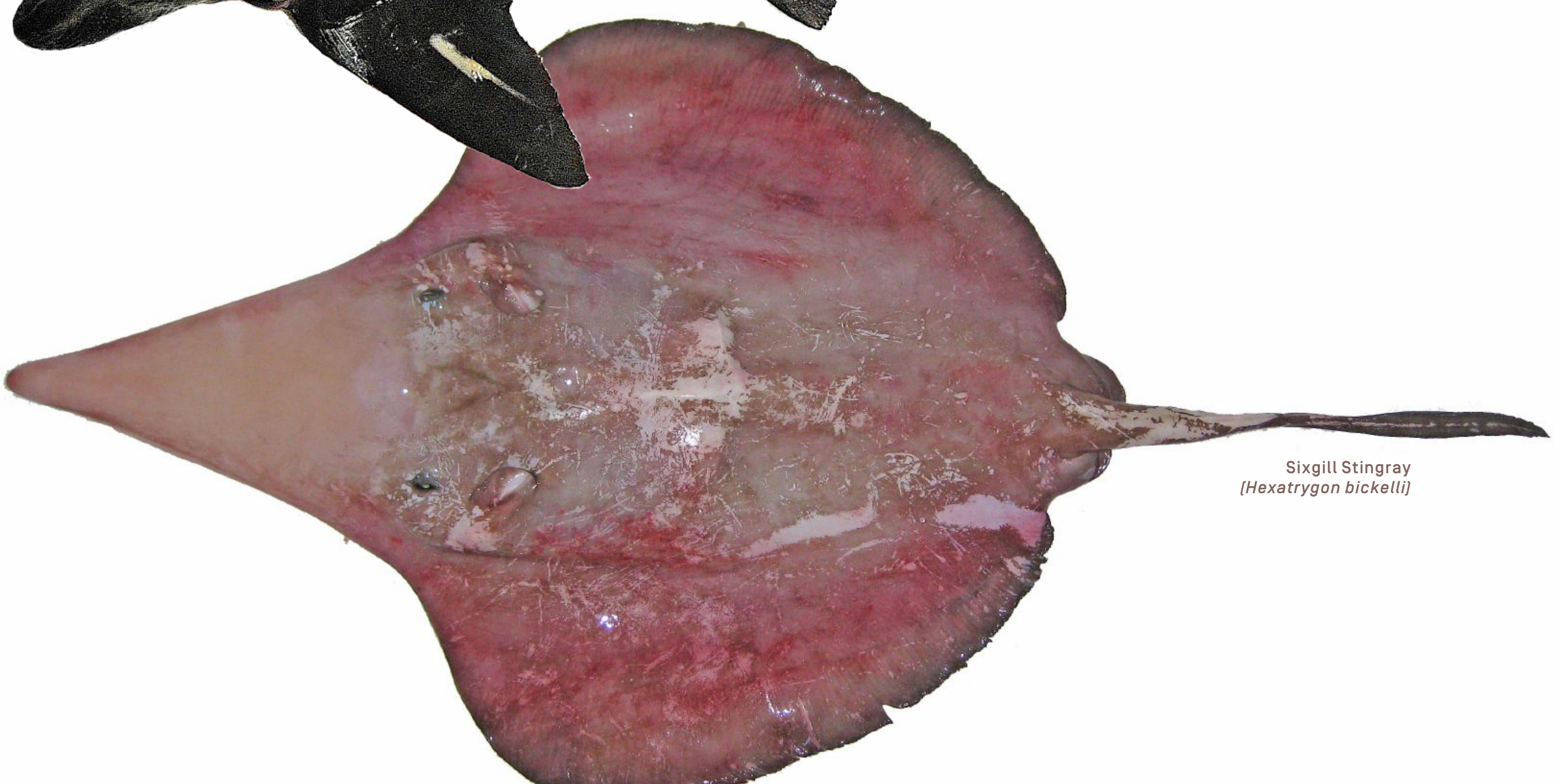
Goblin Shark
(Mitsukurina owstoni)



Atlantic Longnose Chimaera
(Rhinochimaera atlantica)

Photo by Pierre Porcher | IFREMER

Chimaera
(*Hydrolagus* sp.)



Sixgill Stingray
(Hexatrygon bickelli)

Photos by Bernard Seret

Using local ecological knowledge to fill in the knowledge gaps for Ghana's shark fisheries

Written by Issah Seidu IUCN SSC Shark Specialist Group | Africa Regional Group | Member
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Region Update: Africa

Ghana is one of the major elasmobranch (shark and ray) fishing nations in the West African region. Elasmobranch fisheries represent a crucial source of employment, sustenance and income to many coastal communities in Ghana. Yet, like many other regions in the world, elasmobranchs in Ghana are under unsustainable pressure from overfishing, habitat degradation and pollution. Unfortunately, there are very few elasmobranch experts in Ghana, and scientific methods used to collect data on sharks and rays are relatively expensive. These issues have resulted in baseline data such as abundance trends and knowledge regarding the ecology of sharks and rays, essential for detecting population declines and devising effective management strategies and conservation initiatives to safeguard these species, being largely unavailable. To bridge the knowledge gap on shark fisheries in Ghana, we relied on Local Ecological Knowledge of fishers to collect critical ecological data to aid the management of Ghanaian elasmobranch fauna. Specifically, we ascertain ecological factors used by elasmobranch fishers to enhance their fishing operations in Western Ghana.

Data were collected through participant observations, focus group discussions and face-to-face interviews with 16 active and 17 retired fishers in five communities in Western Ghana (Adjoa, Axim, Busua, Dixcove, and Shama). Convenience sampling was used to select active fishers, while snowball sampling was used to choose retired fishers in their various communities.

We found that fishers mostly learned fishing practices and ecological variables from their family members, as apprentices in a crew, and through personal observations in their various communities. They applied these ecological clues over the years to enhance their fishing operations and maximize their catch. Fishers described six categories of local ecological factors they use as clues and how these affect their fishing expeditions. The stated clues are discussed briefly below:

Lunar phase: Most fishers (94%) reported that the lunar phase affects their ability to catch various demersal and pelagic species. The best fishing period is during no or partial moon, which makes the water opaque and prevents schools of fish from seeing the fishing gear and thus makes them more susceptible to being caught.

Seasons and weather conditions: The majority of fishers (87%) stated that the harvesting season for sharks, billfish and most types of tunas is from July to September. The low seasons for these species are from December to February. Fishers stated that the breeding season for sharks is from March to June, as this is the period they mainly observe and catch neonates. Fishers reported the harvesting season for rays as August to October.

Bait types: Fishers recounted that they mostly use freshly caught dolphins, tuna, flying fish and sardinellas as their bait to target sharks. Dolphins were reported as the most effective bait for catching sharks, followed by flying fish and tuna. They stated that the bright and shiny nature of dolphins attracts sharks faster than any other bait. Fishers primarily relied on cold store sardinellas, herrings, beef, and pork as bait in desperate situations when other preferential bait is unavailable.

Seabirds: Most fishers (88%) reported that seabirds play a key role in giving them clues to potential fishing grounds. They disclosed that the presence of large flocks of birds hovering close to the surface of the seawater and dipping their beaks in water is an indication that fish are abundant in the area and that they set their nets in the vicinity of such sites.

Colour of seawater: Fishers stated five different colours of seawater that affect their fishing operations – deep blue, light blue, yellow, red, and light green. The presence of deep blue coloured seawater, referred to as "Adomnsuo" in the local dialect, literally means "divine water", results in fishers catching large quantities of demersal and pelagic species. Most fishers (78%) stated that deep blue water occurs unpredictably once a year between July and October at random locations and does not last for more than two weeks. Fishers recounted that light green seawater provides good conditions for catching larger fish, including sharks and tuna, but that this seawater occurs randomly at any period within the year. The red colour is where they get an abundance of guitarfish and other ray species, and occurs intermittently from June to July. Light green water provides good conditions for larger fish such as sharks, tunas, and billfishes, and according to fishers, it can occur randomly at any period within the year. The yellow colour was the least preferred seawater colour for fishers and occurs intermittently at any period during the year.

Sea current: Most fishers (85%) recounted that strong currents obstruct the movement of fish and result in their fishing boats drifting away from their fishing grounds, while slow currents provide favourable conditions for fish to remain within a smaller area. Two sea currents were described by fishers - westward and eastward currents. Westward currents were regarded as strong and unfavourable for fishing, while the eastward currents are considered to be slow and provide good conditions for catching more fish.

In general, these stated ecological clues can provide invaluable information to inform fisheries management decisions on spatial and/or temporal catch restrictions of elasmobranch species in Ghana. For example, the breeding and harvesting seasons described by fishers have provided a clue about the periods within the year to focus our conservation efforts and provide a baseline from which to conduct further research to empirically determine crucial periods in the life histories of elasmobranch species. This information further demonstrates the need for scientists, conservationists, and fisheries managers to involve fishers in fisheries management research and decision-making. The latter possess an essential knowledge resource that can and should be used to benefit conservation and management decisions.

Funding This work was supported by the Swiss Shark Foundation (Hai-Stiftung), Save Our Seas Foundation and Flying Sharks.

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Photo by Issah Seidu

Landing of a Critically Endangered and protected Spiny Butterfly Ray *(Gymnura altavela)* by a small-scale vessel in Greece

A new study found underreported catches of threatened elasmobranchs in Greece.

Region Update: Mediterranean

Written by Ioannis Giovos

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The level of elasmobranch exploitation in Greece is heavily underreported as sharks and rays are recorded in aggregated categories or misreported once fished, landed and sold. Small-scale fisheries are heavily unmonitored in the country, while most of the elasmobranch's products that enter the market chain are sold mislabeled. This work approaches the actual state of elasmobranch exploitation in Greece while providing insight into mislabeling and draws guidelines for improving their conservation in the country.

New collaborative research, led by iSea, was recently published in the *Journal of Ocean and Coastal Management.* The study aimed at addressing the real state of elasmobranch exploitation in the Mediterranean, with a deep insight into fisheries and trade in Greece.

Like elsewhere in the Mediterranean, the impact of fisheries on elasmobranch populations is understudied due to the lack of data, as elasmobranch catches are reported in aggregated categories, with misidentifications and intentional mislabeling being quite common, while law enforcement and compliance is relatively low in the basin.

In this new study, observers performed 144 visits to auction markets, landing sites and fish markets in four selected Greek ports to monitor elasmobranch landings and fish market products at the species level. When visual identification was not possible, genetic identification tools were used, especially for fish market products.

Results highlighted that small-scale fisheries underreported catches of threatened elasmobranchs. About 50–60% of the elasmobranch landings were threatened species, while the corresponding contribution was reduced to 26% in the fish markets. Mislabeling was common throughout the year, with several species sold under different names to increase profit or hinder their protection status.

It is evident that current practices in Greece do not satisfy Common Fisheries Policy in terms of traceability. The fishing of threatened elasmobranchs raises additional concerns as a conservation priority in the country. To this end, the study proposes an elasmobranch catch report scheme aimed to increase traceability but also research to improve elasmobranch conservation in the country.

Alongside with iSea, the University of Patras, Marine and Environmental Research Lab, the University of Padova, OceanCare, the University of Plymouth, the International Hellenic University, the Fisheries Institute of Kavala and the Florida International University significantly contributed to this work under the funds of OceanCare and the Shark Foundation/Hai Stiftung.

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The 'waste' part of a Starry Smoothhound *(Mustelus asterias)* after skinning

Photo by iSea | isea.com

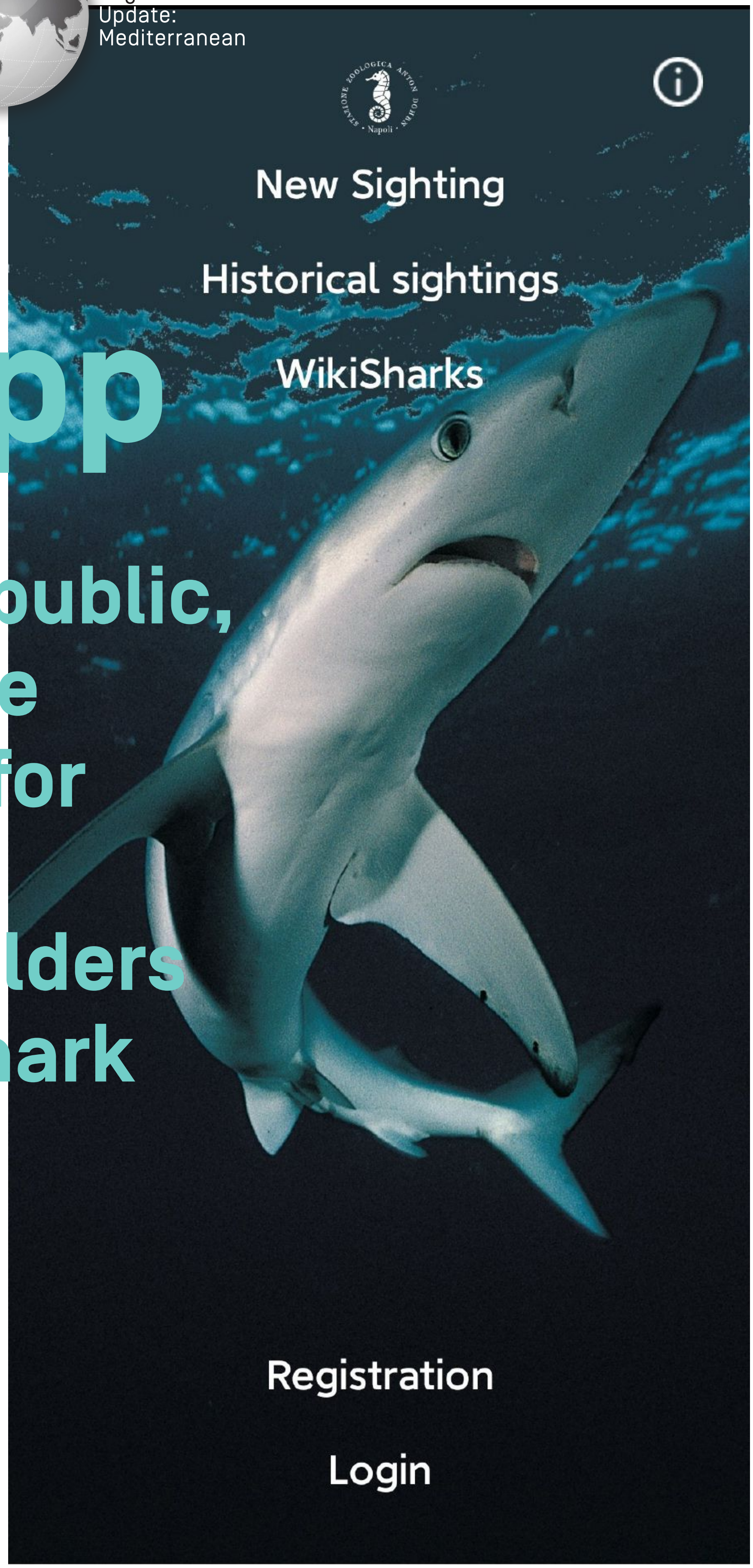
Small scale fisher skinning a Thornback Skate *(Raja clavata)* before cutting its wings

Fishmonger mislabeling ray wings for the protected Angelshark *(Squatina squatina)*

The skinning of a Common Stingray *(Dasyatis pastinaca)* on board, so that it can be sold mislabeled for more profits

Photos by iSea | isea.com

Region Update: Mediterranean



SharkApp

The first Mediterranean public, institutional free app developed for all citizens and marine stakeholders who can help shark conservation

Written by
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Last year the Stazione Zoologica Anton Dohrn (SZN), the Italian National Institute for Marine Biology, Ecology and Biotechnology, developed a new app that works towards shark conservation and raising awareness of these species and their relatives (rays and chimaeras) in the Mediterranean Sea: the SharkApp.

SharkApp is a free citizen science tool that aims to improve the linkage between scientists, users of the sea such as fishers, divers, sailors, conservationists, and others. The application was developed to create awareness among stakeholders on the importance of sharks and their relatives, and draw attention to their state of endangerment and how citizens can help in their conservation.

SharkApp is provided with a detailed learning section with information on all shark species present in the Mediterranean Sea and a glossary with the most common terms used in marine biology, ecology, and specific vocabulary used for sharks.

Moreover, SharkApp is an instrument for collecting information on sightings and shark captures. The app allows, in fact, the recording of data by stakeholders filling in a simple form and with the option of uploading pictures and the GPS location on a map. A team of experts then verifies and validates all the information to ensure that the collected data are accurate and can be entered into a comprehensive sightings database.

Now SharkApp has been implemented and updated thanks to the project LIFE ELIFE - Elasmobranchs Low-Impact Fishing Experience (LIFE18 NAT/IT/000846), funded by the European Commission and coordinated by the SZN in collaboration with other nine European Mediterranean partners *(elifeproject.eu/en/)*. In the framework of the LIFE ELIFE project, SharkApp is currently available in English. Soon, it will also be translated into Arabic, French, and Spanish to make it more accessible for the Mediterranean people.

The app can be downloaded for free on Google Play Store and Apple Store.

Download right now the SharkApp to join elasmobranch research and conservation in the Mediterranean Sea: ***together, we can save them.***

Trading fins for conservation: a new approach for obtaining species and size-specific landings data.

Photo by Jessica Quinlan

Region Update: North America

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Beverly Wade

Ministry of Blue Economy & Civil Aviation, Belize City, Belize

Jessica R. Quinlan

Florida International University, North Miami, Florida, USA

Some of the unsung heroes of shark conservation are the people who go out and sample landings. It's dirty, uncomfortable work that doesn't lend itself well to social media posts. It can be costly and challenging to fund. But data on the species and size composition of landings are the grease in the wheels for management.

One limitation of sampling landings is that researchers can't be everywhere at once. Given funding and time limitations, landings site visits are likely to be infrequent and may therefore contain hidden biases. Getting the fisherfolk themselves to collect species and size data makes more sense since they bring in the animals. But fishing is arduous, and adding onerous reporting requirements is not always a viable option.

Our team, consisting of researchers, fishers, and resource managers, has come up with a new approach for collecting species and size-specific catch data from sharks in Belize, Central America. Though every nation will present different challenges, we think that this approach or variations of it could be useful in many shark fishing nations. They say that progress is 1% inspiration and 99% perspiration, and so it was for this approach, which was developed over a period of over a decade.

Demian: The idea for anal fin sampling came to me at Turneffe atoll, Belize, right before Christmas in 2008. I was there conducting a shark survey, and while soaking a longline in the northeast corner of the reef, the captain pointed out a small fishing camp on one of the nearby cayes. We drove over to say hello to the fishers, who looked like they were finished for the day. A small wooden cabin was nestled on stilts among the mangroves, and a small pack of dogs greeted us on the makeshift dock. The buzzing of flies and aroma of sharks told us the fishers had a good night, and the leader was happy to show us a pile of shark carcasses. He told us a little bit about the sharks he caught and was obviously knowledgeable about the species and their habits. I thought it would be great to sample their catch over time, which he indicated came in fits and spurts and would require frequent visits to document appropriately. Looking down at the headless, tailless and mostly finless dressed shark carcasses, I noticed that the pelvic and anal fins remained attached to the trunk. "They don't buy those fins," the fisher told me, "So I leave them on". Looking at the pile,




Anal fins of Caribbean Reef *(Carcharhinus perezi)*, Blacktip Reef *(Carcharhinus melanopterus)*, Caribbean Sharpnose *(Rhizoprionodon porosus)* and Bonnethead *(Sphyrna tiburo)* Sharks (clockwise from top left)

Photo by Jessica Quintan

I realized that the anal fins were quite variable in morphology and colour. That was the genesis of anal fin sampling. I offered the fisher $1 for every anal fin if he simply dried them in the sun like the main fins that he was selling for the export market. "I'll come back next year, just put them in a bag, and I will collect them then". And so it went, for the next four years, we met up, and I had a record of the camp's landings for the previous year. Working with various collaborators, my students and I used DNA barcoding to identify every anal fin to the species level. Over 80% were Caribbean Reef (Carcharhinus perezi) and Caribbean Sharpnose Sharks (Rhizopriondon porosus). We quickly realized that many of the anal fins were distinctive and could often correctly predict the species-of-origin before the DNA results were in.

In 2012, I had a meeting at the Belize Department of Fisheries with Beverly Wade, Fisheries Administrator. Among the other data I was showing, I provided the species composition of the landings of the Turneffe camp.

Beverly: When Demian showed me the data from Turneffe, I was excited because these data are exactly what was needed for us to manage our shark fishery better. We knew there was a small-scale fishery in Belize, and we had recently prohibited landings of two major tourism species (Nurse (Ginglymostoma cirratum) and Whale (Rhincodon typus) Sharks). We had also implemented a licensing system for shark fishing in which all shark fishers had to obtain a license each year to participate in the fishery. But we still desperately needed systematically collected landings data on the remaining species to determine what types of other regulations we might need to maintain the fishery. I suggested to Demian that we request that all shark fishers submit anal fins of the previous year's catch to obtain the following year's license. After a couple of "teething" years where people forgot, sampled the wrong fins, lost fins, or had their pets chew them up, we started getting hundreds of anal fins each year from all of the major shark fishing communities along the Belizean coast.

Jessica: Flash forward to 2017. I was just at the start of my doctoral degree. I quickly found myself intrigued by the concept of the anal fin monitoring project as Demian explained the idea to me. He went over the distinguishing characters he had come to know as I fervently took notes, worried about missing an important detail. He had recently come back from a trip to Belize and said, "Good news, I've brought back the anal fins from this past year's fishing season for you to get started on". I couldn't wait. Then he plopped down an oversized duffel bag, almost overflowing with hundreds of anal fins. So there I was, in a small, very stinky room with what felt like fins up to my eyebrows. Slowly, as I began to look at each fin individually, I noticed these subtle differences that eventually became glaringly obvious distinguishing features for each species. My sense of being overwhelmed dissipated and was replaced with an eagerness to streamline this idea and make it more accessible and user friendly. Among other things, I developed a visual guide for the fins that the fisheries staff and others in the Caribbean could use (conbio.onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1111%2Fcobi.13688&file=cobi13688-sup-0003-SuppMat.pdf)

Knowing what species were landed and how many of each, we were hopeful that the anal fins could also be used to determine the size (length) of the animals from which the fins came. To do this, we had to better understand the relationship between the length of the anal fin and the animal's length by collecting these paired measurements from whole sharks. This meant spending time in another stinky place: a shark fishing camp in Belize. A short plane ride and one very bumpy, five-hour boat ride down the coast, I arrived at a shark fishing camp accompanied by Belize Fisheries Department staff. I had no idea what to expect or how I'd be received. We quickly settled in and, after setting up camp, we were anxious to see what the nights' fishing would yield the following morning.

The scent of coffee, sounds of breakfast preparations, and the hum of motors from returning dugouts served as our alarm clock: it was time to start the day. As the fishers cleaned their catch, we stood ankle-deep in crimson-tinted water around a makeshift table where we created an assembly line to collect measurements and remove anal fins. While the rest of the camp joined as onlookers, inspecting the process over breakfast, we shared laughs, and each explained how we did our respective work and why. It wasn't long before fishers joined us in recording data, learning how to take length measurements. This was the first of many trips to fishing camps where we got the opportunity to meet different members of the shark fishing community throughout central and southern Belize. The data collected during these visits gave us the key to unlocking the duffle bag of fins' full potential at the university. We were able to fully reconstruct the previous fishing season in terms of species composition and, for the most common species, their sizes as well. The paired measurements enabled us to plot relationships between anal fins size and body size for the most frequently caught sharks, allowing us to regress size-specific data for the Belizean shark fishery from fins alone. Among other findings, we worryingly observed that most Caribbean Reef Sharks were below the size at maturity. Other students in our research group had independently found signs of Caribbean Reef Shark overexploitation in Belize, and this information was passed on to the stakeholders.

Demian: Our work was recently published in the journal Conservation Biology (conbio.onlinelibrary.wiley.com/doi/abs/10.1111/cobi.13688) and has helped guide management decisions in Belize, including the establishment of closed areas to better protect shark populations, especially Caribbean Reef Sharks, around the atolls. The fishing community fully supported this management decision, and we now hire them to monitor sharks to offset the income had they kept fishing these places.

Jess: We continue to monitor the Belize shark fishery through the anal fins program, and we are collecting paired measurements from the less common species in the fishery so that we can size them as well. Most importantly, we continue to foster and grow our respectful relationships with shark fishers and resource managers as we cooperatively work towards their goal of having a sustainable small-scale shark fishery. We are hopeful that the science we are co-producing can help Belize and help guide other nations in the region, possibly throughout the world, to tackle this essential first step towards managing shark fisheries for sustainability.

Photo by Jessica Quinlan

Photo by Eloísa Pinheiro Giareta

Region Update: South America

Releasing for caring: children's inclusion as a strategy to raise awareness and promote guitarfish conservation

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For 11 years, our research group has been working with artisanal fishing communities from the Paraná coast in southern Brazil. Through this partnership, we were able to release nearly 1,200 Shortnose Guitarfish *(Zapteryx brevirostris)* caught as bycatch in coastal fisheries and that would have been sold as "cação" or shark meat. In our region, this species has low commercial value. Despite being classified as Endangered globally according to the IUCN Red List of Threatened Species, dozens of animals are landed daily during the austral winter, most of them still alive. Currently, the species is on the list of species that are prohibited from being captured; however, no additional governmental measures have been adopted to ensure its conservation.

In the beginning, our focus was to include members of the fishing community, society, and work colleagues. However, in the past three years, we felt the need to raise awareness of future generations by including them in our release activities. Our primary focus is now children and adolescents, from 2 to 13 years old, who have intimate contact with the marine environment and, in the future, can become ambassadors for the oceans. While younger children who have had little contact with social media are bold, showing no fear at all, older children and teenagers are afraid to touch animals, possibly as a reflection of the fear generated by the sensationalist media to which they have already been exposed. Regardless, they are all delighted to release the animals and talk about how remarkable the experience was at the end of the activities.

Unfortunately, the only interaction between this age group and live sharks and rays in Brazil occurs in public aquariums. Despite being a promising initiative that allows them to understand that sharks and rays are not evil, the contact with animals during the releases gives them the idea of belonging to something bigger, as our initiative allows them to save a life, and also to understand that guitarfishes belongs in the ocean, and that they can live in harmony with them, their family, and friends. Another advantage is that they start to understand that these animals are not only food but a life they can preserve.

As Dr Rachel Graham, Chair of the Shark Specialist Group Future Leaders Working Group, would say, we are "elasmovangelizing" our children and hopefully their families and friends, but also all of you who are reading this report to include them in your research activities. Please, do not hesitate to contact us to learn more about this initiative and discuss strategies. You can also read more about our release program by accessing our Letter from the Conservation Front Line recently published in Animal Conservation through the QR code provided below.

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Wosnick, Natascha & Wosiak, Caroline & Filho, Osmar. (2020). Pay to conserve: what we have achieved in 10 years of compensatory releases of threatened with extinction guitarfishes. Animal Conservation. 01. 1-3. 10.1111/acv.12651. doi.org/10.1111/acv.12651

Photos by Eloísa Pinheiro Giareta

Photo by Max Janse

Spotted Eagle Ray (*Aetobatus ocellatus*) birth

Working Group Update | Aquarium

Managing an *ex situ* elasmobranch population in Europe

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We don't need to tell you how charismatic elasmobranchs are and how important they are within aquatic ecosystems or explain the threats within this taxon. However, it is essential to reach millions of public aquarium visitors with this information and let them experience the beauty of these remarkable animals. An encounter with a shark is a powerful experience, and not everyone is lucky enough to see one during a dive. Public aquariums display numerous species of elasmobranchs. The role of zoos and public aquariums has changed from focussing solely on recreation and the exhibition of exotic wildlife to the current three main functions of education, scientific research and conservation (Packer and Ballantyne, 2010; Gusset & Dick, 2011).

Public Aquarium Associations

The two most relevant zoo and public aquarium associations within the European region are the European Association of Zoos and Aquaria (EAZA), with over 300 member institutions in 48 countries throughout Europe and the Middle East, and the European Union of Aquarium Curators (EUAC), with members representing 86 European public aquariums. The two associations closely collaborate in the Elasmobranch Taxon Advisory Group (TAG). Within EAZA, 42 TAGs exist on different taxa. The Elasmobranch TAG was founded in 2013 and consists of a steering committee, a veterinary advisory group and coordinators of existing species programmes. In 2021, a conservation working group was added to the TAG. An update is given below on the management status of the *ex situ* populations in Europe and how we plan to develop further work.

TAG history

In 2007, the first breeding programmes were started in the European region on two species of elasmobranchs (Zebra Shark, Stegostoma tigrinum and Bluespotted Fantail Ray, Taeniura lymma). Breeding programmes have been ubiquitous for mammal and bird species since the 1990s, but they were pretty new for fish. The number of programmes slowly increased to five in 2013. In this same year, a Regional Collection Plan (RCP) workshop was organised at London Zoo. The workshop was the official start of the EAZA/EUAC elasmobranch TAG. The main TAG goals were to: 1) link colleagues, animals and information, 2) organise captive breeding programmes, 3) conduct a five-year census of the ex situ European population, and 4) become a central contact for IUCN.

The outcome of the 2013 workshop was a total of nine European studbooks and 26 monitoring programmes (Table 1). It was quite challenging to start with such a large number of coordinators. Still, the urgency was felt throughout the European public aquarium community and resulted in most programmes being active by the end of 2013.

Breeding programmes

The main goal of a breeding programme is maintaining a healthy genetic population within the participating aquarium community. Two programme types are currently used. The first, a European studbook (ESB), is a medium-intensity managed species programme. Individual animals are registered to manage a healthy genetic population, publish a biennial studbook overview, monitor husbandry issues, and give transfer recommendations to facilitate future breeding and prevent inbreeding. The next step in the ESB is to publish best practice guidelines, which compiles all known information about the species and help raise the overall knowledge of the species. A second programme type is a monitoring programme (MON-P), a low-intensity managed species programme that follows the population trend on an individual or population basis. The coordinator publishes a biennial population trend overview and monitors husbandry problems within the species.

Genetic research is used to find solutions to taxonomic challenges and for paternity testing to have the correct pedigree overview within the programme. Individual tagging with a transponder or PIT tag is needed to link administration with a specific animal. It is important to keep track of a specimen's origin to prevent hybridisation and inbreeding and enable possible future reintroduction programmes. The breeding programmes increase the husbandry knowledge of the species. The increase of breeding recommendations and transfers has helped increase reproductive output drastically, decreasing the number of animals taken directly from the wild. Some programmes even had to limit their breeding success due to overrepresentation of specific genes, which could lead to inbreeding depression or because the total number of offspring within the *ex situ* population is too high. Limiting reproductive output is mainly done by creating non-breeding, monosex populations; an initial trial using contraception has also proven successful (Janse and Luten, 2019). Reintroducing the surplus population into the wild usually is not an option due to the strict reintroduction rules and regional legislation. There have been a few reintroduction projects, most of which are conducted in collaboration with an *in situ* conservation project.

Table 1. Species list of managed *ex situ* programmes within the European EAZA/EUAC Elasmobranch TAG

Aetobatus ocellatus	Spotted Eagle Ray
Carcharhinus melanopterus	Blacktip Reef Shark
Carcharhinus plumbeus	Sandbar Shark
Heterodontus fransisci	Horn Shark
*Heterodontus portusjacksoni**	Port Jackson Shark
Neotrygon kuhlii	Kuhl's Maskray
Pristis pristis	Largetooth Sawfish
Pristis zijsron	Green Sawfish
Stegostoma tigrinum	Zebra Shark
Taeniura lymma	Bluespotted Lagoon Ray
Aetomylaeus bovinus	Duckbill Eagle Ray
Atelomycterus marmoratus	Coral Catshark
Carcharias taurus	Sand Tiger Shark
Dasyatis pastinaca	Common Stingray
Dipturus batis species complex	Common Blue Skate
Galeorhinus galeus	Tope
Ginglymostoma cirratum	Atlantic Nurse Shark
Glaucostegus cemiculus	Blackchin Guitarfish
Himantura uarnak	Coach Whipray
Hydrolagus colliei	Spotted Ratfish
Hypanus americanus	Southern Stingray
Mustelus asterias	Starry Smoothhound
Mustelus mustelus	Common Smoothhound
Myliobatis aquila	Common Eagle Ray
Potamotrygon leopoldi	Xingu River Ray
Potamotrygon motoro	Ocellate River Stingray
Pseudoginglymostoma brevicaudatum	Shorttail Nurse Shark
Pteroplatytrygon violacea	Pelagic Stingray
Raja brachyura	Blonde Skate
Raja clavata	Thornback Skate
Raja microocellata	Smalleyed Skate
Raja montagui	Spotted Skate
*Raja radula**	Rough Skate
Raja undulata	Undulate Skate
Rhina ancylostoma	Bowmouth Guitarfish
Rhinobatos rhinobatos	Common Guitarfish
Rhinoptera sp.	Cownose Ray
Scyliorhinus stellaris	Nursehound
Sphyrna lewini	Scalloped Hammerhead
Sphyrna tiburo	Bonnethead Shark
Squatina squatina	Angelshark
Torpedo marmorata	Marbled Torpedo Ray
Triakis semifasciata	Leopard Shark

*New programme which currently has no coordinator

Regional Collection Plan (RCP)

The main goal of an RCP is to define a list of species that need ex situ management within the region. It includes specific recommendations on species, numbers, target population size, number of participating aquariums (Penning et al., 2009), space needed for the target population and collaboration with in situ conservation programmes. An RCP may also recommend against keeping a species within the region when it is a target species in another region or unsuitable to be kept under normal aquarium conditions. An example is the establishment of a European studbook for the Spotted Eagle Ray (Aetobatus ocellatus) by Wroclaw Zoo, Poland and a 'do not obtain' for the Whitespotted Eagle Ray (Aetobatus narinari). The latter species, which has a Caribbean distribution, has a managed programme by a North American colleague of the Association of Zoos and Aquariums (AZA). Both regions will reserve suitable space for their target species of this large ray species.

Before an RCP, a regional census will provide information on the current status of the ex situ population and the species bred under human care. The census is repeated every five years. With 107 participating European aquariums, the latest census showed that 102 chondrichthyan species account for 8.6% of all known species (Janse et al., 2017). The RCP will prioritise the species that stand to benefit from collaborative management, including those not found in the ex situ population but which may need attention due to their threatened status in the wild within the region. An example is establishing a monitoring programme for the common skate (Dipturus batis species complex) by Rotterdam Zoo, the Netherlands, in 2020. This large, benthic species from the temperate region is rarely kept in aquariums but needs conservation action due to its Critically Endangered status. The MON-P coordinator wrote best practice guidelines on the species with information obtained from aquaria that have kept the species, scientific and grey literature and known practice from closely related species. A feasibility study is ongoing to evaluate the possibility of hatching wild-retrieved eggs and reintroducing subadults into nature.

2021 RCP Workshop

An RCP is a dynamic document that needs to be updated every few years to accommodate changes in the ex situ populations and changes in the IUCN Red List classification, including changes in taxonomy, among others.

The Elasmobranch TAG held a second RCP Workshop online on 10, 11 and 18 May 2021, which followed the new EAZA population management structure. Under the new approach, the 'old' ESBs and MON-P programmes will be changed into EEP (European ex situ Program) and a new monitoring programme that further needs to be described. This second workshop was organised by the EAZA office and the TAG steering committee. Workshop participants were programme coordinators and targeted researchers, conservationists, colleagues from the North American AZA, Red List Officers and IUCN SSC Shark Specialist Group representatives. The goal was to incorporate the perspective and knowledge related to the work with wild populations and in situ conservation projects to promote discussion and identify collaboration opportunities. The role of the EAZA office participants was to facilitate the discussion and help with the new method and structure. A second part of the online workshop to finish the accession of 63 species will be held later in 2021.

The species were defined as current programme species, very common or new species found in the European aquariums, and Critically Endangered or Endangered species from the European region currently not found in the ex situ population. The results of both workshops will be compiled in an RCP document which is expected to be ready in the first half of 2022. This document will serve as a guide for the TAG, a list of managed programmes on priority species and information about the ex situ population (e.g., number of individuals, age structure, captive-bred animals). The RCP document is an essential tool for developing Institutional Collection Plans (ICP) by European public aquariums. The RCP document also includes information on the specific roles and objectives of the species programme. These roles vary from direct conservation to non-conservation roles. Direct conservation may concentrate on maintaining a long-term ex situ population after extinction or preparing for reintroduction or assisted colonisation if and when feasible. Non-conservation roles target education on and awareness of the status and threats to the species, increasing interest in the species and its habitat and ecosystem.

Looking into the future

Although the RCP is meant to be a working tool for aquariums and ex situ populations, it has great potential to be relevant to other players in the conservation field as well; not only due to the significant number of species it targets but also because of the amount of information gathered on different aspects of the biology (e.g., gestation period, litter size, size at birth, juvenile growth rate) and husbandry of these species that can be used for the benefit of the populations in the wild. The same is true for the technical know-how in the aquarium community that can be used in collaboration with conservationists and researchers working in the wild. Collaborative scientific research also has numerous possibilities.

The zoo and aquarium community can support conservation initiatives with direct financial input from a single zoo and aquarium or via zoo and public aquarium association funds. Indirect financial support through public fundraising initiatives could be another approach.

The potential for intensifying the collaboration between ex situ management and in situ conservation needs to be explored further in the coming years. Combining the knowledge and skills has the potential to make a big difference. We all have a common goal regarding the conservation of elasmobranch species. For further information or to discuss collaboration, please contact the EAZA/EUAC Elasmobranch TAG chair: Max Janse m.janse@burgerszoo.nl.

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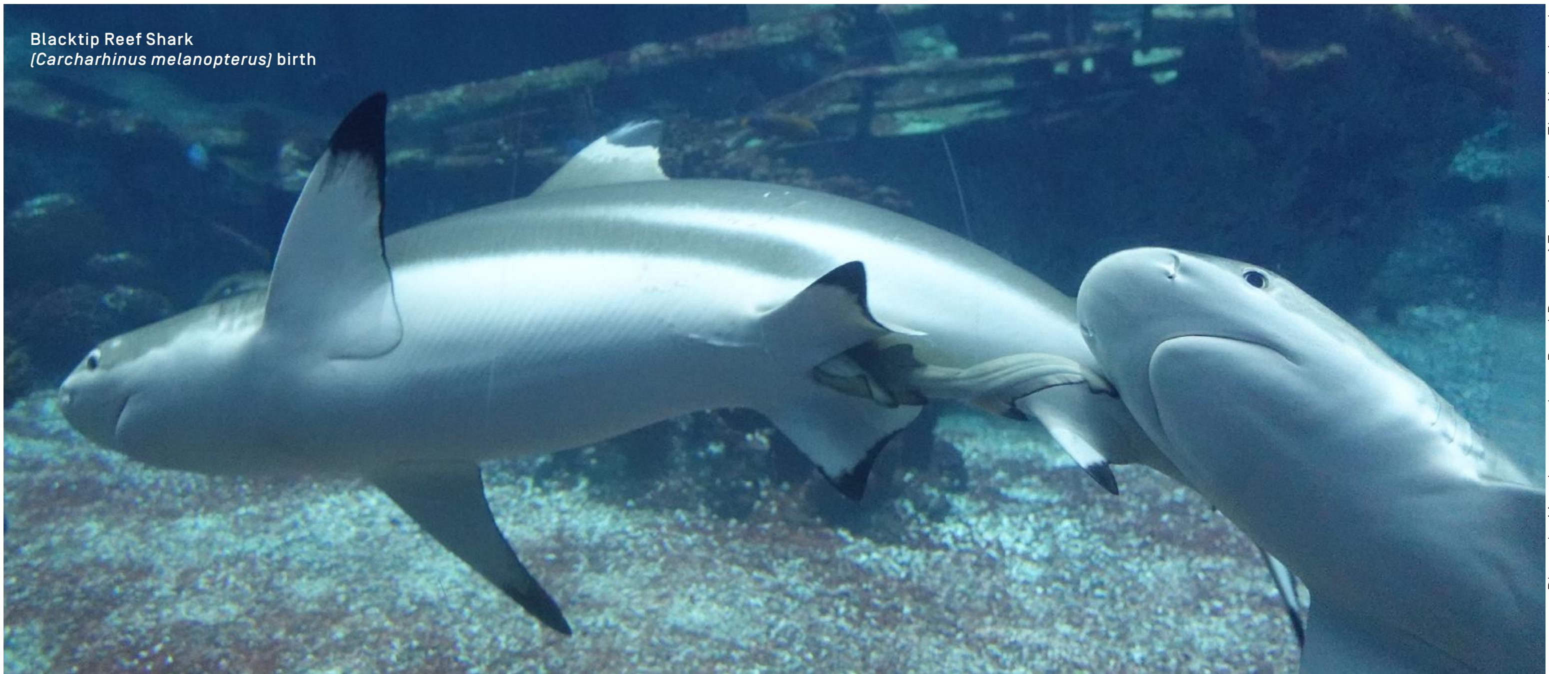


Blacktip Reef Shark
(Carcharhinus melanopterus) birth

Photo by Max Janse works at Royal Burgers' Zoo, Arnhem, The Netherlands

Bowmouth Guitarfish
(Rhina ancylostoma)

Sandbar Shark
(Carcharhinus plumbeus)

Photos by Pedro Pina | Oceanário de Lisboa, Lisboa, Portugal

A Crash Course on the Human Dimensions of Shark Conservation

Dr Rima Jabado
IUCN SSC Shark Specialist Group | Chair

When I was working on my PhD, I remember having to negotiate a lot with one of my supervisors to make sure I could include a human dimensions aspect into my thesis work. I wanted to spend a few months travelling across the United Arab Emirates to talk to fishers and traders before launching into studying the national shark and ray fisheries. It was essential for me because I couldn't understand how I could even start my work without understanding fisheries characteristics, motivations, behaviours, and perceptions of local fishing communities. Over the years, I have had endless conversations with students and other researchers struggling to get funding to make sure they can also incorporate an aspect of human dimensions into their work. But luckily, this field has evolved so much and very quickly over the last decade. Many researchers focused on shark science are increasingly working with coastal communities to understand human behaviour and make sure all stakeholders are involved in discussions related to species conservation. So, I guess it should not have been a surprise when we had almost 500 individuals register within a few days of opening the registration to our Crash Course on the Human Dimensions of Shark Conservation. This five-day course was organized by the Human Dimensions Working Group Chairs, Hollie Booth and Dr Divya Karnad in July and August 2021.

I would like to extend my immense gratitude to Divya and Hollie for planning and executing this event in a short amount of time and to all the speakers who took the time to join us from around the world and share their work and experience in this field. It was fantastic to have so many perspectives and learn more about some of the key considerations when working on human dimensions of shark conservation. Overall, we had over 200 participants on the Zoom calls at any one time, but many have requested that we share the videos. So, for those of you who missed it, you can find below the agenda, and the links to all the seminars uploaded to the IUCN SSC Shark Specialist Group YouTube and Vimeo accounts.

Throughout the course, Hollie and Divya made use of the Vevox platform to engage with participants and get feedback on the course, what participants felt were their needs when it comes to using human dimensions tools in their projects, what they saw as opportunities, and what their primary takeaway from this course were. Some of the results of these polls are provided here.

We hope this course is also valuable to others working on human dimensions of wildlife and encourage you to share the video links with anyone you think might be interested.

What did you find most interesting or helpful? (34)

- overall great knowledge sharing on shark conservation around the world
- the different types of information /knowledge that communities can share with us and the different ways in which we can share information with others
- Day 4 talks stood out for me, especially on getting to know your community/audience before starting the research
- Connecting to other researchers
- methodologies and challenges with its applications
- diverse case studies!
- Different value/culture and different approach for conservation
- Case study
- The broad dimension of social science in Shark Conservation!!!! Completely new field as a shark scientist
- The theoretical inputs on study design were particularly useful. Helpful to have real-world examples, too.
- The various models and case studies
- Papers you share
- Q&A

vevox Audience Engagement

Did it meet your personal learning objectives and expectations? (30)

Not at all	0%
Yes, to some extent	56.67%
Yes, very much so	43.33%
I'm not sure	0%

Allowed selections: 1

What is your primary takeaway from this course? (22)

- The importance of local community in conservation
- Shark conservation is as much of human interaction as it is with species interaction
- We need to really need to reach out to others in the field to share experiences or ask for help
- educating people on sharks to change attitude mindset and behaviour
- Know the work of other colleagues around the world
- Connect with more people with same ideology
- Understand community background prior to doing research
- How to approach to communities
- Diverse SOLUTIONS on Sharks conservation
- Importance of human dimensions
- several research technique to work with people/communities and concern about ethic
- Understanding human dimensions is important for conservation
- Lots of people want to do this kind of work but don't know how
- Respect for the community at all stages of research

vevox Audience Engagement

Date/time	Topic	Speaker(s)
Tuesday, July 27	**Day 1. Human dimensions: What, Why and How?**	
11.00 - 11.15	Course opening, with an introduction to the course and course leaders	Dr Rima Jabado (Elasmo Project and Chair of IUCN SSC Shark Specialist Group)
11.15 - 12.15	Human dimensions: What, Why and How?	Hollie Booth (University of Oxford/WCS)
12.15 - 12.30	Facilitated Discussion	Facilitated by Hollie & Dr Divya (Ashoka University)
Thursday, July 29	**Day 2. Overview of social science research methods for shark conservation**	
11.00 - 11.45	General considerations, common methods and research ethics	Hollie Booth & Dr Divya Karnad (University of Oxford, UK/WCS & Ashoka University, India)
11.45 - 12.00	Case study on Big data and quantitative methods for social-ecological systems	Dr Aaron MacNeil (Dalhousie University, Canada)
12.00 - 12.15	Case study on Local data and mixed methods for understanding drivers and perspectives	Dr Divya Karnad (Ashoka University, India)
12.15 - 12.30	Panel Discussion	All speakers, facilitated by Hollie
Tuesday, August 3	**Day 3. Case studies on human dimensions applications: understanding the socio-ecological situation**	
11.00 - 11.10	Introduction and overview	Dr Divya Karnad (Ashoka University, India)
11.10 - 11.25	Lessons learned from engaging with diverse communities	Dr Ruth Leeney (Independent)
11.25 - 11.40	Understanding fisher's perceptions of sharks through a socio-political lens	Mia Iwane (NOAA Fisheries, Hawaii, US)
11.40 - 11.55	Using LEK and citizen science to fill in the gaps for Ghana's Shark Fisheries	Seidu Issah (Kwame Nkrumah University, Ghana)
11.55 - 12.10	Using social media to combine awareness-raising with research: lessons from Angel Sharks in Libya	Sara Al Mabruk (Higher Institute of Science and Technology, Libya)
12.10 - 12.30	Facilitated discussion	Vanessa Jaiteh (Independent researcher)
Wednesday, August 4	**Day 4. Case studies on human dimensions application areas: designing interventions and changing behaviour**	
11.00 - 11.10	Introduction and overview	Hollie Booth (University of Oxford, UK/WCS)
11.10 - 11.25	Alternative livelihoods for shark fishers in Indonesia	Rafid Shidq (Thresher Shark Project, Indonesia)
11.25 - 11.40	Pay-to-release for guitarfish in Brazil	Natascha Wosnick (Universidade Federal do Paraná, Brazil)
11.40 - 11.55	Towards coexistence between people and sharks in Australia	Carol Martin & Kim Wolfende (New South Wales Department of Primary Industries, Australia)
11.55 - 12.10	Ocean Ambassadors in Mozambique	Genaye Domenico (Marine Mega-fauna Foundation, Mozambique)
12.10 - 12.30	Panel Discussion	All speakers, facilitated by Hollie
Thursday, August 5	**Day 5. Future directions for human dimensions of shark conservation**	
11.00 - 11.10	Introduction and overview	Divya Karnad (Ashoka University, India)
11.10 - 11.20	Harnessing technology and social media for research and behaviour change: lessons from 'why sharks matter'	David Shiffman (Arizona State University, US)
11.20 - 11.40	Harnessing technology and social media for research and behaviour change: lessons from digital marketing, gaming and online surveys	Diogo Verissimo (University of Oxford, UK)
11.40 - 12.00	Q&A / Panel Discussion	All speakers, facilitated by Divya
12.00 - 12.30	Facilitated discussion on next steps for Human Dimensions in the shark world. ● How can human dimensions help us to deliver the IUCN SSC SSG strategic plan? ● What are the needs and opportunities? ● How can we help you?	Facilitated by Hollie & Divya

Collections: vimeo.com/showcase/8696312
youtube.com/playlist?list=PLnP5hrE05yKTuYlQ1sHVxxHBmTrjaGXoG

Day 1 | Tuesday, July 27, 2021 | Human dimensions: what, why, and how?
vimeo.com/579987524 youtu.be/Lml60nMmwn0

Day 2 | Thursday, July 29, 2021 | Overview of social science research methods for shark conservation vimeo.com/580924066 youtu.be/1MTPPJvaHVw

Day 3 | Tuesday, August 3, 2021 | Case studies on human dimensions applications: understanding the socio-ecological situation vimeo.com/586374420 youtu.be/YI4JPFRDpG8

Day 4 | Wednesday, August 4, 2021 | Case study applications: Designing interventions and changing behaviour vimeo.com/589746108 youtu.be/U8grBtYPC3c

Day 5 | Thursday, August 5, 2021 | Future directions for Human Dimensions of Shark Conservation
vimeo.com/589746391 youtu.be/n0G0JIHOzZE

Photo by Simone Caprodossi

Update 2021-2

Working Group Update | Assess

Dr Cassandra Rigby
IUCN SSC Shark Specialist Group | Assess Working Group Chair

The 2021-2 IUCN Red List of Threatened Species update was published on September 4th at iucnredlist.org. A list of 128 shark and ray assessments that were published as part of the update is provided below.

We extend our sincere gratitude to IUCN SSC Shark Specialist Group members and non-members who contributed to these assessments.

For any questions regarding these assessments, contact Cassie Rigby, Red List Authority Coordinator: crigby@westnet.com.au

Updated table of shark and ray IUCN Red List of Threatened Species assessments indicating the previous category species were assigned to and the updated category as published in September 2021.

CR – Critically Endangered
EN – Endangered
VU – Vulnerable
NT – Near Threatened
LC – Least Concern
DD – Data Deficient
NE – Not Evaluated

Order	Family	Genus	Species	Previous Red List category	New Red List category
SHARKS					
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*amblyrhynchoides*	NT	VU
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*amboinensis*	DD	VU
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*borneensis*	EN	CR
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*leucas*	NT	VU
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*limbatus*	NT	VU
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*macloti*	NT	NT
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*plumbeus*	VU	EN
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*sealei*	NT	VU
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*sorrah*	NT	NT
Carcharhiniformes	Carcharhinidae	*Glyphis*	*gangeticus*	CR	CR
Carcharhiniformes	Carcharhinidae	*Glyphis*	*garricki*	CR	VU
Carcharhiniformes	Carcharhinidae	*Glyphis*	*glyphis*	EN	VU

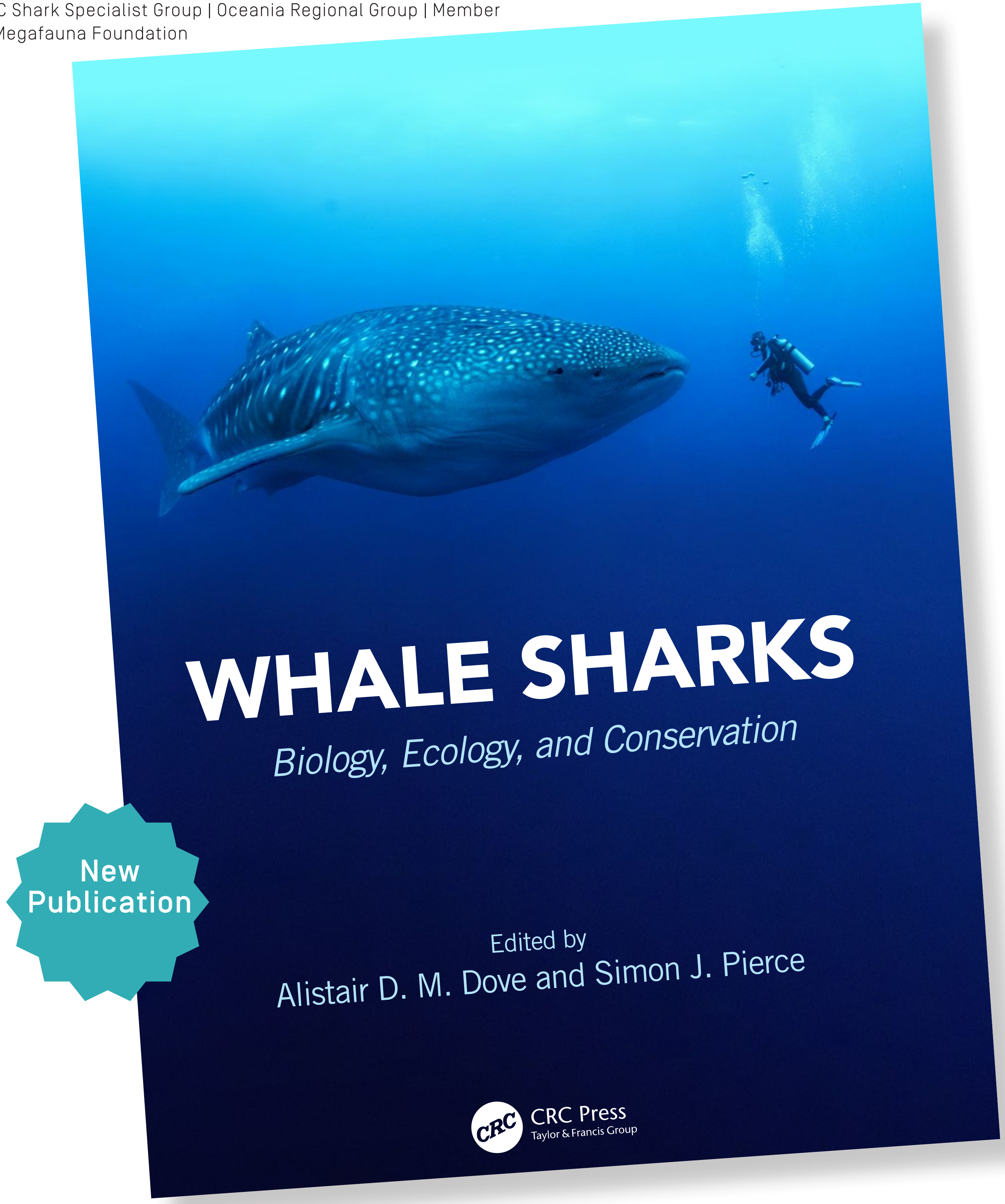
Order	Family	Genus	Species	Previous Red List category	New Red List category
SHARKS					
Carcharhiniformes	Carcharhinidae	*Lamiopsis*	*temminckii*	EN	EN
Carcharhiniformes	Carcharhinidae	*Lamiopsis*	*tephrodes*	NE	EN
Carcharhiniformes	Carcharhinidae	*Loxodon*	*macrorhinus*	LC	NT
Carcharhiniformes	Carcharhinidae	*Negaprion*	*acutidens*	VU	EN
Carcharhiniformes	Carcharhinidae	*Rhizoprionodon*	*oligolinx*	LC	NT
Carcharhiniformes	Carcharhinidae	*Scoliodon*	*laticaudus*	NT	NT
Carcharhiniformes	Hemigaleidae	*Hemigaleus*	*microstoma*	VU	VU
Carcharhiniformes	Hemigaleidae	*Paragaleus*	*pectoralis*	DD	EN
Carcharhiniformes	Hemigaleidae	*Paragaleus*	*randalli*	NT	VU
Carcharhiniformes	Leptochariidae	*Leptocharias*	*smithii*	NT	VU
Carcharhiniformes	Pentanchidae	*Galeus*	*atlanticus*	NT	NT
Carcharhiniformes	Pentanchidae	*Galeus*	*melastomus*	LC	LC
Carcharhiniformes	Pentanchidae	*Galeus*	*polli*	LC	VU
Carcharhiniformes	Proscylliidae	*Proscyllium*	*magnificum*	NE	NT
Carcharhiniformes	Scyliorhinidae	*Atelomycterus*	*baliensis*	VU	LC
Carcharhiniformes	Scyliorhinidae	*Atelomycterus*	*erdmanni*	NE	LC
Carcharhiniformes	Scyliorhinidae	*Atelomycterus*	*marmoratus*	NT	NT
Carcharhiniformes	Scyliorhinidae	*Cephaloscyllium*	*sarawakensis*	DD	CR
Carcharhiniformes	Scyliorhinidae	*Scyliorhinus*	*canicula*	LC	LC
Carcharhiniformes	Scyliorhinidae	*Scyliorhinus*	*cervigoni*	DD	DD
Carcharhiniformes	Scyliorhinidae	*Scyliorhinus*	*stellaris*	NT	VU
Carcharhiniformes	Triakidae	*Hemitriakis*	*indroyonoi*	NE	EN
Carcharhiniformes	Triakidae	*Hemitriakis*	*leucoperiptera*	EN	CR
Carcharhiniformes	Triakidae	*Iago*	*omanensis*	LC	LC
Carcharhiniformes	Triakidae	*Mustelus*	*mustelus*	VU	EN
Carcharhiniformes	Triakidae	*Mustelus*	*widodoi*	DD	VU
Lamniformes	Odontaspididae	*Carcharias*	*taurus*	VU	CR
Orectolobiformes	Ginglymostomatidae	*Nebrius*	*ferrugineus*	VU	VU
Orectolobiformes	Orectolobidae	*Orectolobus*	*leptolineatus*	NE	NT
Squaliformes	Etmopteridae	*Etmopterus*	*polli*	DD	LC
Squaliformes	Etmopteridae	*Etmopterus*	*spinax*	LC	VU
Squaliformes	Oxynotidae	*Oxynotus*	*centrina*	VU	EN
Squaliformes	Oxynotidae	*Oxynotus*	*paradoxus*	DD	VU
Squaliformes	Somniosidae	*Scymnodalatias*	*garricki*	DD	DD
Squaliformes	Somniosidae	*Somniosus*	*pacificus*	DD	NT
Squaliformes	Squalidae	*Squalus*	*blainville*	DD	DD
Squaliformes	Squalidae	*Squalus*	*boretzi*	NE	NT
RAYS					
Myliobatiformes	Dasyatidae	*Bathytoshia*	*brevicaudata*	LC	LC
Myliobatiformes	Dasyatidae	*Bathytoshia*	*lata*	LC	VU
Myliobatiformes	Dasyatidae	*Brevitrygon*	*javaensis*	NE	EN
Myliobatiformes	Dasyatidae	*Dasyatis*	*marmorata*	DD	NT
Myliobatiformes	Dasyatidae	*Dasyatis*	*pastinaca*	DD	VU
Myliobatiformes	Dasyatidae	*Dasyatis*	*tortonesei*	NE	DD
Myliobatiformes	Dasyatidae	*Fluvitrygon*	*kittipongi*	EN	EN
Myliobatiformes	Dasyatidae	*Fluvitrygon*	*oxyrhynchus*	EN	EN
Myliobatiformes	Dasyatidae	*Fluvitrygon*	*signifer*	EN	EN
Myliobatiformes	Dasyatidae	*Fontitrygon*	*garouaensis*	VU	CR
Myliobatiformes	Dasyatidae	*Fontitrygon*	*margarita*	EN	VU
Myliobatiformes	Dasyatidae	*Fontitrygon*	*margaritella*	DD	NT
Myliobatiformes	Dasyatidae	*Fontitrygon*	*ukpam*	EN	CR
Myliobatiformes	Dasyatidae	*Hemitrygon*	*fluviorum*	VU	NT
Myliobatiformes	Dasyatidae	*Hemitrygon*	*laosensis*	EN	EN
Myliobatiformes	Dasyatidae	*Himantura*	*australis*	NE	LC
Myliobatiformes	Dasyatidae	*Himantura*	*uarnak*	VU	EN
Myliobatiformes	Dasyatidae	*Hypanus*	*rudis*	DD	CR
Myliobatiformes	Dasyatidae	*Maculabatis*	*bineeshi*	NE	CR
Myliobatiformes	Dasyatidae	*Makararaja*	*chindwinensis*	DD	DD
Myliobatiformes	Dasyatidae	*Neotrygon*	*australiae*	NE	NT
Myliobatiformes	Dasyatidae	*Neotrygon*	*caeruleopunctata*	NE	LC
Myliobatiformes	Dasyatidae	*Neotrygon*	*orientalis*	NE	LC

Order	Family	Genus	Species	Previous Red List category	New Red List category
RAYS					
Myliobatiformes	Dasyatidae	*Neotrygon*	*trigonoides*	NE	LC
Myliobatiformes	Dasyatidae	*Neotrygon*	*varidens*	NE	LC
Myliobatiformes	Dasyatidae	*Pastinachus*	*stellurostris*	NE	CR
Myliobatiformes	Dasyatidae	*Pateobatis*	*hortlei*	VU	NT
Myliobatiformes	Dasyatidae	*Taeniurops*	*grabatus*	DD	NT
Myliobatiformes	Dasyatidae	*Telatrygon*	*crozieri*	NE	EN
Myliobatiformes	Dasyatidae	*Telatrygon*	*zugei*	NT	VU
Myliobatiformes	Dasyatidae	*Urogymnus*	*acanthobothrium*	NE	DD
Myliobatiformes	Dasyatidae	*Urogymnus*	*polylepis*	EN	EN
Myliobatiformes	Rhinopteridae	*Rhinoptera*	*javanica*	VU	EN
Myliobatiformes	Rhinopteridae	*Rhinoptera*	*jayakari*	NE	EN
Myliobatiformes	Rhinopteridae	*Rhinoptera*	*marginata*	NT	CR
Myliobatiformes	UROLOPHIDAE	*Spinilophus*	*armatus*	DD	DD
Myliobatiformes	Zanobatidae	*Zanobatus*	*maculatus*	NE	NT
Myliobatiformes	Zanobatidae	*Zanobatus*	*schoenleinii*	DD	VU
Rajiformes	Arhynchobatidae	*Arctoraja*	*sexoculata*	NE	DD
Rajiformes	Arhynchobatidae	*Bathyraja*	*hesperafricana*	DD	LC
Rajiformes	Rajidae	*Amblyraja*	*frerichsi*	DD	VU
Rajiformes	Rajidae	*Dentiraja*	*australis*	VU	NT
Rajiformes	Rajidae	*Dentiraja*	*cerva*	NT	NT
Rajiformes	Rajidae	*Dentiraja*	*endeavouri*	NT	NT
Rajiformes	Rajidae	*Dipturus*	*batis*	CR	CR
Rajiformes	Rajidae	*Dipturus*	*doutrei*	DD	LC
Rajiformes	Rajidae	*Dipturus*	*intermedius*	NE	CR
Rajiformes	Rajidae	*Leucoraja*	*elaineae*	NE	DD
Rajiformes	Rajidae	*Leucoraja*	*leucosticta*	DD	NT
Rajiformes	Rajidae	*Neoraja*	*africana*	DD	LC
Rajiformes	Rajidae	*Raja*	*parva*	NE	NT
Rajiformes	Rajidae	*Raja*	*straeleni*	DD	NT
Rajiformes	Rajidae	*Rajella*	*barnardi*	LC	LC
Rajiformes	Rajidae	*Rajella*	*dissimilis*	LC	LC
Rajiformes	Rajidae	*Rajella*	*leoparda*	LC	LC
Rajiformes	Rajidae	*Rajella*	*sadowskii*	DD	LC
Rhinopristiformes	Rhinobatidae	*Pseudobatos*	*buthi*	NE	VU
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*annandalei*	DD	CR
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*borneensis*	NE	EN
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*jimbaranensis*	VU	CR
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*lionotus*	DD	CR
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*manai*	NE	LC
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*penggali*	VU	EN
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*ranongensis*	NE	VU
Rhinopristiformes	Rhinobatidae	*Rhinobatos*	*whitei*	NE	CR
Torpediniformes	Narcinidae	*Narcine*	*atzi*	DD	VU
Torpediniformes	Narcinidae	*Narcine*	*baliensis*	NE	NT
Torpediniformes	Narcinidae	*Narcine*	*prodorsalis*	DD	EN
Torpediniformes	Narcinidae	*Narcine*	*timlei*	DD	VU
Torpediniformes	Narkidae	*Narke*	*dipterygia*	DD	VU
Torpediniformes	Narkidae	*Narke*	*japonica*	VU	VU
Torpediniformes	Narkidae	*Temera*	*hardwickii*	VU	VU
Torpediniformes	Platyrhinidae	*Platyrhina*	*psomadakisi*	NE	NT
Torpediniformes	Torpedinidae	*Tetronarce*	*nobiliana*	DD	LC
Torpediniformes	Torpedinidae	*Tetronarce*	*tremens*	LC	LC
Torpediniformes	Torpedinidae	*Torpedo*	*bauchotae*	DD	EN
Torpediniformes	Torpedinidae	*Torpedo*	*mackayana*	DD	EN
Torpediniformes	Torpedinidae	*Torpedo*	*marmorata*	DD	VU
Torpediniformes	Torpedinidae	*Torpedo*	*torpedo*	DD	VU

Whale Sharks Biology, Ecology, and Conservation

Edited by Alistair D. M. Dove and Simon J. Pierce
Text written by Simon Pierce

IUCN SSC Shark Specialist Group | Oceania Regional Group | Member
Marine Megafauna Foundation



Whale Sharks are a fascinating species. Genuinely, they're amazing. They grow from 50 cm at birth to become the largest fish that has ever lived. They dive to at least 1900 m, whereupon our tags implode. They swim over 10,000 km a year, often without approaching a coast. And they manage all this with a big goofy grin and a general 'oceanic Labrador' vibe.

After years spent working with these spotted wonderfish, it amuses me to remember that I almost dismissed this scientific endeavour out of hand. Way back in 2005, when my friend, then lab-mate and manta ray researcher Andrea Marshall suggested that I visit her in Mozambique to study the Whale Sharks for the first time, I laughed with scorn. I was busy working on under-appreciated and under-protected stingrays; there were whole documentaries on Whale Sharks. I had little interest in spending my time reducing the error bars on the world's largest fish, a charismatic icon. They might as well have been dolphins.

To humour her, I resigned myself to at least look into the topic and… wow, okay. The documentary series turned out to be a mix of plausible speculation and outlandish lies. Hardly anything was known about Whale Shark biology or ecology. From a conservation perspective, there was an existential threat from target fisheries. My interest was piqued. I hopped on a plane to Mozambique, jumped on the boat, and fell in love. These gigantic spotted himbos really are pretty endearing.

Fortunately, several other researchers were embarking on a similar journey at about the same time. We've learned from the pioneers and each other and welcome new people to the field. We've even had a few small conferences exclusively dedicated to sharing knowledge about Whale Sharks. Following one of these, Jeffrey Carrier – senior editor of the fantastic 'Biology of Sharks' series for CRC Press – suggested to the organiser, Al Dove from the Georgia Aquarium, that he should consider producing a book on the species. Al said he'd do it if I'd do it. Sometime later, here we are with a book to sell you.

To capture knowledge on these gigantic sharks, Al and I identified experts on specific topics, from sensory biology to tourism, and invited them to either lead a chapter themselves or build a team. The finished product includes contributions from 35 authors across 13 chapters and 344 pages. Many of the trail-blazing Whale Shark researchers have shared their vast knowledge and field observations, and we've benefitted from recruiting leading shark scientists and conservationists from outside this community to apply their expertise.

While this is definitely a textbook – there are pages and pages and pages of references, trust me, I had to format them – it isn't just a collection of review papers. We asked the chapter authors to identify and address topical questions, including the controversies in their area. Can Whale Sharks be fished sustainably? Are there advantages to holding the world's largest fish in captivity? Is tourism genuinely a good thing? We've argued these points and more.

While Whale Sharks are now, indisputably, one of the better-known marine species, there are still plenty of genuine mysteries to delve into as well. Most Whale Shark tourism and research focus on the few specific sites where the sharks can be regularly seen, with just a few exceptions; it's primarily juvenile males in these areas. After years of research, we still haven't found most female Whale Sharks, adults, or babies. Only one pregnant female Whale Shark had ever been examined in 1995, and only ~30–40 tiny pups have been found. Where are they, and why aren't we seeing more of them? We invited the authors to use their own experience, unpublished data, and opinions to generate testable Whale Shark biology and ecology hypotheses. That was a lot of geeky fun and ensure that the book isn't just a synthesis of published work on the species – it's a roadmap for future research.

Whale Sharks are gentle giants. They've benefited from that, and they've suffered for it too. On the one fin, the species is now the focus of a US$140 million wild tourism industry, which has created a substantial economic incentive for protecting Whale Sharks. On the other, the same characteristics that make them attractive for tourism – large size, placid nature, and a reliable seasonal presence – also led to them becoming targeted by fisheries that have halved their population since the 1980s. Following recognition of their Endangered status, Whale Sharks are now one of the best-protected sharks. Now, they are an effective 'flagship' species, for which conservation efforts broadly benefit other species.

This book goes *deep* into topics that Whale Shark enthusiasts will find interesting. I like to think that there's a lot here for people working with other species, too. While Whale Sharks are a unique species, being the only member of its order to evolve into an overgrown plankton vacuum, many now-standard shark research techniques were pioneered on Whale Sharks. Their large size, amenable behaviour, and lack of specimens available for dissection have encouraged researchers to get creative. Some of the first satellite-linked tags were designed for and deployed on Whale Sharks. They were one of the first species for which photo-identification became a fundamental tool – and are now a test case for integrating artificial intelligence with image processing. The book talks about these and other methods and current work using ultrasound on free-swimming sharks, underwater blood draws, and even in-water semen collection, which… yeah. That may have been a one-off. Anyway, we hope that a few ideas will prove relevant to other species too.

I always think that I learn at the fastest rate about a topic when I start working on it and write it up. I've learnt a lot about these enigmatic ocean giants through this process, and I'm proud of what we've achieved with this book. Hopefully, it'll help a few more people fall in love with Whale Sharks and inspire them to help safeguard the recovery of the world's greatest fish :)

Simon Pierce (and would be Al Dove, too, if he wasn't off gallivanting in the Galapagos).

females, in contrast, veered to the southwest after only 500 km, and their tags detached in almost the same location, approximately 2,000 km southwest of Galapagos.

During their movements along the EF, whale sharks appeared to track tropical instability waves (Ryan et al. 2017), which are generated seasonally by shearing of the South Equatorial Current and the North Equatorial Countercurrent (Sweet et al. 2009). These instability waves propagate along the front and accumulate both plankton and their predators, such as planktivorous seabirds (Spear et al. 2001). The EF is the largest, but not the only, upwelling system in the region. Other upwelling systems include the Peru-Humboldt and the region southwest of Galapagos (Ryan et al. 2017). Indeed, by September, the adult females turned back along the EF towards Galapagos, with at least five individuals being either tracked or photographed near the island later in the same season (Hearn et al. 2016). These sharks, along with those tagged at Darwin Island in September–October, continued to move east, and by the end of December and early January each year, all individuals whose tags had not detached were in the upwelling system along the shelf break of southern Ecuador and northern Peru (Figure 6.7). Their mean speed was >40 km each day, far greater than that of most sharks tagged at feeding constellations (~10–30 km per day; see Table 6.1).

Sharks have not been tracked beyond this period due to tag shedding, but a dataset of whale shark encounters with the tuna purse-seine fishery, provided by the onboard observer program of the Inter-American Tropical Tuna Commission (IATTC), both validates the movement results and suggests a hitherto unknown important area for whale sharks (Figure 6.8; Román et al. 2018).

From July through September, as with the satellite tracks, whale sharks were encountered along the EF, coinciding with the period of the highest surface water chlorophyll levels in this region and the lowest levels in coastal waters of Ecuador (Figure 6.8a). At the end of the year, whale sharks were reported along the continental shelf, again coinciding with movement data an[...] increased productivity in surface waters (Figure 6.8b). However, in the first quarter, [...] tracks exist, whale shark encounters were almost exclusively limited to the coastal re[...]

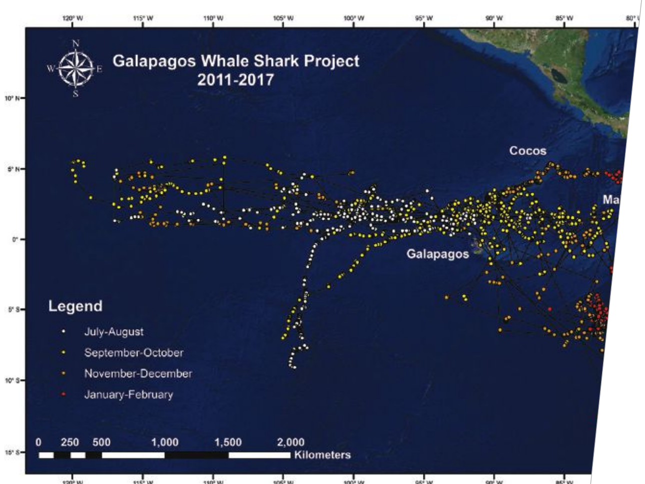


Figure 6.7 Annual tracks from whale sharks tagged at Darwin Island, Galapagos Mar[...]

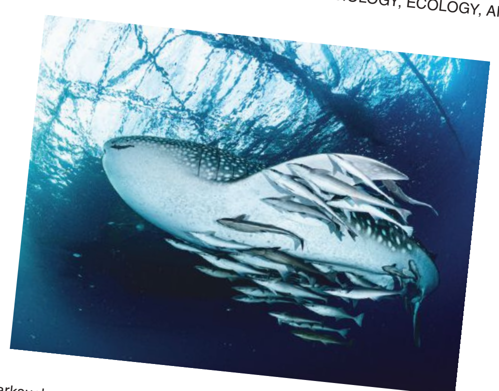


Figure 4.5 Live sharksuckers, *Echeneis naucrates* gathered beneath a whale shark. (Picture credit: Simon J. Pierce.)

Figure 4.6 A mark left by recent attachment of a common shark sucker or remora, *Remora* on a whale shark in St. Helena. (Picture credit: Simon J. Pierce.)

4.4.4 Shelterers

A wide range of fish species can be observed schooling or shoaling around the large bodies of whale sharks. In many of these cases, the behavior is transient or fleeting, which suggests that this relationship is facultative and temporary at best. This behavior may be an example of simple thigmotaxis, where smaller animals are attracted to large objects (Vassilopoulou et al. 2004), or they may use close proximity to the large bodies of whale sharks as some form of protection from predators. Most often it involves smaller fishes such as anchovies (Engraulidae), scads (Carangidae: *Decapterus* spp.) and smaller mackerels like the Indian mackerel *Rastrelliger kanagurta* (Table 4.2) (Figure 4.7); the silver pomfret *Pampus argenteus* Euphrasen, 1788 (Stromatiidae) was also

Editor Bios

Dr Alistair D. M. Dove is a broadly trained marine biologist and currently Vice President of Science and Education at Georgia Aquarium in Atlanta, USA. He oversees international research programs on Whale Sharks, Manta Rays, coral reefs, sharks, and dolphins. Alistair graduated from The University of Queensland in Brisbane, Australia, with a BSc Honours (1st Class) in 1995 and a PhD in Microbiology and Parasitology in 1999, for which he was awarded a University Medal and Dean's List commendation. His early research focus was on parasites and diseases in freshwater and marine environments. Still, after a period studying diseases of lobsters, he began focusing on the biology and ecology of whale sharks after moving to Georgia Aquarium in 2006.

Dr Simon J Pierce is a co-founder and Principal Scientist at the Marine Megafauna Foundation, where he leads the global Whale Shark research and conservation program. Simon is also a science advisor to the Wildbook for Whale Sharks global database, a founding board member of the Sawfish Conservation Society, and a member of the IUCN SSC Shark Specialist Group. Simon holds a BSc in Ecology from Victoria University of Wellington in New Zealand and a BSc (Hons, 1st Class) and PhD in stingray biology from The University of Queensland.

Reviews

One of life's greatest joys is being eye-to-eye with the world's largest fish – the awe-inspiring and ever-mysterious Whale Shark. In this comprehensive and extensively referenced volume, Dove and Pierce have brought together the world's leading scientists to review this shark's fascinating biology and its elusive ecology. More than a collection of scientific facts, it is a roadmap for the conservation actions needed to ensure humanity continues to benefit from this "utterly extraordinary species". Whether you are an inquisitive citizen scientist or a trained expert, you will find awe aplenty within its pages.

Dr George Leonard
Chief Scientist, Ocean Conservancy

Al Dove and Simon Pierce showcase the magnificent Whale Shark like never before! Within the pages of Whale Sharks: Biology, Ecology and Conservation, this enigmatic creature is revealed scientifically with an easy-to-understand style. Of particular interest is the attention given to the range of threats facing whale sharks and the vital need for conservation. Open the pages of this book and be transported into the mysterious world of Whale Sharks!

Brian Skerry
Award-winning Photographer at National Geographic Magazine and Fellow at National Geographic Society

The largest and arguably one of the most magnificent fish in the sea finally gets the attention it deserves in this volume dedicated to these gentle giants. Whale Sharks have previously been relegated to passing mentions in many treatments of shark biology. While many essential volumes have been published on the more charismatic Great White Shark, Whale Sharks have been largely neglected. Studies of these giant ocean travellers are complex, compounded by their large size and often rare appearances. Few have been maintained in captive facilities, though data from these few are beginning to reveal secrets of their biology that may aid in protecting their fragile biology. At long last, Dr Al Dove and Dr Simon Pierce have assembled a collection of papers from foremost experts who study these ocean wanderers. Together, they provide insight into important facets of their biology. The authors' insights suggest strategies to protect these sharks through wise management practices and conservation efforts. This volume belongs on the shelf of every ichthyologist and scientist concerned for the fate of the oceans' largest fish.

Dr Jeffrey C. Carrier
Professor Emeritus of Biology, Albion College, Senior Editor, The Biology of Sharks and Their Relatives series

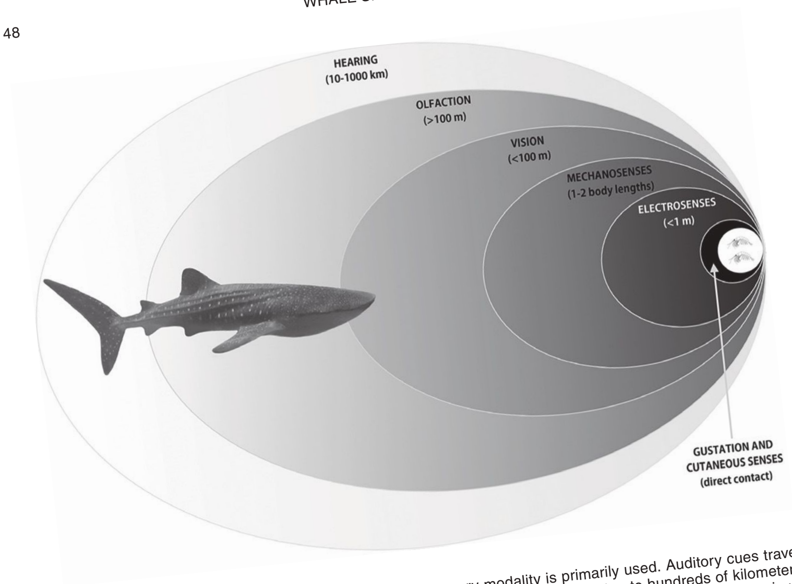


Figure 3.1 The detection distance over which each sensory modality is primarily used. Auditory cues travel the greatest distance in water and can be detected by sharks from ten to hundreds of kilometers away. Olfactory cues can be detected by sharks from over 100 m a… cues is used at distances up to 100 m, and the mechanosensory lat… body lengths away from the shark. The electrosensory system is us… electrical stimuli up to 30 cm, where gustation is only used upon c…

3.2 SENSORY SYSTEMS

3.2.1 Introduction

Sharks and their relatives possess a suite of highly specialized sens… predators, find prey, and navigate through the aquatic environment. … different distances (Figure 3.1), sharks are capable of using multiple … switching between them as they approach a stimulus (Gardiner et al. 2… and molecular differences suggest the relative importance of each s… (Collin et al. 2016), but there is still much to learn about the sensory… Even less is known about the sensory system of whale sharks in partic… study in both field and captive environments. Predictions for sensory… whale shark, based on characteristics of other related species in the … planktivorous sharks, but further work is necessary to understand … sensory system in the whale shark to better describe their influence…

3.2.2 Hearing

Sound in the aquatic environment is an important sensory c… because it can travel distances from tens to hundreds of kilome…

Figure 2.1 The single litter of whale shark pups to be examined by scientists, from a 10.6 m "megamamma" female caught in Taiwan in 1995. (Photo: Hua Hsun Hsu, George Chen Shark Research Center, National Taiwan Ocean University, Taiwan.)

Figure 2.2 Empty egg cases and a fetus from the "megamamma" pregnant female whale shark caught in Taiwan. (Photo: Hua Hsun Hsu, George Chen Shark Research Center, National Taiwan Ocean University, Taiwan.)

shark, as it was described in the resulting paper (Joung et al. 1996), contained around 300 embryos in varying stages of development in its twin uteri (Figure 2.1). Some empty egg cases from embryos that had already hatched were found in the uteri; 24 egg cases were measured and had an average length of 21 cm (Chang et al. 1997). Some other embryos were still present inside their egg cases, with their yolk-sac attached. Most embryos, however, had already left their eggs and were nearly ready for birth (Figure 2.2). The largest size-class of embryos, 58–64 cm TL, had clear vitelline scars at the prior attachment point of their now fully absorbed yolk-sacs (Joung et al. 1996). The sex ratio of all the embryos that were inspected was 123:114 (female:male), which was not significantly different from 1:1. This litter, at slightly above 300 embryos (variably referred to as 304–307 in the initial description), is the largest – by a considerable margin – that has ever been recorded in a shark. The next largest litter in an individual shark appears to be 135 from a blue shark *Prionace glauca*, although the average for that species is only around 30 (Nakano and Stevens 2008).

2021 Save Our Seas Foundation Ocean Storytelling Photography Grant

Stories spark the imagination and nurture ideas. They are, without doubt, our most powerful form of communicating and connecting, both with each other and the world around us.

The Save Our Seas Foundation (SOSF) has a strong history of supporting marine conservation and education projects but believes that we must communicate through engaging stories to truly translate knowledge into effective, meaningful change. An inspiring or compelling story can spur positive action in ways that no presentation of facts can.

We are delighted to introduce our new emerging Ocean Storytelling Grant, which will focus on photography in its inaugural year. These grants are led by Thomas Peschak, Director of Storytelling and National Geographic photo-grapher, in collaboration with Kathy Moran, Deputy Director of Photography at National Geographic, and Jennifer Samuel, Photo Editor at National Geographic.

These grants build on SOSF's previous Marine Conservation Photography Grants' legacy and are dedicated to finding and supporting a new and diverse generation of conservation storytellers. While we are specifically looking for photographers who can tell conservation stories about our oceans, the call is not limited to underwater photography. Applicants should think broadly – story topics can range from the animals themselves to fisheries to the communities whose lives are intertwined with marine life. Four successful grantees will receive a fully-funded assignment to shoot a conservation photo story on location (including day rate and travel) under direct mentorship from the Ocean Storytelling Grant team.

SOSF is particularly seeking to support early-career and emerging storytellers and encourage new voices with new perspectives and photographic approaches. As such, applications must have no more than five years of professional experience in any photography related discipline. Over two-thirds of previous photo grant applicants were male, and almost 80% were from North America and Europe. To actively remedy these imbalances pervasive throughout the industry, SOSF encourages women and applicants from South and Central America, the Caribbean, the Middle East, Africa, Asia, and underrepresented communities to apply for this opportunity. Applications will be accepted both directly via open call and through nomination.

We hope to encourage applicants from all backgrounds the world over in our search for exciting new voices and distinct perspectives in the field of conservation storytelling.

The award includes a cash prize (2,000 USD), a year of mentorship, a day rate for a 3- to 4-week shoot, and all logistical costs for the shoot covered.

More information:
saveourseas.com/ocean-storytelling-photography-grant/

Applications must be submitted via the SOSF grant online portal:
saveourseasgrants.smapply.io

The closing date for the 2021 SOSF Ocean Storytelling Photography Grant is November 30, 2021, @ 18:00 CET.


Photo by Mac Stone | macstonephoto.com


Photo by Joris van Alphen | jorisvanalphen.com


Photo by Justin Gilligan | justingilligan.com


Photo by Sirachai (Shin) Arunrugstichai | shinsphoto.com

Upcoming Meetings 2021-2022

All meetings are subject to change due to the impacts of the coronavirus (SARS-CoV-2 | COVID-19) situation that varies in location and time. Please visit the respective websites and communication from the organising host organisation for more information.

24th Annual Scientific Meeting
European Elasmobranch Association (EEA)
November 3 – 5, 2021
Leiden, The Netherlands
eulasmo.org
elasmobranch.nl/eea2021/

The European Elasmobranch Association (EEA) is a non-profit umbrella organisation of European organisations dedicated to the study, management and conservation of sharks, skates, rays and chimaeras (cartilaginous fishes or chondrichthyans). The EEA is not a public membership body, but an association of national organisations within Europe and the North-east Atlantic, some of these are scientific bodies, others are public membership organisations. EEA member bodies take turns to host the annual scientific meeting.

6th Southern African Shark & Ray Symposium (SASRS)
November 17 – 19, 2021
Gansbaai, South Africa
sharkandraysymposium.com

The Southern African Shark and Ray Symposium is a biennial meeting of the academic community of Southern Africa The SASRS will be composed of a combination of oral and poster presentations, workshops, and public events – with plenty of added fun and adventure planned for attendees. Keynote presentations will be scheduled throughout the Symposium.

II ELASMulheres Symposium
November 06 – 12, 2021
Brazil, virtual
doity.com.br/ii-elasmulheres
elasmulheres.weebly.com

ELASMulheres is an annual event organized by Brazilian women who research distinct aspects of elasmobranchs. Its name, in Portuguese, means "ELAS" (THEY, female) and "Mulheres" (Women), besides playing with the word "ELASM"o-branchs.
The goal of ELASMulheres is to contribute to our knowledge of elasmobranchs through talks and discussions provided by female scientists. The symposium also encompasses the scientific communication of studies developed by young women to empower this minority group working with sharks and rays. Men are welcome to watch and present at II ELASMulheres, even though Brazilian female researchers will give main talks. Since the symposium aims to promote equality, it will be presented in Portuguese. If you are not in Brazil and want to participate, please contact the organizing committee at elasmulheres.simposio@gmail.com. We will be glad to provide further instructions on how to participate if you are a foreign language speaker and not familiar with Portuguese.

5th International Marine ProtectedAreas Congress (IMPAC5)
September 1 – 8, 2022
Vancouver, Canada
impac5.ca

International Marine Protected Areas Congresses (IMPAC) are an opportunity for the global community of marine conservation managers and practitioners to exchange knowledge, experience and best practices to strengthen the conservation of marine biodiversity and to protect the natural and cultural heritage of the ocean.

IMPAC5 will be jointly hosted by the Host First Nations — Musqueam Indian Band, Squamish Nation, and Tsleil-waututh Nation — together with the Province of British Columbia, the Government of Canada, the Canadian Parks and Wilderness Society (CPAWS) and the International Union for the Conservation of Nature (IUCN).

IMPAC5 is an opportunity to bring together Indigenous peoples and cultures from around the world to embrace a collaborative approach and learn from Indigenous leadership in ocean conservation.

Join thousands of marine protected area professionals from around the world to chart a course towards protecting 30% of the ocean by 2030. Learn about traditional marine protection practices and innovative sustainability initiatives from local and international indigenous experts.

Sharks International Conference 2022 (SI2022)
October 10 – 14, 2022
(online virtual conference)
October 20 – 22, 2022 (physical in-person conference)
Valencia, Spain
si2022.org

The hugely successful Sharks International conference is coming to Europe in 2022! Between October 10-22 the world's largest international shark conference will bring together a strong community of shark and ray researchers, communicators, and advocates. All in the name of addressing the challenges of elasmobranch conservation. The conference will be hosted by the Shark Trust, SUBMON, and L'Oceanogràfic and includes five online days leading up to a three-day physical event at L'Oceanografic Aquarium in Valencia, Spain. If your work involves sharks and you want to be part of the discussion, please sign up to the SI2022 portal, which will soon begin shaping the conference through videos, podcasts, and community discussion.

IUCNSSG.org
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twitter.com/IUCNShark
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youtube.com/user/IUCNSSG
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