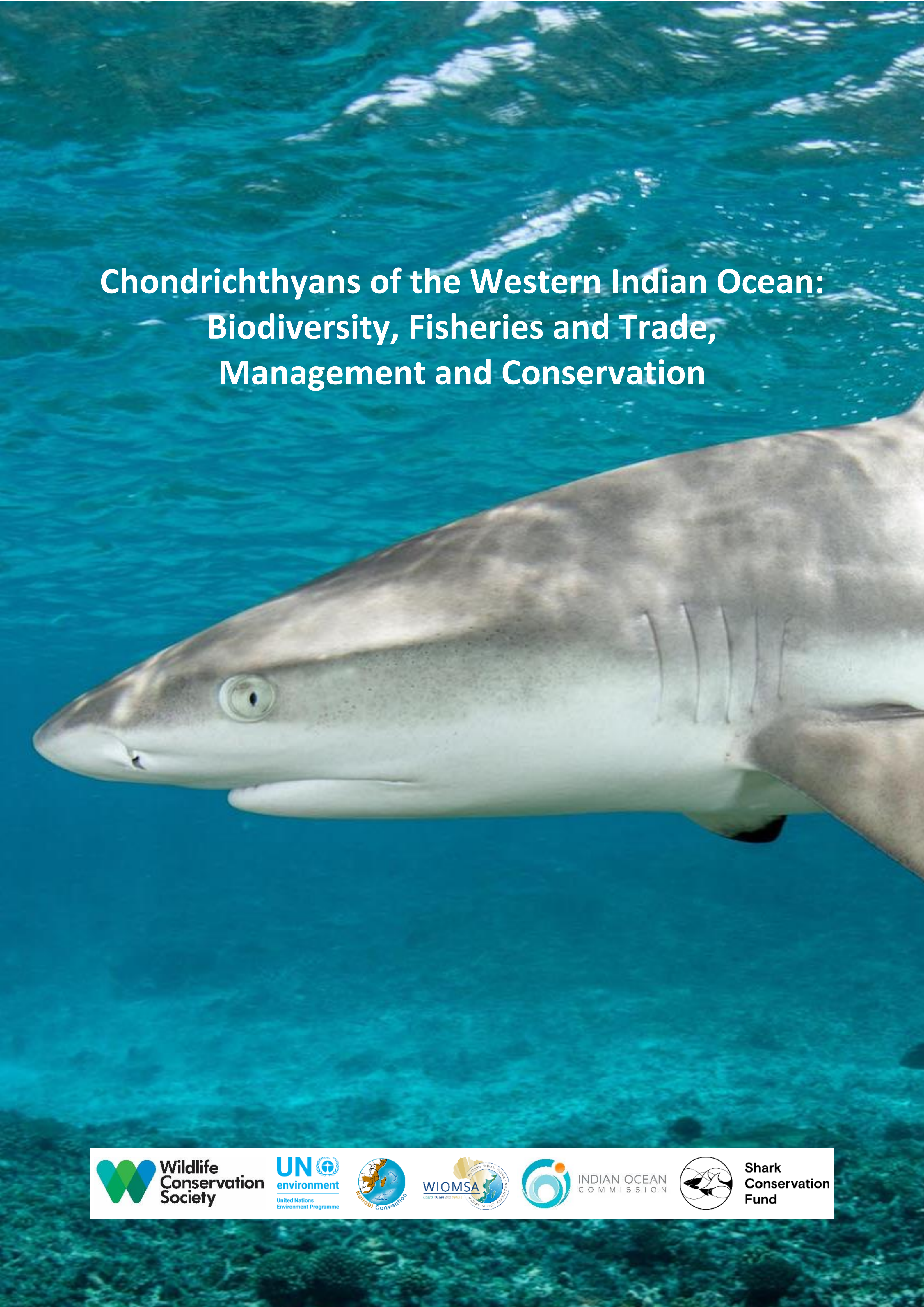
Chondrichthyans of the Western Indian Ocean: Biodiversity, Fisheries and Trade, Management and Conservation



Wildlife Conservation Society
UN environment
United Nations Environment Programme
Nairobi Convention
WIOMSA
Indian Ocean Commission
Shark Conservation Fund

Chondrichthyans of the Western Indian Ocean: Biodiversity, Fisheries and Trade, Management and Conservation

A Status Report prepared by the Wildlife Conservation Society for the Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region

October 2022

Disclaimer

The views expressed in this report do not necessarily reflect those of the Wildlife Conservation Society (WCS), the Nairobi Convention Secretariat, nor any of the Parties or institutions represented by the authors and contributors.

The designation of geographical entities in this report and the presentation of the material do not imply the expression of any opinion whatsoever on the part of WCS, the Nairobi Convention Secretariat, or any of the report's authors or their organizations, concerning the legal status of any country, territory, or area, or its authorities, or concerning the delimitation of its frontiers or boundaries.

Where the designation "country or area" appears in this report, it covers countries, territories, or areas.

Contacts

Dr. Rhett Bennett
Program Manager
Western Indian Ocean Shark and Ray Conservation Program
Wildlife Conservation Society
Grahamstown, South Africa
Email: rbennett@wcs.org

David van Beuningen
Associate Conservation Biologist
Western Indian Ocean Shark and Ray Conservation Program
Wildlife Conservation Society
Cape Town, South Africa
Email: dvanbeuningen@wcs.org

Markus Bürgener
Senior Program Officer
TRAFFIC East/Southern Africa
Cape Town, South Africa
Email: markus.burgener@traffic.org

Suggested citation

Bennett RH, van Beuningen D, Bräutigam A, Bürgener MCR, Bladon A, Kiszka JJ, Leeney RH, Okes N, Samoilys M. 2022. *Chondrichthyans of the Western Indian Ocean: Biodiversity, Fisheries and Trade, Management and Conservation.* A Status Report prepared by the Wildlife Conservation Society for the Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region. Wildlife Conservation Society, New York: 339 pp, 2 appendices. https://doi.org/10.19121/2022.Report.44805

ISBN: 978-0-9903852-8-8

DOI: https://doi.org/10.19121/2022.Report.44805

Cover photograph: Blacktip reef shark *Carcharhinus melanopterus*, Seychelles. Photograph taken by Dr Ryan Daly – Save Our Seas Foundation.

Foreword

Executive Summary

Chondrichthyans (sharks, rays and their relatives) are a diverse group of fishes, comprising approximately 1,280 species globally. As apex and mesopredators, as well as prey for larger species, they form important components of marine ecosystems. They are also of great socioeconomic importance, as they are heavily targeted globally due to the high value of their meat, livers, fins, gill plates, teeth and liver oil. Owing to their life history characteristics of slow growth, late age at maturity and relatively few offspring, most chondrichthyan populations are highly susceptible to exploitation. Consequently, overfishing and other threats have led to chondrichthyans becoming one of the most threatened groups globally, with one third of the world's chondrichthyan species now classified globally as threatened (i.e., categorised as Vulnerable, Endangered or Critically Endangered) according to the Red List of Threatened species, published by the International Union for the Conservation of Nature, meaning that these species face a high to extremely high risk of extinction in the wild.

The Western Indian Ocean (WIO) is known for its rich marine biodiversity and encompasses a global hotspot for chondrichthyan diversity and endemism, with over 220 chondrichthyan species confirmed. In most WIO countries, fisheries are extensive, including domestic artisanal, commercial and industrial fisheries, foreign fleets through fishing rights agreements, and illegal, unregulated and unreported (IUU) fishing. There is intense fishing pressure on chondrichthyan species and, although they are taken as bycatch in many fisheries, chondrichthyan species comprise important targets in most fisheries due to a high demand for meat for local consumption and export, and for the high value trade in the fins of sharks and shark-like rays. As such, 89 (40%) of the chondrichthyan species confirmed in the WIO are currently classified as threatened by the IUCN. Sustainable utilization of these resources is thus paramount, and both a social and ecological issue.

However, data regarding chondrichthyan catches is limited, with most fisheries being poorly monitored and total catches unknown. Furthermore, there is limited legislation in most WIO countries for the effective management of chondrichthyan species. This is unfortunate, as many of the threats facing chondrichthyans were noted several decades ago. At a global level, this led to the development by the Food and Agriculture Organization (FAO) of the United Nations, in 1999, of an International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks), a guiding instrument that was established to ensure the conservation and long-term sustainable use of shark (and other chondrichthyan) resources. The IPOA-Sharks advocates that States responsible for the mortality of sharks, or in whose waters sharks are fished, should each adopt a national plan of action for the conservation and management of their shark stocks, based on the principle that States that contribute to fishing mortality on a species or stock should participate in its management.

In response to these issues, and due to the regional remit and convening role of the Nairobi Convention (*Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region*) for the management of East African coastal resources, chondrichthyan species and their conservation and management needs were recognized at the seventh Conference of the Parties to the Nairobi Convention (CoP7), held in Maputo, Mozambique, in December 2012. At this CoP, Decision CP7/12[1] called for regional collaboration on the conservation and management of sharks, in addition to the preparation of a Regional Status Report on the state of knowledge on sharks (understood to include all chondrichthyans) in the WIO. This Report was developed in response to that call, and presents the current status of knowledge on the biodiversity, fisheries, trade, policy, legislation and threats, as they relate to chondrichthyan species, within the WIO.

[1] *"Decision CP7/12: Conservation of Sharks*

1. To call for regional collaboration, in consultation with the Secretariats of the Convention on International Trade in Endangered Species, Convention on Migratory Species, regional fisheries management organizations and other partners, on the conservation and management of sharks.

2. Request the Secretariat in collaboration with the Contracting Parties to prepare a regional status report on the state of sharks especially on matters of institutional, legal and capacity and report to the next Conference of Parties."

Overall, the Report reveals the main threats facing chondrichthyans in the Nairobi Convention area of the WIO to include: overexploitation and excessive mortality of chondrichthyan (particularly threatened) species; inadequate national-level policy and legislation in most countries; inadequate protection afforded by existing Marine Protected Areas (MPAs) throughout the WIO; poor implementation of management and conservation measures defined under Multilateral Environmental Agreements (MEAs); high levels of illegal, unreported and unregulated (IUU) chondrichthyan fishing and trade (facilitated by poor levels of compliance with and enforcement of existing regulations); inadequate species-level catch data (across most fisheries) and inadequate biological and ecological knowledge to support necessary management improvements; and limited capacity and awareness for effective chondrichthyan conservation and management.

The Report addresses biodiversity, fisheries, trade and policy within the WIO, with a chapter covering these aspects at national level for each of the ten Nairobi Convention Member States.

The final chapter presents an overview of the major threats facing chondrichthyans, and details required and recommended actions that should be taken or considered by all ten States, for improved chondrichthyan management in the WIO. The primary and overarching action needed for improved chondrichthyan management and conservation in the WIO is to reduce mortality levels, particularly those of threatened species whose populations are declining. This links to the six key areas identified within the Report, which require improvement in order to improve chondrichthyan management and conservation in the WIO (see Table 7.1 and section 7.4, for more detail on required actions).

The key recommended actions include:

- **strengthening management and conservation measures** to reduce chondrichthyan mortality (e.g., implementing direct measures to decrease mortality, amending MPA planning to increase conservation benefits to chondrichthyans, and implementing actions recommended through global fisheries management guiding instruments (including binding and voluntary commitments under MEAs).
- **strengthening policy and legislation**;
- **improving compliance and enforcement**;
- **improving data collection and reporting**, particularly fishery data, and knowledge on WIO chondrichthyans;
- **strengthening national and regional capacity**;
- **improving awareness and communication** of the threat status and management needs of chondrichthyans in the WIO.

Nairobi Convention Member States are all Party to the Convention on Biological Diversity (United Nations 1992) and are thus committed to implementing the Aichi Biodiversity targets which include *inter alia* sustainable management and harvesting of all fish stocks[2], conserving a minimum proportion of coastal and marine (particularly biologically important) areas[3], and improving the conservation status of threatened species[4] (CBD Secretariat 2010). These Aichi target actions therefore align well with actions proposed in the current report, for improved chondrichthyan management and conservation in the WIO.

[2] Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use; Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

[3] Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity; Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

[4] Strategic Goal C; Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Authors and Acknowledgements

This report has been compiled by an evolving team of experts working with several organizations committed to the conservation of sharks and rays and the conservation and sustainable development of the Western Indian Ocean Region. Over the course of compilation of this report, the authors and editors have drawn on the expertise and input of a wide range of contributors – scientists, fisheries experts, policy experts, resource managers, technicians, conservationists, Nairobi Convention Focal Points and others – listed below.

Authors:

Rhett Bennett, Wildlife Conservation Society
David van Beuningen, Wildlife Conservation Society
Amie Bräutigam, formerly Wildlife Conservation Society
Markus Bürgener, TRAFFIC East/Southern Africa
Annabelle Bladon, former Consultant to Wildlife Conservation Society
Jeremy Kiszka, Florida International University
Ruth Leeney, Protect Africa's Sawfishes
Nicola Okes, TRAFFIC East/Southern Africa
Melita Samoilys, CORDIO East Africa

Editors:

Rhett Bennett and David van Beuningen

Contributors and Reviewers, in alphabetical order by surname:

The following individuals are acknowledged for their valuable contributions to the preparation of the Report, such as sharing of data or knowledge, responding to questionnaires, fact-checking, and facilitation of the preparation of sections of text. Individuals marked with an asterisk are acknowledged for providing valuable technical reviews of certain chapters, country profiles or the full report:

- Aly Bachiry Adhouhouri, Centre Nationale de Recherches Océanographiques (Madagascar)
- Said Ahamada, Indian Ocean Commission Biodiversity Programme (Mauritius)
- Mohamud Hassan Ali, Federal Ministry of Fisheries and Marine Resources (Somalia)
- David Ardill*, Independent Fisheries Consultant (Mauritius)
- Monica Barone*, Food and Agriculture Organization (Italy)
- Stephen Berbera, Berbera Port Authority (Somalia)
- Jude Bijoux, Seychelles Fishing Authority (Seychelles)
- Gillian Braulik, Private Researcher (Tanzania)
- Isabel Chauca, Instituto Oceanográfico de Moçambique (Mozambique)
- Alison Clausen, formerly Wildlife Conservation Society (Madagascar)
- Geremy Cliff, Kwa-Zulu Natal Sharks Board (South Africa)
- Hugo Costa, Wildlife Conservation Society (Mozambique)
- Ryan Daly, formerly Port Elizabeth Museum at Bayworld and Rhodes University (South Africa)
- Charlene da Silva*, Department of Forestry, Fisheries and Environment (South Africa)
- Isabel Marques da Silva, Universidade Lúrio (Mozambique)

- Tim Davenport, Wildlife Conservation Society Tanzania Program (Tanzania)
- Matthew Dicken, KwaZulu-Natal Sharks Board and Nelson Mandela Metropolitan University (South Africa)
- Dave Ebert, Pacific Shark Research Center (USA)
- Sean Fennessy*, Oceanographic Research Institute (South Africa)
- Stela Fernando*, Instituto Oceanográfico de Moçambique (Mozambique)
- Arnault Gauthier*, Centre Sécurité Requin (La Réunion)
- Sarah Glaser*, formerly One Earth Future (USA)
- Rodney Govinden, Seychelles Fishing Authority (Seychelles)
- David Guyomard, Comité Régional des Pêches Maritimes et des Élevages Marins de La Réunion (La Réunion)
- Frances Humber, Blue Ventures (United Kingdom)
- Nigel Hussey, University of Windsor (Canada)
- Sebastien Jaquemet*, Université de la Réunion (La Réunion)
- Narriman Jiddawi, Institute for Marine Sciences, University of Dar es Salaam (Zanzibar)
- Boaz Kaunda-Arara, University of Eldoret (Kenya)
- Baraka Kuguru*, Tanzania Fisheries Research Institute (Tanzania)
- Benedict Kiilu, Kenya Fisheries Service (Kenya)
- Sarah Markes, Wildlife Conservation Society (Tanzania)
- Hakim Davis Matola, Tanzania Fisheries Research Institute (Tanzania)
- Sónia Ricardo Muando, Centro de Pesquisa do Ambiente Marinho e Costeiro (Mozambique)
- Elizabeth Mueni, Kenya Fisheries Service (Kenya)
- Nyawira Muthiga*, Wildlife Conservation Society Kenya Program (Kenya)
- Stephen Ndegwa, Kenya State Department of Fisheries (Kenya)
- John Nevill*, Environment Seychelles (Seychelles)
- Clay Obota, CORDIO East Africa (Kenya)
- Remy Oddenyo*, Wildlife Conservation Society Kenya Program (Kenya)
- Simon Pierce, Marine Megafauna Foundation (Mozambique)
- Chris Poonian, Community Centered Conservation (C3) (United Kingdom)
- Vola Rakotonjanahary, Ministère des Ressources Halieutiques et de la Pêche (Madagascar)
- Ravaka Ranaivoson, Wildlife Conservation Society (Madagascar)
- Christelle Razafindrakoto, Wildlife Conservation Society (Madagascar)
- David Rowat, Seychelles Marine Conservation Society (Seychelles)
- Abdirahim Ibrahim Sheik Heile*, Ministry of Fisheries and Marine Resources (Somalia)
- Jorge Sitoe, Wildlife Conservation Society (Mozambique)
- Jadiyde Solonomenjanahary*, Ministry of Environment (Madagascar)
- Trishna Sooklall, Albion Fisheries Research Centre (Mauritius)
- Marc Soria, Institut de Recherche pour le Développement (France)
- Hamidou Soulé*, University of Comoros (Comoros)
- Arthur Tuda*, Western Indian Ocean Marine Science Association (Zanzibar)
- Nina Wambiji, Kenya Marine and Fisheries Research Institute (Kenya)
- Luke Warwick*, Wildlife Conservation Society (USA)
- Sabine Wintner, formerly KwaZulu-Natal Sharks Board (South Africa)
- Oliver Wright, TRAFFIC East/Southern Africa (South Africa)

Acknowledgements

WCS, the authors and the editors would like to acknowledge and record appreciation for the collaboration and support of the Nairobi Convention Secretariat and Member State Focal Points, the Indian Ocean Commission (IOC) and the Western Indian Ocean Marine Science Association (WIOMSA), in the development and finalization of this report and broader collective efforts to advance the conservation and sustainable use of sharks and rays in the Western Indian Ocean region.

The authors acknowledge UNEP-Nairobi Convention and WIOMSA for the use of and access to the marine protected area (MPA) shapefiles of the Western Indian Ocean MPA Outlook[5] and its associated database[6] (UNEP-Nairobi Convention and WIOMSA 2021a, b).

Aspects of the preparation of the report were supported through funding from the Indian Ocean Commission Biodiversity Programme and the Shark Conservation Fund (a philanthropic collaborative pooling expertise and resources to meet the threats facing the world's sharks and rays; The Shark Conservation Fund is a project of Rockefeller Philanthropy Advisors).

[5] UNEP-Nairobi Convention and WIOMSA. 2021a. Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets. UNEP and WIOMSA, Nairobi, Kenya, 298 pp.

[6] UNEP-Nairobi Convention and WIOMSA. 2021b. Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets. WIO MPA Database version August 2021 UNEP, WIOMSA, and Macquarie University.

Table of Contents

Abbreviations and Acronyms

ABNJ	Areas Beyond National Jurisdiction
AFRC	Albion Fisheries Research Centre
ANAC	Administração Nacional de Áreas de Conservação (Mozambique)
ASCLME	Agulhas and Somali Current Large Marine Ecosystems Project
BMU	Beach Management Unit
BRD	Bycatch Reduction Device
BRUV	Baited Remote Underwater Video
BYCAM	Bycatch Assessment and Mitigation in West Indian Ocean Fisheries (WIOMSA Project)
CCPs	Contracting and Co-operating Non-contracting Parties (with regards to SIOFA)
CEPAM	Centro de Pesquisa do Ambiente Marinho e Costeiro (Mozambique)
CFMA	Collaborative Fishery Management Area
CFP	(EU) Common Fisheries Policy
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLAS	Complexe des lacs Ambondro et Sirave (Madagascar)
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CNRO	Centre Nationale de Recherches Océanographique
CNRS	Centre National de la Recherche Scientifique (France)
COFI	FAO Committee on Fisheries
CoP	Conference of the Parties (Member States of a treaty)
CORDIO	Coastal Oceans Research and Development in the Indian Ocean
CPCs	Contracting Parties and Cooperating Non-Contracting Parties (with regards to IOTC)
CR	Critically Endangered – as per *IUCN Red List of Threatened Species*
CRPMEM	Comité Régional des Pêches Maritimes et des Élevages Marins (La Réunion)
CSP	Centre de Surveillance des Pêches (Madagascar)
DAFF	Department of Agriculture, Forestry and Fisheries (South Africa)
DD	Data Deficient – as per *IUCN Red List of Threatened Species*
DEA	Department of Environmental Affairs (South Africa)
DEAL	Direction de l'Environnement, de l'Aménagement et du Logement (La Réunion)
DGF	Direction Générale des Forêts (Madagascar)
DGM	Direction Générale de la Mer (Madagascar)
DGRHP	Direction de la Pêche et de l'Aquaculture (Madagascar)
DMSOI	Direction de la Mer Sud Océan Indien (France)
DNRH	Direction National des Ressources Halieutiques (Union des Comores)
DSFA	Deep Sea Fishing Authority (Tanzania)
EN	Endangered – as per *IUCN Red List of Threatened Species*
EEZ	Exclusive Economic Zone
EU	European Union
aFAD	anchored Fish Aggregating Device
FAD	Fish Aggregating Device
FAO	Food and Aquaculture Organization of the United Nations
FGS	Federal Government of Somalia
FMC	Fisheries Monitoring Centre (Seychelles)
FPA	Fisheries Partnership Agreement
FPS	Fisheries Protection Service (Mauritius)
IDEPA	Instituto Nacional de Pesca e Desenvolvimento da Aquicultura (Mozambique)

IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer
IIP	Instituto Nacional de Investigação Pesqueira (Mozambique)
INIP	Unidade Nacional de Inspeção de Peixes (Mozambique)
IOC	Indian Ocean Commission
IOTC	Indian Ocean Tuna Commission
IPOA-Sharks	(FAO) International Plan of Action for the Conservation and Management of Sharks
IRD	Institut de Recherche pour le Développement (France)
ITC	International Trade Centre (of United Nations and World Trade Organization)
IUCN	International Union for the Conservation of Nature
IUU	Illegal, Unreported and Unregulated
KeFS	Kenya Fisheries Service
KES	Kenya Shilling
KMFRI	Kenya Marine and Fisheries Research Institute
KZN	KwaZulu-Natal (Province of South Africa)
KZNSB	KwaZulu-Natal Sharks Board
LC	Least Concern – as per *IUCN Red List of Threatened Species*
LME	Large Marine Ecosystem
LMMA	Locally Managed Marine Area
MADE	Mitigating Adverse Ecological impacts of open ocean fisheries (European Commission)
MALNF	Ministry of Agriculture, Livestock, Natural Resources and Fisheries (Tanzania)
MCC	Maritime Coordination Committee (Somalia)
MCS	Monitoring, Control and Surveillance
MEA	Multilateral Environmental Agreement
MEE	Ministry of Environment and Energy (Seychelles)
MEEMF	Ministère de l'Environnement, de l'Ecologie et des Forêts (Madagascar)
MIMAIP	Ministério do Mar, Aguas Interiores e Pesca (Mozambique)
MITADER	Ministério do Terra, Ambiente e Desenvolvimento Rural (Mozambique)
MLFD	Ministry of Livestock and Fisheries Development (Tanzania)
MoEMRFS	Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (Mauritius)
MoFMR	Ministry of Fisheries and Marine Resources (Somalia)
MoP	Ministry of Planning (Somalia)
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MPRH	Ministère des Ressources Marines et de la Pêche (Madagascar)
MLRA	Marine Living Resources Act (South Africa)
MSCC	Maritime Security Coordination Committee (Somalia)
NCMS	Nairobi Convention Member State(s)
NDF	Non-Detriment Finding (under CITES)
NEI	Not Elsewhere Included
NEMA	National Environmental Management Authority (Kenya)
NES	Not Elsewhere Specified
NPCS	National Parks and Conservation Service (Mauritius)
NPOA	National Plan of Action (under FAO International Plan of Action)
NE	Not Evaluated – as per *IUCN Red List of Threatened Species*
NT	Near Threatened – as per *IUCN Red List of Threatened Species*
ORI	Oceanographic Research Institute (South Africa)
ORI-CFTP	Oceanographic Research Institute’s Cooperative Fish Tagging Project
PSMA	Port State Measures Agreement

PUCL	Precautionary Upper Catch Limit
REPMAR	Regulamento geral da Pesca Marítima (Mozambique)
RFB	Regional Fishery Body
RFMO	Regional Fisheries Management Organization
RPOA	Regional Plan of Action (under FAO International Plan of Action)
SADC	Southern Africa Development Community
SAR	Special Administrative Region (of the People's Republic of China)
SDF&BE	State Department of Fisheries and Blue Economy (Kenya)
SEAO	Southeast Atlantic Ocean
SFA	Seychelles Fishing Authority
SIOFA	Southern Indian Ocean Fisheries Agreement
SNPA	Seychelles National Parks Authority
SMRSS	Somali Maritime Resource and Security Strategy
SSG	Shark Specialist Group of IUCN Species Survival Commission
Sharks MOU	(CMS) Memorandum of Understanding on the Conservation of Migratory Sharks
SIOFA	South Indian Ocean Fisheries Agreement
SWIO	Southwest Indian Ocean
SWIOFC	Southwest Indian Ocean Fisheries Commission
SWIOFish	Southwest Indian Ocean Fisheries Governance and Shared Growth Project (World Bank)
SWIOFP	Southwest Indian Ocean Fisheries Project (under ASCLME Project)
TAC	Total Allowable Catch
TAE	Total Allowable Effort
TAFIRI	Tanzania Fisheries Research Institute
TED	Turtle Excluder Device
TRAFFIC	Trade Records Analysis of Fauna and Flora in Commerce
UCT	University of Cape Town (South Africa)
UN	United Nations
UNESCO-MAB	United Nations Educational, Scientific and Cultural Organization's Man and the Biosphere Programme
UoE	University of Eldoret (Kenya)
VFC	Village Fishing Committee
VMS	Vessel Monitoring System
VU	Vulnerable – as per *IUCN Red List of Threatened Species*
WCS	Wildlife Conservation Society
WIO	Western Indian Ocean (defined in this report as the Nairobi Convention area)
WIOFish	The Western Indian Ocean Fisheries database (developed under the auspices of the IUCN)
WIOMSA	Western Indian Ocean Marine Science Association
WPEB	Working Party on Ecosystems and Bycatch (IOTC)
WWF	World Wide Fund for Nature

CHAPTER 1

Introduction

1.1 Chondrichthyans in the global context

What are chondrichthyans?

Chondrichthyes (or chondrichthyans) is the term referring to sharks, rays and their relatives – species that are characterized by a skeleton made of cartilage, as opposed to a skeleton of bone, as in teleost fishes (or finfish), such as tuna and groupers. The biological diversity of the chondrichthyes group, comprising approximately 1,280 species globally (Last et al. 2016c, Weigmann 2016, Serena et al. 2020, Ebert et al. 2021a), is reflected too in the diversity of habitats used and ecosystem functions provided by this group.

Ecological role of chondrichthyans

Chondrichthyan species form important components of marine ecosystems, acting as apex and mesopredators, as well as prey for larger species (Prugh et al. 2009, Dulvy et al. 2017, Elston et al. 2020). Population declines or their removal from an ecosystem can thus lead to direct or indirect effects on other species or the ecosystem as a whole (Heithaus et al. 2008, 2012, Baum and Worm 2009), although the ecological ramifications remain poorly understood (Grubbs et al. 2016). Conventional knowledge suggests that declines in apex and mesopredators, such as certain shark and batoid species, would cascade (have knock-on impacts) through the entire food web (Myers et al. 2007, Baum and Worm 2009). Recent evidence suggests that such impacts are likely more nuanced, and that the top-down influences and removal of these predators remain uncertain and specific to each ecosystem (Desbiens et al. 2021, Rupp and Bornatowski 2021). Nevertheless, the influence of shark and batoid species on their immediate environment is undeniable, and although trophic cascades are extremely complex to study in natural systems (Rupp and Bornatowski 2021), further research is needed to determine how these interactions manifest at the ecosystem scale.

Global fisheries and trade

Chondrichthyans are captured around the world, both as target species and as incidental catch in fisheries targeting other species (Stevens et al. 2005). Fishing pressure on chondrichthyans is increasing as access to previously targeted teleost species (e.g., tuna and reef fishes) declines, due to depletion and management restrictions (Dulvy et al. 2014). The high values of their meat, livers, fins, gill plates, teeth and liver oil have also encouraged more widespread chondrichthyan targeting (Fowler et al. 2002, Clarke et al. 2006, Lack and Sant 2008, Dent and Clarke 2015, McClenachan et al. 2016, Fields et al. 2018, Pavitt et al. 2021). In particular, over the last two decades, chondrichthyan fins have become some of the most valuable of all seafood commodities, with an estimated value of USD438.6 million in 2011 (Clarke et al. 2007, Dent and Clarke 2015). Global shark mortality is estimated at 63 to 273 million sharks per year, with conservative estimates of ~100 million sharks in 2000 and ~97 million in 2010, with global trade in chondrichthyan products estimated at ~USD1 billion per year (Worm et al. 2013, Dent and Clarke 2015, Davidson et al. 2016).

The state of knowledge on the global market for chondrichthyan products has been the focus of increased research in recent years. Species-specific genetic testing of 4,800 fin samples from a Hong Kong market identified at least 76 different chondrichthyan species in the international fin trade, but with nearly half of all samples from just four species: blue sharks *Prionace glauca,* silky sharks *Carcharhinus falciformis*, shortfin mako sharks *Isurus oxyrinchus* and scalloped hammerhead sharks *Sphyrna lewini* (Fields et al. 2018). Furthermore, for the period 2007 to 2016, the majority of commercial trade in chondrichthyan species listed on the Appendices of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES[7]) comprised meat and fins,

[7] www.cites.org

largely from wild-caught hammerhead sharks (Sphyrnidae) (Pavitt et al. 2021).

Shark fin trading networks appear to be resilient to increased regulation and stock declines and appear to be intensifying in the face of overfishing to ensure that consumer demand continues to be met (Eriksson and Clarke 2015). The current trade in shark fins (and chondrichthyan products in general) is not sustainable, and although management interventions are advancing in response to expanding fisheries, they are often poorly implemented or insufficiently comprehensive to negate population declines (Eriksson and Clarke 2015). Given that chondrichthyans play an important role in global food security, there is an urgent need to shift chondrichthyan fisheries towards sustainability (Bräutigam et al. 2015, Simpfendorfer and Dulvy 2017, Dulvy et al. 2021; Jorgensen et al. 2022).

Global threats and issues

Although chondrichthyans face threats from climate change, ocean acidification, pollution, and habitat loss and degradation (O'Brien et al. 2013, Rosa et al. 2017, Dulvy et al. 2021), fisheries (legal and illegal) are by far the greatest threat faced by chondrichthyans globally (Dulvy et al. 2014, 2021, Pacoureau et al. 2021). Chondrichthyan species are characterized by life histories that are not resilient to disturbances (Cortés 2000), such as slow growth, late maturity and low reproductive rates, making them highly susceptible to overfishing (Worm et al. 2013). Global fishing pressure is estimated to have increased 18-fold over the five decades since 1970, and has led to major population declines of reef-associated shark species, and an estimated 71% decline in abundance of oceanic shark and batoid populations, globally (Pacoureau et al. 2021). However, this is not a new threat – the high levels of chondrichthyan catch and the resulting impacts on their populations were identified as a major cause for concern more than three decades ago. This led the United Nations Food and Agriculture Organization (FAO) to develop an International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) in 1999, which too highlighted overfishing of chondrichthyans as a major threat, in addition to limited knowledge relating to species identification, poor recording of fishing effort, a paucity of information regarding chondrichthyan biology and a lack of species-specific catch, landing and trade data (FAO 1999).

Accurate identification of chondrichthyans to species level is challenging, particularly when they are processed at sea (removal of fins, heads and other parts) (FAO 2000). There is also limited catch and effort data for chondrichthyan species in many fisheries, which combined with poor species-level identification results in inadequate information to conduct reliable fisheries stock assessments for most chondrichthyan species (FAO 2000). Additional issues include taxonomic uncertainty for some species (especially batoids), which complicates management; a dearth of knowledge regarding specific areas critical for chondrichthyans such as mating, aggregation, nursery and parturition areas; lack of coordination among governments to manage transboundary stocks; and poor management and enforcement of existing measures, which is further complicated in areas beyond national jurisdiction (FAO 2000).

A lesser threat facing chondrichthyans is targeted culling to reduce shark-human interactions. Although shark-human interactions are rare – globally there was an average of 80 shark-human interactions per year in the period 2010 to 2019, of which 6.8% were fatal[8] – they can have substantial social, economic and ecological consequences, particularly in areas with high incidences of attacks on humans (Hazin et al. 2008, Lemahieu et al. 2017). Mitigation measures usually include the use of gill nets to reduce coastal shark populations and thus decrease risk (Dudley 1997, Lemahieu et al. 2017), but such measures are indiscriminate and result in high levels of bycatch of non-target chondrichthyans and other marine fauna[9]. More recently, some shark control programs have reduced catches of non-target species by replacing gill nets with drumlines (baited hooks that are more selective for large sharks, with reduced bycatch of smaller sharks and other marine species (e.g., Cliff and Dudley 2011)), or SMART drumlines that allow for the release of bycatch species (Guyomard et al. 2019), while others favour bather awareness over lethal methods (e.g., Engelbrecht et al. 2017).

[8] https://www.floridamuseum.ufl.edu/shark-attacks/yearly-worldwide-summary/

[9] https://shark.co.za/Pages/SharkCatchStats

Alternative economic value of chondrichthyans

Beyond the direct extractive value of chondrichthyans, they also generate economic value through their role in nature-based tourism and recreation, which can improve perceptions towards sharks and facilitate their conservation (Ziegler et al. 2020). Economic benefits of the shark-watching industry have been demonstrated at local and global scales, particularly for great white sharks *Carcharodon carcharias*, basking sharks *Cetorhinus maximus* and whale sharks *Rhincodon typus* (Davis and Tisdell 1999, Topelko and Dearden 2005, Gallagher and Hammerschlag 2011, Cisneros-Montemayor et al. 2013). The value of the shark-diving industry to the economy of Palau was valued at USD18 million per year (Vianna et al. 2010), while the total annual revenue of a shark-feeding activity in French Polynesia was estimated at USD5.4 million, with the 13 sicklefin lemon sharks *Negaprion acutidens* most often observed at the site having an average contribution of around USD316,699 each (Clua et al. 2011). In the Bahamas, where longline fishing was prohibited in 1993 and a shark sanctuary was established in 2011, shark diving generates USD113.8 million annually (Haas et al. 2017).

Cisneros-Montemayor et al. (2013) estimated that ~590,000 shark watchers spend USD314 million per year, globally, directly supporting 10,000 jobs. These authors predicted that the number of shark watchers could more than double by 2033, generating USD780 million in tourist expenditure around the world. Indeed, just whale shark tourism, which currently occurs at 35 sites globally, attracts approximately 980,000 individuals yearly, and generated roughly USD139 million in 2019 (Ziegler and Dearden 2021).

There are also numerous shark-watching operations across the Western Indian Ocean (WIO). In East Africa, USD7.55 million was spent in 2011 by 3,000 shark watchers, employing 331 people (Cisneros-Montemayor et al. 2013). In South Africa, a survey of divers at Aliwal Shoal indicated that the direct value of tiger sharks *Galeocerdo cuvier* to the diving industry in that area was approximately USD924,000 (Dicken and Hosking 2009). Annual shark watching expenditure in South Africa was around USD6.07 million, compared with a USD478,000 landed value, while in 2011 annual shark watching expenditure in Seychelles was USD3.47 million, compared with a USD14,000 landed value (Cisneros-Montemayor et al. 2013). In a localized study of the economic benefits of manta ray *Mobula* spp. tourism in Mozambique, manta-focused tours generated approximately USD10.9 million annually in direct revenue to dive operators in Inhambane Province, with an estimated direct economic impact (including associated tourism expenditures) of USD34.0 million annually (Venables et al. 2016). These authors estimated that between USD16.1 million and USD25.7 million would be lost to the region each year in the absence of manta ray tourism. In Nosy Be, Madagascar, tourist questionnaires and a survey of whale shark tour operators indicated that the three-month whale shark season in 2019 generated USD1.5 million for the local economy (Ziegler et al. 2021). There is thus a strong incentive to promote shark and batoid ecotourism, where possible.

1.2 Chondrichthyans in the Western Indian Ocean

The WIO is known for its rich marine biodiversity, comprising a variety of critical habitat types such as estuaries, mangroves, salt marshes, seagrass beds, sandy shores, rocky shores and reefs, coral reefs, the continental shelf and deep-sea environments (Schleyer 2015). These habitats support a diverse range of species, with the WIO (and particularly the SWIO) being considered a global hotspot for chondrichthyan diversity (Dulvy et al. 2014), with 224 species recorded to date (~18% of all known chondrichthyan species). This rich diversity includes at least 135 shark species, 80 batoid species and 9 chimaera species (Sommer et al. 1996, Fricke et al. 2009, 2018, Anam and Mostarda 2012, Ebert 2013, 2014a, Wickel et al. 2014, Ebert and van Hees 2015, Nevill et al. 2015, Last et al. 2016c, Ebert et al. 2021a). Owing to the lineages present, the WIO is considered a global hotspot for chondrichthyan evolutionary distinctiveness (Dulvy et al. 2014, Stein et al. 2018). There is also a considerable level of endemicity among chondrichthyan species in the WIO, which, together with the high species richness, gives the WIO chondrichthyans a high irreplaceability index (Stein et al. 2018, Derrick et al. 2020).

Approximately 50 chondrichthyan species are endemic to the region, and some to a single country. Despite the diversity of species and global importance of the WIO region for chondrichthyans, there is limited biological and ecological information on most chondrichthyan species, particularly in relation to other regions in the world (Ducatez 2019), and limited information on how they are impacted by fisheries.

In most WIO countries, fisheries are extensive, with a range of fishing gears used in domestic artisanal, commercial and industrial fisheries, and from foreign fleets through fishing rights agreements, and through illegal, unregulated and unreported (IUU) fishing (Kiszka and van der Elst 2015). These fisheries exert considerable effort on coastal resources. There is intense fishing pressure on chondrichthyan species and, although they are sometimes taken as bycatch, they comprise important targets in most fisheries due to a high demand for shark meat for local consumption and export. Chondrichthyan fins are also in huge demand in the WIO for the global shark fin trade, especially for Critically Endangered wedgefishes *Rhynchobatus* spp. and scalloped hammerhead sharks *Sphyrna lewini*, whose fins are considered high value (Dent and Clarke 2015). In recent years, there has also been a growing demand for the gill plates of mobulid rays for the Asian market and other chondrichthyan products, such as shark livers for oil, particularly for pharmaceutical products (Samoilys et al. 2015).

Human population growth in the WIO is among the highest in the world, with over a quarter residing within 100 km of the coast (Obura et al. 2017). There is also evidence of human migrations towards and among coastal areas in search of improved food security and livelihoods (Barnes-Mauthe et al. 2013). Human population growth in the WIO will lead to an increased demand for marine resources, including chondrichthyan products. The resulting pressure from artisanal fisheries, scaled across the WIO, could pose a comparable (if not larger) threat than industrial fishing fleets (Pollom et al. in prep.). Sustainable utilization of these resources is thus paramount, and as much a social issue as it is an ecological issue. However, there are currently limited data on the catches of chondrichthyans (especially at species level), most fisheries are poorly monitored and total catches are unknown (Worm et al. 2013). There is also limited legislation in most WIO countries for the protection and management of chondrichthyan species, which should be addressed as a matter of urgency.

1.3 Conservation status of chondrichthyan species

Assessing the conservation status of species

The International Union for the Conservation of Nature Red List of Threatened Species (IUCN Red List) categorises species according to factors such as their population trends and threats faced (such as fishing impacts). The Red List categories of Vulnerable, Endangered and Critically Endangered are considered “threatened” categories, and include species facing a high to extremely high risk of extinction in the wild (IUCN 2019). While the IUCN categories impose no regulatory actions on governments, they provide an objective assessment of the status of each species as defined by global experts and the best available scientific information. They therefore provide a useful benchmark for management authorities, when developing species-level management measures. The precautionary approach suggests that the harvesting of threatened species should be regulated or avoided.

Global conservation status of chondrichthyans

The timing of this report has quite fortunately coincided with the conclusion of a global project to conduct first or revised IUCN Red List assessments for all chondrichthyan species globally, with a series of new assessments being published over the past three years; some as recently as September 2021 (Dulvy et al. 2021). The conservation status information presented in this report is therefore up to date, as of September 2021.

Globally, a total of 1,199 chondrichthyan species (of an estimated global species count of 1,280) were recently assessed or re-assessed. These assessments place 391 (32.6%) of the world’s chondrichthyan species within one of the three threatened categories, implying that these species face a high to extremely high risk of extinction in the wild (Dulvy et al. 2021, IUCN 2021).

This is a considerable increase in the proportion of threatened chondrichthyans, from 24%, over just seven years (Dulvy et al. 2014). The single most common threat identified as the cause of these population declines, and identified as a primary (or the only) threat for every one of these 391 species, is overfishing (Dulvy et al. 2021). Furthermore, within the oceanic sharks and batoids, three-quarters are considered threatened with extinction (Pacoureau et al. 2021). Oceanic sharks and batoids tend to be migratory, which complicates their management as they are vulnerable to fisheries in the waters of multiple countries (Barkley et al. 2019). Coastal chondrichthyans are also under immense pressure from fisheries. A global baited remote underwater video (BRUV) survey, which comprised more than 15,000 samples on 371 reefs in 58 countries, revealed that 20% of reefs surveyed had no sharks present, with reefs in some nations having no sharks recorded at all (MacNeil et al. 2020). These findings highlight the considerable impact that global fisheries are having on chondrichthyan populations, and the need for improved management controls and species protections.

Conservation status of chondrichthyan species in the Western Indian Ocean

Chondrichthyans have been targeted in several WIO countries for more than a century (Marshall and Barnett 1997). Owing to overfishing and other human impacts, the stocks of numerous WIO chondrichthyan species have declined dramatically (Pollom et al. in press, Dulvy et al. 2014, Kiszka and van der Elst 2015, MacNeil et al. 2020), with the WIO now considered a global "darkspot" in terms of the number of imperilled chondrichthyan species (Davidson and Dulvy 2017). The global assessment of shark abundances on coral reefs indicated major population declines in many reef-associated shark species, particularly in parts of the WIO (MacNeil et al. 2020).

Following the recent global revision of chondrichthyan IUCN Red List statuses (Dulvy et al. 2021, IUCN 2021), the situation in the WIO is in fact worse than that at the global scale, as 89 (40%) of the 224 species of chondrichthyans in the WIO are now considered threatened. These include 13 (6%) Critically Endangered, 32 (14%) Endangered and 44 (20%) Vulnerable species. This represents a near doubling from 45 threatened species (20% of the WIO chondrichthyan species), over the past five to ten years. Among the threatened species, five are endemic to the WIO (representing 10% of endemic WIO chondrichthyan species), including the greyspot guitarfish *Acroteriobatus leucospilus,* Madagascar skate *Dipturus crosnieri*, honeycomb catshark *Holohalaelurus favus*, African spotted catshark *H. punctatus* and shorttail nurse shark *Pseudoginglymostoma brevicaudatum*.

In addition, 37 species in the WIO (17%) are classified as Data Deficient by the IUCN, i.e., there is inadequate information to make a direct or indirect assessment of the species' risk of extinction, and a further six species (3%) have not yet been evaluated (IUCN 2021). Considering the extensive fishing pressure in the region, it is possible that at least some of these 43 Data Deficient and Not Evaluated species would be placed in a threatened category, if adequate data were available for an IUCN assessment. There is thus a critical need for improved knowledge (in particular through fisheries monitoring of catches at species level, and quantification of mortality levels), corrective management, reduced mortality rates and improved conservation of the chondrichthyan species in the WIO, particularly those that are threatened or likely to become threatened.

The chondrichthyan families most at risk in the WIO include the Pristidae (sawfishes), Rhinidae (wedgefishes), Myliobatidae (eagle rays), Sphyrnidae (hammerhead sharks), Mobulidae (manta and devil rays), Lamnidae (great white and mako sharks) and Alopiidae (thresher sharks). The most threatened species are generally either impacted by both inshore (mainly artisanal) and offshore (mainly industrial) fisheries (Dulvy et al. 2014), such as hammerhead sharks, or are targeted for specific body parts, such as the wedgefishes for their highly valued fins and manta and mobula rays for their gill plates. All of these species have low resilience to overexploitation, and should be prioritized for WIO regional conservation efforts.

1.4 Chondrichthyan conservation instruments

Addressing chondrichthyan conservation globally

There is global concern over levels of chondrichthyan fishing mortality and the consequent declines in chondrichthyan abundance in many areas of the world. The distribution ranges of most chondrichthyan species straddle multiple jurisdictions, and many species targeted or caught as bycatch in fisheries are migratory (Fowler 2014). Chondrichthyan species are thus largely transboundary resources that supply national, regional and global markets, and their conservation and management are complicated by the need for multilateral approaches, including coordinated fisheries management measures and trade controls at exporting and importing points along the product value chain. Considering the threats to chondrichthyan species globally, several multilateral environmental agreements (MEAs) now consider chondrichthyan species for multilateral management, protection or trade regulation, and several guiding documents have been developed to guide effective management of these species (see Chapter 5).

Among the many MEAs concerned with the management of populations of wild animals, CITES was developed to ensure that international trade in animal and plant products is not detrimental to their survival. The Convention lists several Appendices of species that are subjected to international trade controls. The *Convention on the Conservation of Migratory Species of Wild Animals* (CMS[10]) provides a global platform for the conservation and sustainable use of migratory animals and their habitats. The Convention provides a legal foundation for internationally coordinated conservation measures for migratory species, through the listing on specific Appendices of species that require protection or coordinated multilateral management. Numerous chondrichthyan species are now listed on the Appendices of CITES and CMS, thus increasing the mandate of governments to address the conservation and management needs of these species, through improved protections and trade regulation.

Addressing chondrichthyan conservation in the Western Indian Ocean

Within the Indian Ocean, in addition to the global MEAs to which most WIO nations are members, there are several regulatory environmental bodies that were established specifically for the management of natural resources, including coastal and fishery resources in the WIO or Indian Ocean regions. Two of the main conservation and management instruments that could drive the improved conservation of chondrichthyan species in the WIO, and the sustainability of their fisheries, are briefly mentioned below.

The *Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region* (Nairobi Convention[11]) is a Regional Seas Programme of the United Nations Environment Programme. The Convention provides a policy framework for Member States, for the coordination of management and development of the coastal and marine environments of Eastern Africa[12]. The Convention's *Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* includes several species Annexes, to inform resource managers of Member States which species warrant management or legal protection at national level. While no chondrichthyan species are currently listed on these annexes, the Protocol and its annexes are to be reviewed, numerous chondrichthyan species have been proposed for inclusion, and the Member States now recognize the conservation and management needs of chondrichthyan species in the WIO.

The *Indian Ocean Tuna Commission* (IOTC[13]) is an intergovernmental regional fisheries management organization (RFMO) responsible for the management of tuna and tuna-like species in the Indian Ocean. However, the Commission also addresses the issues of bycatch in these fisheries, and has therefore developed and imposed regulations on its Party States relating to the fishing, handling, retention and reporting of selected chondrichthyan species that are considered to be under threat from the IOTC-linked fisheries directed at tuna and tuna-like species.

---

[10] www.cms.int

[11] www.unep.org/nairobiconvention/

[12] The "Convention area" shall be comprised of the marine and coastal environment of that part of the Indian Ocean situated within the Eastern African region and falling within the jurisdiction of the Contracting Parties to this Convention (UNEP 1985, Article 2(a)).

[13] www.iotc.org

Chondrichthyan management needs in the Western Indian Ocean

The global decline in the populations of many chondrichthyan species (MacNeil et al. 2020, Dulvy et al. 2021, Pacoureau et al. 2021) means that improved management is critical. Regulatory and spatial measures that reduce fishing impacts and mortality on chondrichthyans are urgent (Dulvy et al. 2021). The listing of threatened chondrichthyan species under global MEAs, and specific regulations adopted by RFMOs, provide at least the first step towards regulatory improvements for the effective management of threatened taxa. While the IUCN Red List categories carry no legal requirement for action, the regulations and protective measures for threatened species imposed by CMS, CITES and the IOTC are legally binding on Member States, and should thereby guide the development of the national legal frameworks for improved management.

The WIO is home to 27 (57%) of the 47 chondrichthyan species that are listed on Appendix I or Appendix II[14] of CITES – species that are considered to be in need of trade controls due to the impacts that harvesting and international trade have on their populations. The region also has 25 (68%) of the 37 chondrichthyan species listed on Appendices I and II[15] of CMS – migratory species considered to be threatened throughout their ranges or at greater risk due to movement patterns that span multiple countries and jurisdictions. These listings of such species are a strong reflection of their poor conservation status, and the high levels of threat that they face. However, many States that are signatory to such MEAs and parties to the different RFMOs currently fail to meet these binding commitments, and so fall short in their obligations to implement such multilateral agreements. This is applicable to many WIO States and, indeed, there is generally limited legislation for chondrichthyan species in many WIO countries.

There is thus a need for improved legislation for and management of chondrichthyans at regional and national levels in the WIO, to reduce the impacts of fishing on these threatened species and to improve adherence to the respective MEAs. There is also a need to identify species whose populations within the WIO require stricter management or warrant full protection (in addition to gear- and area-based regulations), and accommodate these species in relevant management texts, at both national and WIO regional levels.

There are also many knowledge gaps regarding WIO chondrichthyans, *inter alia* information on species distribution ranges and population connectivity, aspects of their ecology (e.g., the size at attainment of sexual maturity and locations of ecologically important areas), levels of fishing mortality and many other aspects needed for informed management. Governments should thus encourage and facilitate research towards filling these gaps.

1.5 Rationale for a *Regional Status Report* on chondrichthyans in the Western Indian Ocean

In recognition of increasing global concerns regarding the declining status of chondrichthyans, and in response to the generally limited information available on chondrichthyan species in the WIO region, a global hotspot of chondrichthyan diversity, the Nairobi Convention Member States agreed at their 7th Conference of the Parties (CoP7) held in Maputo, Mozambique, in December 2012, to include sharks (understood to include sharks and batoids) in the Convention's Program of Work for 2013–2017. Specifically, the Parties called for i) the development and implementation of priority projects, including on shark conservation (and including but not limited to financing and management thereof), ii) regional collaboration on the conservation and management of sharks, and iii) the preparation of a regional status report on the state of knowledge on sharks and rays in the WIO. It is in this context that this WIO Regional Status Report was prepared.

This report aims to present the current state of knowledge on sharks and rays in the WIO region, and describe the conservation and management actions

[14] cites.org/eng/app/appendices.php

[15] cms.int/en/page/appendix-i-ii-cms

that are being – and are recommended to be – taken at national and regional levels. The report is not intended to be a comprehensive assessment of sharks and rays in the WIO, but rather to provide an assessment of the current knowledge base, raise awareness of current threats, identify priority aspects and taxa for future research, and provide some recommendations to support improved management, both regionally across the WIO and at national level for the Nairobi Convention Member States. The report addresses aspects including the biodiversity of chondrichthyan species in the WIO, their current conservation status and recent trends therein, fisheries for and trade in chondrichthyan products, the current status of policy implementation for chondrichthyan species (particularly threatened species), and recommendations for improved management and conservation, which are detailed in the chapters that follow.

Along with the Status Report, two other documents were prepared in parallel, to provide support for improved conservation and management and thereby support for the recommendations presented herein. The first of these documents is the *Regional Roadmap for the Conservation and Management of Shark and Ray Species in the Western Indian Ocean*, presented in Appendix A to this Report, intended to provide a guiding document for scientific institutions and fishery management agencies, to fill current knowledge gaps and act as a framework for developing national management plans for improved conservation and management of chondrichthyans.

The second is a list of shark and ray species, proposed for inclusion on the Annexes of the *Nairobi Convention Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* (hereinafter referred to as the Nairobi Convention Protocol). The listing of species on the Nairobi Convention Protocol is intended to provide a legal instrument, in this case a centralized list of species, from which resource managers of Member States can identify shark and batoid species that warrant specific management or legal protection. The document *Recommendations for Shark and Ray Listings in the Annexes of the Nairobi Convention Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* is presented in Appendix B to this Report.

Structure of this Report

This chapter provides a basic context for the development of this Report. In the sections that follow, the Report presents a detailed rationale for the Report and the history of its development (Chapter 2), and overviews of the biodiversity, status of ecological and biological knowledge, conservation status (Chapter 3), fisheries, catch, trade (Chapter 4), governance framework and management instruments (Chapter 5), as they relate to chondrichthyans at regional level in the WIO. The Report then proceeds with detailed presentations of these aspects at national level, along with national recommendations for future research, capacity building and improved policy and management, for each of the ten Nairobi Convention Member States (or their dependent territories) (Chapter 6).

The Report draws on the findings of each of these chapters to conclude with a summary of the threats facing chondrichthyan species in the WIO region and a detailed presentation of the required and recommended actions to be taken at regional and national levels, particularly in terms of policy improvement, conservation priorities, species-level management, national adherence to multilateral environmental and fisheries agreements, research priorities and capacity building (Chapter 7).

Sections 5.5.1, 5.6.2 and 7.2 provide quick reference summaries of required and recommended actions, while these are presented in detail in sections 5.6.3 and 7.4.

The report is intended to provide an overview of these aspects and a reference for representatives of government agencies, fisheries management bodies, scientists, conservationists and any other stakeholders with an interest in the effective and sustainable management of chondrichthyans in the WIO.

CHAPTER 2

Regional Chondrichthyan Status Report and Guiding Documents

2.1 Preparation of Regional Status Report and accompanying guiding documents

2.1.1 Status report on chondrichthyans of the Western Indian Ocean

Chondrichthyan resources in the Western Indian Ocean (WIO) region are under intense fishing pressure from all fishery sectors, and the populations of numerous species have declined significantly in recent years. These species require improved and urgent management attention; however, there is generally limited information available on chondrichthyan species in the WIO region, which in turn limits the development of appropriate management measures. In response to these issues, and considering the regional guiding role of the Nairobi Convention for the management of East African resources, chondrichthyan species and their conservation and management needs were recognized at the seventh meeting of the Conference of the Parties to the Nairobi Convention (CoP7), held in Maputo, Mozambique, in December 2012. At this CoP, Decision CP7/12[16] on the conservation of sharks, called for regional collaboration on the conservation and management of sharks, in addition to the preparation of a Regional Status Report on the state of knowledge on sharks (understood to include all chondrichthyans) in the WIO. The requested report was intended to provide relevant available information to inform further decision-making with respect to chondrichthyans in the WIO.

In response, the Wildlife Conservation Society (WCS), in collaboration with TRAFFIC (Trade Records Analysis of Flora and Fauna in Commerce), Florida International University (FIU), the IUCN shark specialist group and the Nairobi Convention Secretariat, initiated in 2014 a project to compile a Regional Status Report on chondrichthyans in the Nairobi Convention geographic area[17] of the WIO. The initiative was partly supported through funds provided by the Indian Ocean Commission (IOC) Biodiversity Program. This team of collaborating organizations, including experts on aspects of chondrichthyan ecology, fisheries, trade and conservation, and through the support of numerous other contributors, compiled a Review Draft of the Status Report.

With assistance from the Nairobi Convention Secretariat, a questionnaire was developed (in English, French and Portuguese) to structure requests for information from Nairobi Convention Focal Points, fisheries agencies, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) national authorities, and other agencies and experts. These questionnaires included components on the constraints, gaps and priorities for chondrichthyan conservation and management in each Nairobi Convention Member State. The responses provided useful insights and were incorporated in relevant sections throughout this report.

In June 2015, at the 8th Conference of the Parties to the Nairobi Convention (CoP8), held in Mahe, Seychelles, the Parties adopted Decision CP8/9[18] calling for the report's completion, review, and submission to the Nairobi Convention Secretariat for consideration at the 9th CoP.

---

[16] *"Decision CP7/12: Conservation of Sharks*

1. To call for regional collaboration, in consultation with the Secretariats of the Convention on International Trade in Endangered Species, Convention on Migratory Species, regional fisheries management organizations and other partners, on the conservation and management of sharks.

2. Request the Secretariat in collaboration with the Contracting Parties to prepare a regional status report on the state of sharks especially on matters of institutional, legal and capacity and report to the next Conference of Parties."

[17] The "Convention area" shall be comprised of the marine and coastal environment of that part of the Indian Ocean situated within the Eastern African region and falling within the jurisdiction of the Contracting Parties to this Convention. The extent of the coastal environment to be included within the Convention area shall be indicated in each protocol to the Convention taking into account the objectives of the protocol concerned" UNEP 1985, Article 2(a).

[18] *"Decision CP8/9: Threatened and Endangered Marine Species*

1. To urge the Secretariat, in partnership with the Wildlife Conservation Society, to finalize the Regional Status Report on Sharks and Rays in the Western Indian Ocean and circulate the report to all Contracting Parties for review and submit the final report with findings for consideration at the next Conference of Parties"

The Review Draft was subsequently reviewed by country experts at a regional technical workshop, titled *Sharks and Rays of the Southwest Indian Ocean: Status Review and Development of a Roadmap for Conservation and Management,* hosted by the IOC in Mauritius, in April 2017, in collaboration with the Nairobi Convention, WCS and TRAFFIC. The workshop was attended by delegates from all ten Nairobi Convention Member States, and was intended *inter alia* for comments and additional input to the Status Report, by technical experts and government authorities in the Nairobi Convention Member States. A subsequent version of the Review Draft was developed during 2017 and 2018, incorporating the comments and inputs from the technical workshop. Although the Report had not yet been finalized, the findings from this 2018 amended version were presented at the 9th Conference of the Parties to the Nairobi Convention (CoP9), held in Mombasa, Kenya, in August 2018. At this CoP, Decision CP9/5[19] was made, calling for finalization and validation of the Status Report.

This draft report has now been amended in several stages, as new information has become available, to form a final Validation Draft. During the period of development of this report, numerous chondrichthyan species were included in the Appendices of one or more multilateral environmental agreements, or the species management measures of relevant Regional Fishery Bodies, and the revised version of the Status Report incorporates all available information on such changes. Furthermore, a global initiative by the IUCN Species Survival Commission's Shark Specialist Group to ensure up-to-date assessments according to the IUCN Red List of Threatened Species, for all ~1,280 species of chondrichthyans globally, drew to a close in 2021, which resulted in new or updated IUCN categorizations for approximately 170 (76%) of the 224 chondrichthyan species in the WIO, since 2018, with the most recent assessments published in September 2021. The current IUCN Red List statuses for all WIO chondrichthyan species are presented and discussed herein.

The Validation Draft of the Status Report was reviewed and validated by relevant technical experts within the WIO countries, through the support of the Nairobi Convention Secretariat and focal points, in 2021 and 2022. The current document represents the finalized and validated Regional Status Report on Chondrichthyans in the WIO.

2.1.2 Regional roadmap for the conservation and management of sharks and rays in the Western Indian Ocean

The International Plan of Action for the Conservation and Management of Sharks[20] (IPOA-Sharks), developed in 1999 by the FAO (FAO 1999) called on FAO Member States in which there were shark-directed fisheries or fisheries taking sharks as bycatch, to develop similar National Plans of Action for the Conservation and Management of sharks (NPOA-Sharks, or Shark NPOAs), by 2001. All ten Nairobi Convention Member States are members of the FOA and have shark-directed fisheries or fisheries that take sharks as bycatch, or harbour species of sharks that are captured by fisheries in the waters of other countries, and therefore by definition should have developed an NPOA-Sharks. However, by the start of 2017, such Shark NPOAs (as advocated by the FAO IPOA-Sharks) had been developed in only three of the ten Nairobi Convention Member States, namely Seychelles, South Africa and Mauritius (although the latter had not been implemented).

Furthermore, the preparation of the Status Report revealed several recurring issues across the Nairobi Convention Member States, in terms of the management and conservation of chondrichthyan species. One of the issues identified was generally limited policy and legislation developed specifically for chondrichthyan species, or legislation which includes these taxa in the text, in most WIO countries. There is thus a need for improved legislation and policy for chondrichthyan conservation in most Nairobi Convention Member States, which includes (and could be partially driven through) the development of Shark NPOAs.

[19] *"Decision CP9/5: Amendment of the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region*

3. To request the secretariat and responsible partners to expedite the process of finalization and validation of the status report on sharks and rays, including the regional roadmap, and to report thereon before the next Conference of Parties;"

[20] Understood to include all chondrichthyan species.

In response to the need for guiding policy for chondrichthyans in the WIO, to the IPOA-Sharks and to the request by the Parties to the Nairobi Convention to call for regional collaboration on the conservation and management of sharks (Decision CP7/12 as cited previously), a region-wide initiative was undertaken to develop a policy document to guide and prioritize conservation and management activities for chondrichthyans in the WIO region. The development of this document was initiated at the regional technical workshop held in Mauritius in 2017 (*Sharks and Rays of the Southwest Indian Ocean: Status Review and Development of a Roadmap for Conservation and Management*), and was one of the primary objectives of that workshop.

The workshop included an overview of current knowledge on the biodiversity and catch of chondrichthyans in the WIO region and the trade in the products of these species, as well as international mandates for their conservation and management. Representatives from Comoros, France, Kenya, Madagascar, Tanzania, Zanzibar, Seychelles, Mozambique and Somalia presented issues relating to shark and ray conservation and management, including knowledge gaps, issues with governance and limitations in capacity. Following a summary presentation of the findings and recommendations of the draft regional *Status Report*, break-out sessions were held to discuss these findings and recommendations, and to identify gaps in and priorities for the conservation and management of chondrichthyans in the WIO. Building on these outcomes, a Draft Regional Roadmap titled *Roadmap for the Conservation and Management of Sharks and Rays of the Western Indian Ocean* was developed, composed of six key objectives and associated required actions to meet those objectives.

A subsequent workshop, *Advancing the development of a regional roadmap for the conservation and management of sharks and rays in the Southwest Indian Ocean*, was hosted by WCS as a special session of the 10th WIOMSA (Western Indian Ocean Marine Science Association) scientific symposium in Dar es Salaam in November 2017, bringing together stakeholders from seven Nairobi Convention Member States (France – La Réunion, Kenya, Madagascar, Mozambique, Seychelles, South Africa and Tanzania), including representatives from academic, research and management organizations. At this meeting, delegates refined the objectives and required actions presented in the Draft Regional Roadmap. The comments and suggestions proposed during the November 2017 special session were subsequently assimilated and incorporated into an amended Draft Regional Roadmap. This amended version was then disseminated widely by email, in June 2018, to scientific and management stakeholders in all Nairobi Convention Member States, soliciting final comments and inputs to the Regional Roadmap. All comments received were incorporated into the Final Draft Regional Roadmap, which was presented at the 9th Nairobi Convention CoP, in Mombasa, in 2018. At this CoP, Decision CP9/5 called for finalization and validation of the Regional Roadmap. This final validated version of the Regional Roadmap is presented in Appendix A to this Report.

Goal and objectives of the Regional Roadmap

The overarching goal of the Regional Roadmap is "the effective conservation and management of chondrichthyans in the Western Indian Ocean to ensure their optimal and sustainable long-term use and maintaining their ecological function for the benefit of coastal States in the region". The Roadmap is intended to provide a guide for scientific institutions, fishery management agencies and other institutions in the WIO to achieve this goal. The specific objectives of the Roadmap are:

- To improve the knowledge both on shark and ray species and their fisheries, including their role in the ecosystem, to inform conservation and management;
- To ensure that directed fisheries for sharks and rays, and fisheries that catch sharks and rays incidentally, are sustainable and properly managed;
- To improve the conservation status of sharks and rays in the region through recovery of threatened species and restoration of depleted species, and enhance their contributions to ecosystem integrity, community livelihoods, and national economies; and
- To increase public awareness of threats to sharks and rays and their habitats, and enhance public participation and conservation activities.

The Regional Roadmap identifies six priority objectives for shark and ray conservation and management in the WIO, along with specific actions to be taken and links to existing projects and programs through which these activities could be implemented. The Regional Roadmap is therefore intended to provide both a useful framework to guide and prioritize conservation and management activities for chondrichthyans at the WIO regional level, and to form a basis that national authorities could use for the development of shark NPOAs and chondrichthyan policy and legislation within the Nairobi Convention Member States.

2.1.3 List of chondrichthyan species proposed for protection in the Western Indian Ocean

In addition to the Status Report and Regional Roadmap, a third document was prepared to inform authorities on chondrichthyan species within the WIO that require stricter harvesting controls or full protection. The List was developed in response to 1) the high proportion of threatened chondrichthyan species in the WIO, 2) the general lack in most WIO countries of chondrichthyan-specific legislation, or general legislation which applies to these species, 3) numerous binding protections imposed by multilateral environmental agreements to which many Nairobi Convention Member States are Party, and 4) a series of Nairobi Convention CoP decisions.

Decision CP7/12[21] on the conservation of sharks called for regional collaboration on shark conservation, in consultation with the secretariats of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and Regional Fisheries Management Organizations (the latter referring to the Indian Ocean Tuna Commission, IOTC). Decisions CP8/4[22] and CP9/5[23] called for amendment of the *Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* and its annexes.

The document therefore identifies appropriate chondrichthyan species recommended for listing on the relevant annexes of this Nairobi Convention Protocol. The annexes provide an objective, centralized list of species, to inform resource managers of Member States as to which species warrant management or legal protection at national level. However, to date, no chondrichthyan species have been listed on any of the Protocol's annexes. The proposed species were included by virtue of binding commitments under multilateral environmental agreements, such as CMS or CITES, or a prohibitive conservation measure (including retention and targeting bans) imposed by the IOTC. Such binding commitments are addressed in detail in Chapter 5. Species were also proposed for listing based on their conservation status, according to their categorization on the IUCN Red List of Threatened Species.

This *Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* stresses the importance of sustainable utilization of East Africa's fauna and flora. Specifically, article 4 of the Protocol: *Species of Wild Fauna Requiring Special Protection* calls on Parties to "take all appropriate measures to ensure the strictest protection of the endangered wild fauna species listed in annex II". Accordingly, species listed as Endangered or Critically Endangered on the IUCN Red List of Threatened Species (those considered to be facing a very high to extremely high risk of extinction in the wild, IUCN 2001), and those species prohibited from capture or commercial trade through binding commitments to CMS and CITES and through prohibitive resolutions of the IOTC, should be listed in Annex II of the Protocol.

---

[21] *"Decision CP7/12: Conservation of Sharks*

1. To call for regional collaboration, in consultation with the Secretariats of the Convention on International Trade in Endangered Species, Convention on Migratory Species, regional fisheries management organizations and other partners, on the conservation and management of sharks.

[22] *"Decision CP8/4: Review of the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region*

1. To request the Contracting Parties in collaboration with the Secretariat and implementing partners to finalize the review of the protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region and its annexes; and report back on the progress at the Ninth Conference of Parties."

[23] *"Decision CP9/5: Amendment of the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region*

1. To agree to initiate the process of amending the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region and the annexes thereto in line with the provisions of the Convention;

2. To request the secretariat, in collaboration with partners, to organize consultations and support the process of amending the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region and the annexes thereto, and to report thereon to the next Conference of Parties;"

Similarly, article 5 of the Protocol: *Harvestable Species of Wild Fauna* states that "Contracting Parties shall take all appropriate measures to ensure the protection of the depleted or threatened wild fauna species listed in annex III" and that "such wild fauna species shall be regulated in order to restore and maintain the populations at optimum levels". It therefore stands to reason that species listed as Vulnerable on the IUCN Red List (threatened, facing a high risk of extinction in the wild; IUCN 2021) and those listed as Near Threatened (close to qualifying for or likely to qualify for a threatened category in the near future; IUCN 2021), should be included in Annex III, to provide a mechanism to regulate their harvest to avoid further population reductions. Those species requiring commercial trade controls under CITES and those requiring regional management plans under CMS, should also be listed in this Annex.

The Proposed Species List was also initially developed during the regional technical workshop in Mauritius, in 2017. Subsequently, however, further chondrichthyan species present in the WIO have been listed on the Appendices of CITES and CMS, and further retention bans have been imposed for several chondrichthyan taxa, under the IOTC. There have also been revised IUCN Red List assessments for 150 WIO chondrichthyan species since the 2017 workshop. All of these amendments have been incorporated into the revised list of species proposed for listing on the relevant annexes of the Nairobi Convention Protocol. Due to the dynamic nature of threats to these species, and considering both declining populations and improving conservation measures, and as new data become available, it is likely that classifications such as CITES listings and IUCN Red List statuses will change over time. Therefore, the proposed listings should be treated as dynamic and adaptive, in order that they may be amended in the future as deemed necessary.

The document is presented in Appendix B to this report, and is intended to encourage the listing of appropriate species on Annex II, III or IV of the Nairobi Convention Protocol, based on the level of protection needed, to guide managers in each State as to which chondrichthyan species in the WIO require full protection or harvesting restrictions, or for which regional management plans should be developed based on their migratory ecology. The document is also intended to prompt Nairobi Convention Member States to similarly protect and regulate relevant chondrichthyan species within national jurisdictions.

2.2 Presentation to the Nairobi Convention Conference of Parties

The findings of the Draft Status Report, the Draft Regional Roadmap and Proposed Species List were presented at the WIOMSA Science-to-Policy platform, in July 2018, ahead of the 9th Nairobi Convention CoP. The documents were subsequently presented at the WIOSAP Project Steering Committee Meeting, during the 9th Nairobi Convention CoP, held in Mombasa, Kenya, in August 2018. At that time, the Status Report was not yet finalized, and the Report and its findings (along with the Regional Roadmap and Proposed Species List) were not validated by the Parties.

The Parties noted the progress made towards the finalization of the Status Report and commended the efforts of the contributors. Decision CP9/5 was adopted, calling for i) the amendment of the *Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* and its associated annexes, as well as ii) the finalization and validation of the Status Report and Regional Roadmap, for presentation at the 10th Nairobi Convention CoP.

Pursuant to these Decisions, the Proposed Species List was revised in 2021, subsequent to new resolutions published by the IOTC and numerous IUCN Red List assessment revisions, as they relate to WIO chondrichthyan species. The document was submitted in July 2021 in the form of a discussion paper for inclusion in the first output of the *WIO Science to Policy Platform Series*, established jointly by the Nairobi Convention and WIOMSA.

The final Regional Roadmap and the final list of chondrichthyan species proposed for inclusion in the annexes of the Protocol are included within this Status Report (see Appendices A and B, respectively). In the interests of informing improved knowledge, conservation and management of chondrichthyan species in the WIO, and realising that many of the revised IUCN Red List assessments indicated further degradation of WIO chondrichthyan populations, all three documents are hereby presented, to be taken up by the Nairobi Convention Conference of Parties.

2.3 Definitions and geographic delineation

2.3.1 Taxonomic nomenclature

Chondrichthyan: The term chondrichthyan refers to all species within the Class Chondrichthyes – one of three classes of living fishes, comprising all sharks, batoids and chimaeras – groups of fish species characterized by having a cartilaginous skeleton. There are two subclasses within the Chondrichthyes: Holocephalans and Elasmobranchs (Figure 2.1).

Holocephali: The term Holocephali or Holocephalan refers to the subclass Holocephali, one of the two subclasses within the Chondrichthyes, which contains all chimaera species.

Chimaera: The term chimaera refers to species within the subclass Holocephalans. The chimaeras differ from shark and batoid species by having a single gill slit and rubbery skin which lacks denticles (Ebert 2014a).

Elasmobranch: The term elasmobranch refers to the second subclass of Chondrichthyes (Elasmobranchii) that includes all shark and batoid species.

Shark: The term "shark" refers to species within a sub-group of Chondrichthyes that covers all true shark species – generally torpedo-shaped animals, which are relatively well known.

Batoid: The term batoid refers to a sub-group of Chondrichthyes, characterized by having flattened bodies and pectoral fins fused to the head, including rays (stingrays, manta rays and eagle rays), skates and "shark-like rays". The latter includes several orders of batoids that are true batoids but have a physical appearance somewhat resembling sharks – this group includes the sawfishes, wedgefishes, guitarfishes and giant guitarfishes.

The term chondrichthyan is used throughout this report, and refers to all known species in this Class. Many institutions (e.g., FAO and IUCN Shark Specialist Group) use the term "shark" in a broad sense to refer to the entire class Chondrichthyes. While this may simplify the preparation and reading of text, this usage can be misleading and has tended to obscure the importance of the batoids in the "shark" conservation endeavour. Use of the terms "sharks and rays" to refer to all chondrichthyans is more appropriate, but this i) excludes the chimaeras and ii) excludes the skates and shark-like rays which are not rays by definition, but rather batoids. The use of the terms "sharks," "batoids," and "chimaeras" to refer individually to these three groups aims to restore due emphasis to the full species complement of this group of fishes.

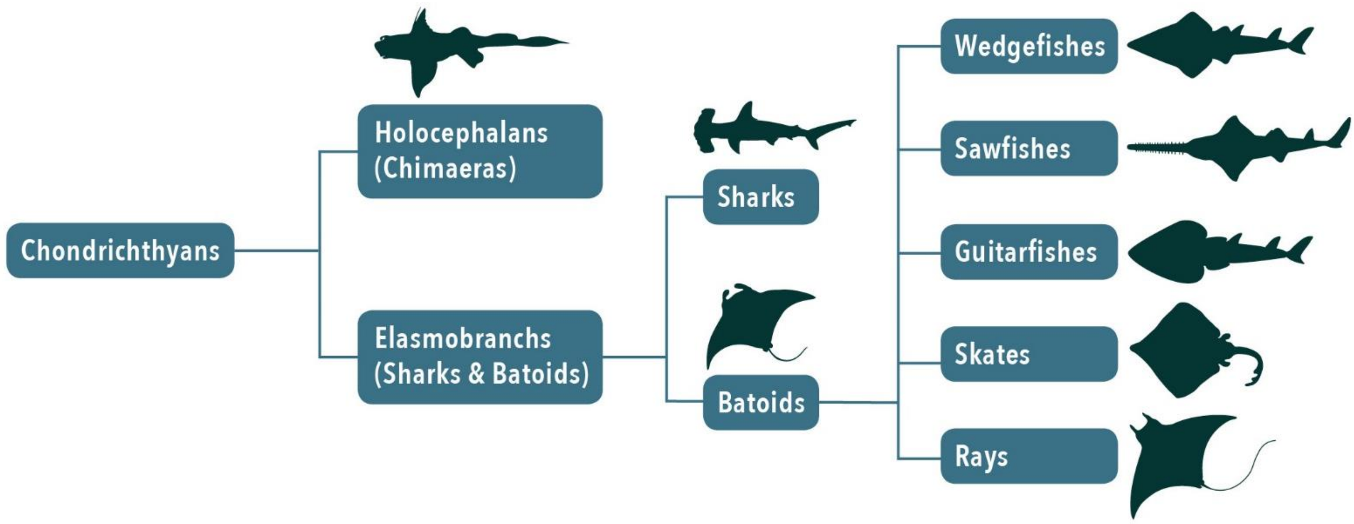


Figure 2.1: Schematic representation of the Class Chondrichthyes, which contains the subclasses Holocephalans (chimaeras) and the elasmobranchs (sharks and batoids), as defined in text.

The term "shark" is therefore used herein to refer only to true sharks. The term "shark" is used in several instances to refer to all chondrichthyan species but only when this term has been quoted directly, or used in a document title (such as the *International Plan of Action for the Conservation and Management of Sharks*). However, efforts have been made to clarify when the term "shark" has been used in documents sourced in this report to describe all chondrichthyans. In some instances, however, it has been impossible to discern the taxonomic scope of the usage of this term.

This report follows standard species nomenclature, with both common name and scientific name (in italics) given on the first mention of a species in each chapter and in each sub-section of Chapter 6: Country Reports, thereafter the scientific name alone is used following the first mention.

2.3.2 Geographic delineation

"Nairobi Convention Area": The geographic scope of this report is the Nairobi Convention Area as defined in Article 2(a) of the Convention text: "The "Convention area" shall be comprised of the marine and coastal environment of that part of the Indian Ocean situated within the Eastern African region and falling within the jurisdiction of the Contracting Parties to this Convention. The extent of the coastal environment to be included within the Convention area shall be indicated in each protocol to the Convention taking into account the objectives of the protocol concerned" (UNEP 1985) (Figure 2.2).

The focal area for this Status Report therefore incorporates the Exclusive Economic Zones (EEZs) of the ten Nairobi Convention Member States, including the continental East African States from the Republic of South Africa north to the Federal Republic of Somalia, including the Republic of Mozambique, the United Republic of Tanzania and Republic of Kenya, and the island States comprising the Union of Comoros, the Republic of Madagascar, the Republic of Mauritius, the Republic of Seychelles and the French Indian Ocean Departments of Mayotte and La Réunion (Figure 2.2). This area therefore encompasses a large portion, but not all, of the Western Indian Ocean, as commonly defined.

"Western Indian Ocean": Although the report focuses on the Nairobi Convention geographic area, some of the information presented refers to the broader Western Indian Ocean, such as regional fishery statistics, particularly for fisheries that extend into areas beyond national jurisdiction (ABNJ). The geographic area referred to here by the term Western Indian Ocean or WIO includes the Indian Ocean waters of the ten Nairobi Convention Member States, from South Africa (including part of the Eastern Cape Province and the Kwazulu-Natal Province only) in the southwest, to Somalia (south of Ràs Hafun, and excluding Somaliland as an independent State of Somalia) in the northwest, and to Mauritius in the east (Figure 2.2), following the delineation of the Indian Ocean by the International Hydrographic Organization (IHO 1953), and excludes the marginal seas to the north.

"FAO Major Fishing Area 51": The FAO delineates the oceans into fishery areas, for collation and reporting of fisheries statistics. Therefore, the official chondrichthyan catch statistics for the Nairobi Convention Member States, as published by the FAO and presented in Chapter 4, are analysed in the context of total global catch from FAO Major Fishing Area 51, which encompasses the Nairobi Convention area and beyond, extending to the coasts of the Arabian Peninsula and South Asia. In instances where the data refer to the broader WIO (or FAO Major Fishing Area 51), this is indicated.

"Southwest Indian Ocean": The term southwest Indian Ocean (SWIO) has been used in certain texts to describe the Nairobi Convention area; however, although the SWIO is encompassed by the Nairobi Convention area, the SWIO by definition excludes northern East Africa, i.e., Kenya and Somalia, which are part of the Nairobi Convention Area.

Country delineations and political boundaries, including EEZ limits, follow those presented in the WIO Marine Protected Area Outlook report (UNEP-Nairobi Convention and WIOMSA 2021a). Therefore, for the purposes of this Status Report, Mayotte is included as a Department of France and is reported in the French Indian Ocean Territories profile in Chapter 6. The Zanzibar Archipelago is included in the United Republic of Tanzania, and therefore reported with the Tanzania country profile in Chapter 6.

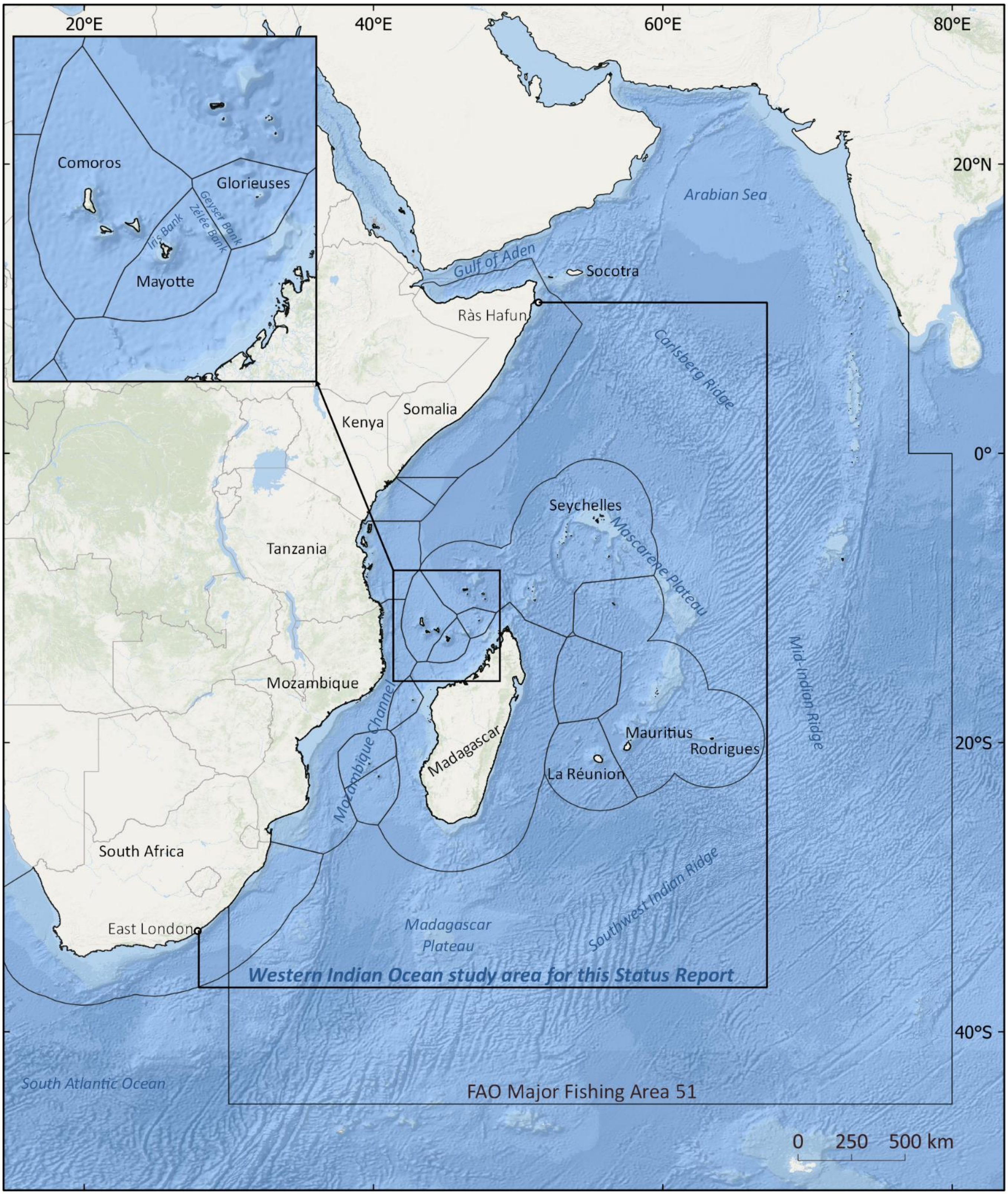


Figure 2.2: Map of the Western Indian Ocean area, showing the general Western Indian Ocean study area as defined for this Status Report, FAO Major Fishing Area 51, Nairobi Convention Member States and their Exclusive Economic Zones, and several locations, islands and submerged banks mentioned in the Report.

CHAPTER 3

Chondrichthyans of the Western Indian Ocean

3.1 Chondrichthyan biodiversity in the Western Indian Ocean

Chondrichthyans first appeared in the fossil record approximately 420 million years ago, making them one of the oldest extant (living) vertebrate lineages (Compagno 1999). Owing to their long evolutionary history, they are now one of the most ecologically diverse and speciose of all vertebrate groups (Dulvy et al. 2014), comprising approximately 1,280 species globally (Weigmann 2016, Serena et al. 2020). Sharks in particular embody high degrees of evolutionary distinctiveness (Dulvy et al. 2017), i.e., species that contribute some of the largest proportions of evolutionary history, rendering them of considerable conservation importance (Derrick et al. 2020).

Studies on the global status of chondrichthyans have identified the Western Indian Ocean (WIO) as a priority region for chondrichthyan conservation (Dulvy et al. 2014, 2017, Stein et al. 2018). Chondrichthyan species documented in the WIO include a diversity of coastal, open-ocean and deep-sea species, and several species that enter estuaries and rivers. Northeast South Africa, southern Mozambique and southwest Madagascar in particular fall within a global chondrichthyan biodiversity hotspot, possibly second only to the Coral Triangle, and one of four global hotspots for endemic and threatened chondrichthyan species (Dulvy et al. 2014, Davidson and Dulvy 2017, Derrick et al. 2020, Ebert and Knuckey in press). This chapter describes chondrichthyan biodiversity and taxonomy in the WIO, including national and regional species checklists, and presents the status of biological and ecological knowledge and research priorities.

The Nairobi Convention area of the WIO harbours at least 224 chondrichthyan species, ~18% of known chondrichthyan species globally. This rich diversity includes at least 135 shark species, 80 batoid species and nine species of chimaera (Table 3.1) (Sommer et al. 1996, Letourneur et al. 2004, Fricke et al. 2009, 2018, Anam and Mostarda 2012, Ebert 2013, 2014a, 2014b, Wickel et al. 2014, Ebert and van Hees 2015, Nevill et al. 2015, Last et al. 2016c, Ebert et al. 2021a). Approximately 50 chondrichthyan species are endemic to the WIO, with at least 15 species thought to occur in only one WIO country. A further 12 known species occur only in areas beyond national jurisdiction (ABNJ; Table 3.1). Madagascar has the highest number of national endemic chondrichthyan species (six), which are confined only to that country's EEZ. The families Pentanchidae (deepwater catsharks), Rajidae (skates) and Rhinobatidae (guitarfishes), have the highest numbers of species endemic to the WIO, with 13, 7 and 6, respectively.

South Africa, Mozambique and Madagascar have the highest chondrichthyan species richness of the WIO countries, with approximately 155 species in South Africa (from East London eastwards) (Ebert et al. 2021c), 131 in Mozambique and 108 in Madagascar (see Table 3.1). Species richness decreases northwards to Kenya and Somalia, and among the WIO island States. In all WIO countries, there are many more confirmed shark species than batoid species, with chimaera species significantly lower in number (Table 3.1).

Table 3.1: Chondrichthyan species richness in countries and areas within the Nairobi Convention area of the Western Indian Ocean (ABNJ: areas beyond national jurisdiction).

Country/Area	Shark	Batoid	Chimaera	Total
ABNJ	41	12	3	56
Comoros	31	7	0	38
France				
- La Réunion	36	12	0	48
- Mayotte	33	17	0	50
Kenya	45	33	1	79
Madagascar	72	35	1	108
Mauritius	42	14	0	56
Mozambique	77	51	3	131
Seychelles	51	18	0	69
Somalia	51	25	1	77
South Africa	93	57	5	155
Tanzania	57	40	1	98
Nairobi Convention area	135	80	9	224

The most speciose chondrichthyan orders in the WIO include the Carcharhiniformes (ground sharks), Squaliformes (sleeper sharks), Myliobatiformes (stingrays and their relatives) and Rajiformes (skates), represented in the WIO by 71 species (27 genera), 35 species (16 genera), 32 species (20 genera) and 25 species (13 genera), respectively (Table 3.2). In contrast, the orders Echinorhiniformes (bramble sharks), Heterodontiformes (bullhead sharks) and Squatiniformes (angel sharks) are each represented by a single species in the WIO (Table 3.2).

The most common shark families in the WIO include Carcharhinidae (requiem sharks) and Pentanchidae (deepwater catsharks), each represented by 24 species, while the most common batoid families are Dasyatidae (whiptail stingrays) and Rajidae (skates), each represented by 16 species (Table 3.2). The WIO is also represented by high numbers of *Acroteriobatus* (guitarfish) and *Bythaelurus* (deepwater catsharks) species. At least five of the eight valid *Acroteriobatus* species occur in the WIO (Weigmann et al. 2021a), of which three are endemic to the region. Eight of the 12 valid *Bythaelurus* species occur in the WIO (Weigmann 2016, Weigmann et al. 2016), of which seven are endemic to the region (Weigmann and Kaschner 2017).

Longline fishery data from the WIO suggest that the most abundant pelagic shark families in the region are Alopiidae (thresher sharks), Carcharhinidae and Lamnidae (mackerel sharks) (Kiszka and van der Elst 2015). The silky shark *Carcharhinus falciformis* and blue shark *Prionace glauca*, both of which belong to the family Carcharhinidae, are the most abundant pelagic shark species in the WIO (Kiszka and van der Elst 2015), whereas the shortfin mako shark *Isurus oxyrinchus* is the most common lamnid shark in the region (Smale 2008, Groeneveld et al. 2014).

There are also 42 shark, 23 batoid and one chimaera species in the WIO that are classified as migratory or possibly migratory, based on movement behaviour and known or potential movements across jurisdictional boundaries (Fowler 2014). The management of such species is complex, as they are vulnerable to fisheries in the waters of multiple countries (Barkley et al. 2019).

Table 3.2: Total number of batoid, chimaera and shark species within each order and family known to occur in the Western Indian Ocean region.

Order	Family	Species	Total
Batoids			
Myliobatiformes	Aetobatidae	1	32
	Dasyatidae	16	
	Gymnuridae	2	
	Hexatrygonidae	1	
	Mobulidae	7	
	Myliobatidae	3	
	Plesiobatidae	1	
	Rhinopteridae	1	
Rajiformes	Anacanthobatidae	3	25
	Arhynchobatidae	2	
	Gurgesiellidae	4	
	Rajidae	16	
Rhinopristiformes	Glaucostegidae	1	14
	Pristidae	2	
	Rhinidae	3	
	Rhinobatidae	8	
Torpediniformes	Narcinidae	3	9
	Narkidae	4	
	Torpedinidae	2	
Chimaeras			
Chimaeriformes	Callorhinchidae	1	9
	Chimaeridae	4	
	Rhinochimaeridae	4	
Sharks			
Carcharhiniformes	Carcharhinidae	24	71
	Galeocerdidae	1	
	Hemigaleidae	3	
	Pentanchidae	24	
	Proscyllidae	3	
	Pseudotriakidae	1	
	Scyliorhinidae	5	
	Sphyrnidae	3	
	Triakidae	7	
Echinorhiniformes	Echinorhinidae	1	1
Heterodontiformes	Heterodontidae	1	1
Hexanchiformes	Chlamydoselachidae	1	5
	Hexanchidae	4	
Lamniformes	Alopiidae	3	12
	Carchariidae	1	
	Cetorhinidae	1	
	Lamnidae	3	
	Mitsukurinidae	2	
	Odontaspididae	1	
	Pseudocarchariidae	1	
Orectolobiformes	Ginglymostomatidae	2	5
	Hemiscyllidae	1	
	Rhincodontidae	1	
	Stegostomatidae	1	
Pristiophoriformes	Pristiophoridae	4	4
Squaliformes	Centrophoridae	9	35
	Dalatiidae	5	
	Etmopteridae	8	
	Oxynotidae	1	
	Somniosidae	6	
	Squalidae	6	
Squatiniformes	Squatinidae	1	1

There are also several chondrichthyan species in the WIO known only from a few specimens. The longnose pygmy shark *Heteroscymnoides marleyi* is known from one specimen washed up on a Durban beach in South Africa (Fowler 1934, Ebert et al. 2021a); the Andaman legskate *Cruriraja andamanica* is known from one record off Tanzania (McEachran and Fechhelm 1982); the Falkor chimaera *Chimaera didierae* is known from one specimen collected near Walter's Shoal (Clerkin et al. 2017); and Elaine's skate *Leucoraja elaineae* is described from one specimen caught off Malindi, Kenya, during a research trawl (Ebert and Leslie 2019). The Comoro catshark *Scyliorhinus comoroensis* is known from two specimens, one from Madagascar (Fricke et al. 2018) and one from Comoros, where the species has also been photographed during deepwater submersible surveys (Ebert et al. 2013). The shorttail legskate *Sinobatis brevicauda* is known from two specimens on the Saya de Malha Bank (Weigmann and Stehmann 2016), while the crying izak catshark *Holohalaelurus melanostigma* is known from four specimens caught off Pemba Island (Tanzania) and southern Kenya (Human 2006, Pollom et al. 2019). The honeycomb catshark *Holohalaelurus favus* has not been recorded in the WIO since the mid-1970s, aside from one record in 2007 (Pollom et al. 2020).

The WIO region also has numerous large charismatic species, such as whale sharks *Rhincodon typus*, bull sharks *Carcharhinus leucas,* tiger sharks *Galeocerdo cuvier*, hammerhead sharks (family Sphyrnidae) and manta and devil rays (family Mobulidae). Historically, the WIO was also home to at least two Critically Endangered sawfish species (family Pristidae; Faria et al. 2013); however, the green sawfish *Pristis zijsron* is thought to have been extirpated completely from the region, and the largetooth sawfish *P. pristis* is now extremely rare in the WIO and possibly locally extinct in some Range States, such as Mozambique and South Africa (Harrison and Dulvy 2014, Everett et al. 2015, Dulvy et al. 2016, Leeney 2017, Braulik et al. 2020, Yan et al. 2021). A third sawfish species, the narrow sawfish *Anoxypristis cuspidata*, is possibly extant along the Indian Ocean coast of Somalia, in the northern part of the Nairobi Convention area, but its presence is unconfirmed.

3.2 National and regional chondrichthyan species checklists

3.2.1 Chondrichthyan taxonomic history in the Western Indian Ocean

Chondrichthyan taxonomy, although lagging behind regions such as north America and Europe, has a long history in the WIO, particularly in Southern Africa (Compagno 1999). The explorative work of Sir Andrew Smith (a Scottish surgeon and naturalist) in the 1820's to 1840's represents some of the early descriptions and illustrations of shark and ray species in South Africa (Smith 1839, 1849). Similarly, numerous chondrichthyan species were detailed in the 19th century explorative reports of Playfair and Günther (1866) from East Africa, particularly Zanzibar.

In the first three decades of the 20th century, J.D.F Gilchrist, a Scottish scientist who became a government marine biologist in South Africa, conducted long-term faunal surveys in the offshore waters of South Africa including surveys for chondrichthyan species (Compagno 1999). From these surveys, Gilchrist and his students published numerous accounts and descriptions of new species of chondrichthyans from South African waters (*inter alia* Gilchrist 1902, 1913, 1921, 1922a, 1922b, Gilchrist and Thompson 1916, Gilchrist and von Bonde 1924). Subsequently, J.L.B. Smith, a chemistry professor and renowned ichthyologist, described over 375 southern African fish species from the late 1930s to the late 1960's, including at least 18 chondrichthyan species, which were published in numerous scientific articles and several volumes of *The Sea Fishes of Southern Africa* (*inter alia* Smith (1949, 1965) and revised by Smith and Heemstra (1986)).

In the subsequent half century, chondrichthyan taxonomic work has grown considerably, with at least 59 different authors having described new chondrichthyan species and several taxonomists specialising in chondrichthyan taxa (Ebert and van Hees 2015). A series of publications in the 1960's and 1970's comprehensively described the species of at least 12 families of batoids (Wallace 1967a, 1967b, 1967c) and 20 families of sharks (Bass et al. 1973, 1975a, 1975b, 1975c, 1975d, 1976) from the east coast of southern Africa, and many deep-water chondrichthyan species were described in this period (Hulley 1966, 1969, 1970, 1971, 1972a, 1972b, 1973, Hulley and Penrith 1966, Hulley and Stehmann 1977). Chondrichthyan taxa in East Africa were described further by Compagno (1986) and Compagno et al. (1989), with the biodiversity and distribution of southern African skates (Rajiformes) described by Compagno and Ebert (2007). The history of chondrichthyan taxonomy in southern Africa is recounted in detail by Compagno (1999) and Ebert and van Hees (2015).

The number of recorded chondrichthyan species, particularly in southern Africa, has increased exponentially in recent decades (Ebert and van Hees 2015), through new species descriptions, taxonomic assessments and improved field data collection resulting in new species distribution records. Since 2011, 15 shark, four skate, three chimaera, two guitarfish and two ray species have been described from the WIO (Ebert and Cailliet 2011, Ebert et al. 2011, 2016, 2021b, Weigmann et al. 2014a, 2016, 2018, 2020, 2021a, 2021b, White and Weigmann 2014, Ebert and Clerkin 2015, Kaschner et al. 2015, Last et al. 2016a, 2016d, Weigmann and Stehmann 2016, Clerkin et al. 2017, Ebert and Gon 2017, Viana et al. 2017, 2018, Weigmann and Kaschner 2017, White et al. 2017, Ebert and Leslie 2019). Five of the eight species in the genus *Bythaelurus* and three of the four species in the family Pristiophoridae that are found in the WIO region were described in the last 10 years.

The sharks and skates were described primarily from specimens collected during the Russian RV 'Vityaz' research cruise (1988–1989), which covered deeper waters of the WIO between the Gulf of Aden and the southern end of the Madagascar Ridge, and focused mainly on poorly studied areas such as the Saya de Malha Bank, Mozambique Channel, Madagascar Ridge and Socotra Islands, resulting in one of the largest collections of deep-water chondrichthyans from the WIO (Weigmann et al. 2013, 2014b, 2018, Kaschner et al. 2015). Surveys conducted in 1996, 2012 and 2014, at depths of 500–1,500 m along the Madagascar Ridge, collected eight undescribed chondrichthyan species (Ebert and Clerkin 2015, Ebert et al. 2016, 2021b, Weigmann et al. 2016, Clerkin et al. 2017, Cordova and Ebert 2021). This suggests that other undescribed species may inhabit the WIO deep sea.

Despite these taxonomic advances, there remains considerable taxonomic uncertainty within several chondrichthyan orders and families, particularly among the batoids. The whiptail stingrays (Dasyatidae), represented by at least 12 genera and 16 species in the WIO (Ebert and van Hees 2015, Last et al. 2016c), require taxonomic confirmation, with some species needing verification of their geographic distributions. The Rhinopristiformes (sawfishes, wedgefishes, guitarfishes and giant guitarfishes) require confirmation of their distributions and taxonomy, while among the sharks there remains much taxonomic uncertainty within the families Centrophoridae (gulper sharks), Etmopteridae (lantern sharks) and Squalidae (dogfish sharks).

Understanding the diversity and species composition within a country, area or region is fundamental for effective conservation and management. Several field and identification guides have been developed for chondrichthyans in the WIO, such as those for the east coast of South Africa (d'Aubrey 1964), Tanzania (Bianchi 1985, Gates 2016) southern Africa (Compagno et al. 1989), Mozambique (Fischer et al. 1990), Somalia (Sommer et al. 1996), Kenya (Anam and Mostarda 2012), deep-sea chondrichthyans of the Indian Ocean (Ebert 2013, 2014a), pelagic chondrichthyans of the WIO (Ebert 2014b), the Arabian Seas (including Somalia) (Jabado and Ebert 2015), and inshore waters of the Seychelles (Smith and Smith 1965, Nevill et al. 2015). Furthermore, chondrichthyan species checklists, or general fish species checklists containing chondrichthyan species, have been developed for Mauritius (Baissac 1990), the Mascarene Islands (Fricke 1999), Mozambique (Pereira 2000), Geyser and Zélée banks (Chabanet et al. 2002), Rodrigues (Heemstra et al. 2004), deep-sea fishes of the Comoros (Heemstra et al. 2006), La Réunion (Letourneur et al. 2004, Fricke et al. 2009), Europa Island (Fricke et al. 2013), Mayotte (Wickel et al. 2014), Madagascar (Fricke et al. 2018) and South Africa (Ebert et al. 2021c).

However, within the WIO, despite the richness of chondrichthyan species recorded to date (at least 224 species) and the history of chondrichthyan taxonomic work, national species checklists are currently out of date for most countries, with no comprehensive checklist of species at the WIO regional level.

3.2.2 Chondrichthyan species checklists for the Western Indian Ocean

This section presents comprehensive, up-to-date national and regional chondrichthyan species lists for the WIO region and each Nairobi Convention Member State and describes the process to compile these lists.

National species lists consider the chondrichthyan species confirmed from within the EEZs of each of the ten Nairobi Convention Member States, including the five East African mainland States (Somalia, Kenya, Tanzania, Mozambique and South Africa) and the five States represented by the WIO islands (Comoros, Seychelles, Madagascar, Mauritius, and the French departments of Mayotte and La Réunion) (Figure 2.1). Owing to their geographically scattered nature and limited geographic coverage, the species of Îles Éparses (a French Indian Ocean Territory) are not presented separately herein; while chondrichthyan species present on the Iris, Zélée and Geyser banks are recorded in the list of species of Mayotte due to their geographic proximity. It should be noted that for the purposes of the regional and national species lists, a northern cut-off is made along the Somali coastline at Ràs Hafun, which represents the northern boundary of the Indian Ocean[24] (IHO 1953), a western cut-off is made along the South African coastline at East London, due to a sharp transition from sub-tropical to temperate waters and a significant boundary for several chondrichthyan species (Ebert et al. 2021c), a southern cut-off is made at the southern limit of the South African EEZ, south of East London, and an eastern cut-off is made at the eastern-most limit of the Mauritian EEZ (eastwards of the island of Rodrigues) (Figure 2.1). The regional species list considers the combined list of chondrichthyan species present across the ten Nairobi Convention Member States, as well as the areas beyond national jurisdiction (ABNJ) within the Nairobi Convention area.

Preliminary national and regional species lists for the WIO compiled under the Retrospective Analysis of the South West Indian Ocean Fisheries Project (SWIOFP) by Dave Ebert (Pacific Shark Research Centre), and those published by Kiszka and van der Elst (2015), were used as a baseline. These lists were subsequently revised in collaboration between Dave Ebert and the Wildlife Conservation Society's (WCS) Western Indian Ocean Shark and Ray Conservation Program (unpublished data), based on species occurrences and distributions published in the primary peer-reviewed scientific literature and in relevant technical reports.

Documents referenced include detailed species accounts for specific taxa or areas (e.g., reports by Bass et al. in the 1970s for sharks off the east coast of southern Africa), technical reports (including species identification guides and national checklists, such as those defined in section 3.2.1) and available grey literature. The comprehensive global reference books *Rays of the World* (Last et al. 2016c) and *Sharks of the World* (Ebert et al. 2021a) were also cross-referenced.

Numerous new or resurrected species and even families of chondrichthyans have been described in the region over the past two decades, and there are several "first WIO" records of species from other areas not previously recorded in the WIO. Even within the past three to four years, there have been many updates and additions to the regional and national species lists, particularly considering the findings of regional studies, such as the BY-Catch Assessment and Mitigation (BYCAM) project funded by the Western Indian Ocean Marine Science Association (Temple et al. 2018, 2019), and ongoing assessments conducted by WCS and other organizations in the SWIO (WCS, unpublished data). There have also been at least two formal chondrichthyan species checklists published, including those for Madagascar (Fricke et al. 2018) and South Africa (Ebert et al. 2021c). Several taxonomic name changes have also been made over the past two decades, and such species are listed herein by their revised (current) names. Species names and their families have been modified according to changes proposed by White et al. (2013), Last et al. (2016b), Weigmann et al. (2016), White et al. (2017), Weigmann et al. (2020), Ebert et al. (2021a), Weigmann et al. (2021a) and other works, such as Eschmeyer's Catalog of Fishes (Fricke et al. 2021), particularly for batoids. Every effort has been made to include all newly described species, new distributions and taxonomic changes.

A comprehensive list of the 224 chondrichthyan species confirmed in the WIO is presented in Table 3.3, indicating the WIO States (and territories) in which each species is confirmed, or reported.

[24] As defined by the International Hydrographic Office (IHO 1953)

Table 3.3: Chondrichthyan species in the Western Indian Ocean (WIO), indicating countries in which the species is confirmed (1) or reported but not confirmed (-), and whether the species is migratory (M) or possibly migratory (P) (Fowler 2014), or endemic to the WIO region (E), listed on Appendix I and/or II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) or the Convention on the Conservation of Migratory Species of Wild Animals (CMS), or prohibited from retention by a Resolution of the Indian Ocean Tuna Commission (IOTC). IUCN refers to each species' conservation status as assessed by the IUCN Red List of Threatened Species (IUCN 2021). (ZA = South Africa, MZ = Mozambique, TZ = Tanzania, KE = Kenya, SO = Somalia, MG = Madagascar, MU = Mauritius, RE = La Réunion, SC = Seychelles, KM = Comoros, YT = Mayotte, ABNJ = Areas Beyond National Jurisdiction; "*" denotes chondrichthyan species that have been described from the WIO region since 2011).

Family	Species name	Author(s)	Common name	ZA	MZ	TZ	KE	SO	MG	MU	RE	SC	KM	YT	ABNJ	RANGE	CITES	CMS	IOTC	IUCN
BATOIDS																				
MYLIOBATIFORMES																				
Aetobatidae	*Aetobatus ocellatus*	(Kuhl, 1823)	Indian eagle ray	1	1	1	1	1	1	1	1	1	1	1	1	M				VU
Dasyatidae	*Bathytoshia brevicaudata*	(Hutton, 1875)	Shorttail stingray	1	1					1										LC
Dasyatidae	*Bathytoshia lata*	(Garman, 1880)	Brown stingray	1	1	1					1		1							VU
Dasyatidae	*Dasyatis chrysonota*	(Smith, 1828)	Blue stingray	1	-				1		-		-			PM				NT
Dasyatidae	*Himantura leoparda*	Manjaji-Matsumoto & Last, 2008	Leopard whipray	1	1	1	1	1												VU
Dasyatidae	*Himantura uarnak*	(Gmelin, 1789)	Honeycomb stingray	1	1	1	1	1	1	1		1		1		M				EN
Dasyatidae	*Maculabatis ambigua**	Last, Bogorodsky, & Alpermann, 2016	Baraka's whipray		1	1	1	1	1											NT
Dasyatidae	*Megatrygon microps*	(Annandale, 1908)	Smalleye stingray	1	1	1	1									M				DD
Dasyatidae	*Neotrygon caeruleopunctata**	Last, White, & Serét, 2016	Bluespotted maskray	1	1	1	1	1	1	1				1						LC
Dasyatidae	*Pastinachus ater*	(Macleay, 1883)	Broad cowtail ray	1	1	1	1	1	1			1	-	1						VU
Dasyatidae	*Pateobatis fai*	(Jordan & Seale, 1906)	Pink whipray	1	1	1								1		M				VU
Dasyatidae	*Pateobatis jenkinsii*	(Annandale, 1909)	Jenkins whipray	1	1	1	1	1	1											VU
Dasyatidae	*Pteroplatytrygon violacea*	(Bonaparte, 1832)	Pelagic stingray	1	1	1	1	1	1	1	1	1	1	1	1	M				LC
Dasyatidae	*Taeniura lymma*	(Forsskål, 1775)	Bluespotted ribbon-tailed stingray	1	1	1	1	1	1			1		1						LC
Dasyatidae	*Taeniurops meyeni*	(Müller & Henle, 1841)	Blotched stingray	1	1	1	1	1	1	1	1	1		1						VU
Dasyatidae	*Urogymnus asperrimus*	(Bloch & Schneider, 1801)	Porcupine ray	1	1	1	1	1	1			1		1						VU
Dasyatidae	*Urogymnus granulatus*	(Macleay, 1883)	Mangrove whipray				1					1		1						VU
Gymnuridae	*Gymnura natalensis*	(Gilchrist & Thompson, 1911)	Diamond ray	1	1											PM				LC
Gymnuridae	*Gymnura poecilura*	(Shaw, 1804)	Longtail butterfly ray		-	-	1	1	-											VU
Hexatrygonidae	*Hexatrygon bickelli*	Heemstra & Smith, 1980	Sixgill stingray	1	-										1					LC
Mobulidae	*Mobula alfredi*	(Krefft, 1868)	Reef manta ray	1	1	1			1			1	1	1	1	M	II	I, II	Y	VU
Mobulidae	*Mobula birostris*	(Walbaum, 1792)	Giant manta ray	1	1	1	1	1	1	1	1	1	1	1	1	M	II	I, II	Y	EN
Mobulidae	*Mobula eregoodoo*	(Cantor 1849)	Longhorned pygmy devil ray	1	-	1	-	1	-	-	-	-	-	-	-	PM	II	I, II	Y	EN
Mobulidae	*Mobula kuhlii*	(Valenciennes, 1841)	Shortfin devil ray	1	1	1	1	1	1	-	-	1	-	1		M	II	I, II	Y	EN
Mobulidae	*Mobula mobular*	(Bonnaterre, 1788)	Spinetail devil ray	1	1	1	1	1	1			1		1	1	M	II	I, II	Y	EN
Mobulidae	*Mobula tarapacana*	(Philippi, 1892)	Sicklefin devil ray	1	-	1				1	1				1	M	II	I, II	Y	EN
Mobulidae	*Mobula thurstoni*	(Lloyd, 1908)	Bentfin devil ray	1	-	1			1						1	PM	II	I, II	Y	EN
Myliobatidae	*Aetomylaeus bovinus*	(Saint-Hilaire, 1817)	Duckbill ray	1	1	1										PM				CR
Myliobatidae	*Aetomylaeus vespertilio*	(Bleeker, 1852)	Ornate eagle ray	1	1	1	1					1				PM				EN
Myliobatidae	*Myliobatis aquila*	(Linnaeus, 1758)	Common eagle ray	1	1	1	1			1	1					PM				CR
Plesiobatidae	*Plesiobatis daviesi*	(Wallace, 1967)	Deepwater stingray	1	1							-			1					LC
Rhinopteridae	*Rhinoptera jayakari*	Boulenger, 1895	Shorttail cownose ray	1	1	1	1	1	1						1					EN
RAJIFORMES																				
Anacanthobatidae	*Anacanthobatis marmorata*	(Von Bonde & Swart, 1923)	Spotted legskate	1	1										-	E				NT
Anacanthobatidae	*Indobatis ori*	(Wallace, 1967)	Black legskate		1				1						-	E				LC
Anacanthobatidae	*Sinobatis brevicauda**	Weigmann & Stehmann, 2016	Shorttail legskate												1	E				LC
Arhynchobatidae	*Bathyraja tunae*	Stehmann, 2005	Tuna's skate		-	-			-						1	E				LC
Arhynchobatidae	*Notoraja hesperindica**	Weigmann, Séret & Stehmann, 2021	Western blue skate		1				1							E				NE
Gurgesiellidae	*Cruriraja andamanica*	(Lloyd, 1909)	Andaman legskate			1														DD
Gurgesiellidae	*Cruriraja hulleyi*	Aschliman, Ebert, & Compagno, 2010	Roughnose skate	1											-					LC
Gurgesiellidae	*Cruriraja parcomaculata*	(von Bonde & Swart, 1923)	Triangular skate	1	1										-	E				LC
Gurgesiellidae	*Fenestraja maceachrani*	(Séret, 1989)	Madagascar pygmy skate						1						-	E				DD
Rajidae	*Dipturus campbelli*	(Wallace, 1967)	Blackspot skate	1	1											E				NT
Rajidae	*Dipturus crosnieri*	(Serét, 1989)	Madagascar skate						1						-	E				VU
Rajidae	*Dipturus johannisdavisi*	Alcock, 1899	Travancore skate			1														DD
Rajidae	*Dipturus lanceorostratus*	(Wallace, 1967)	Rattail skate	1	1											E				DD
Rajidae	*Dipturus springeri*	(Wallace, 1967)	Roughbelly skate	1	1	1	1		1						-					LC
Rajidae	*Dipturus stenorhynchus*	(Wallace, 1967)	Prownose skate	1	1	1	1									E				DD
Rajidae	*Leucoraja compagnoi*	(Stehmann, 1995)	Compagno's skate	1											-					DD
Rajidae	*Leucoraja elaineae**	Ebert & Leslie 2019	Elaine's skate				1									E				DD
Rajidae	*Leucoraja wallacei*	(Hulley, 1970)	Yellowspotted skate	1	1										-					VU
Rajidae	*Okamejei heemstrai*	(McEachran & Fechhlem, 1982)	East African skate		1	1	1									E				LC
Rajidae	*Raja clavata*	Linnaeus, 1758	Thornback skate	1					1	1	1					PM				NT
Rajidae	*Raja ocellifera*	Regan, 1906	Twineyed skate	1	-	-	-													EN

Family	Species name	Author(s)	Common name	ZA	MZ	TZ	KE	SO	MG	MU	RE	SC	KM	YT	ABNJ	RANGE	CITES	CMS	IOTC	IUCN
Rajidae	*Raja straeleni*	Poll, 1951	False thornback skate/Biscuit skate	1	1				-	-						M				NT
Rajidae	*Rajella caudaspinosa*	(Von Bonde & Swart, 1923)	Munchkin skate	1											-					LC
Rajidae	*Rajella paucispinosa**	Weigmann, Stehmann, & Thiel, 2014	Sparsethorn skate		1										-	E				LC
Rajidae	*Rostroraja alba*	Lacepède, 1803	Spearnose skate	1	1		1		1			1								EN
RHINOPRISTIFORMES																				
Glaucostegidae	*Glaucostegus halavi*	Forsskål, 1775	Halavi guitarfish				1										II			CR
Pristidae	*Pristis pristis*	(Linnaeus, 1758)	Largetooth sawfish	1	1	1	1	1	1	-	-	-				M	I	I, II		CR
Pristidae	*Pristis zijsron*	(Bleeker, 1851)	Green sawfish	1	1	-	1	1		-	-						I	I, II		CR
Rhinidae	*Rhina ancylostomus*	Bloch & Schneider, 1801	Bowmouth guitarfish or shark ray	1	1	1	1	1	1	1	1	1		1			II			CR
Rhinidae	*Rhynchobatus australiae*	Whitley, 1939	Bottlenose wedgefish		1	1	1	1	1	1	1	1					II	II		CR
Rhinidae	*Rhynchobatus djiddensis*	(Forsskål, 1775)	Whitespotted wedgefish	1	1	-	-	-	-	-	-	-		-		M	II			CR
Rhinobatidae	*Acroteriobatus annulatus*	Smith, 1841	Lesser guitarfish	1												M				VU
Rhinobatidae	*Acroteriobatus andysabini**	Weigmann, Ebert, & Séret, 2021	Malagasy Blue-spotted Guitarfish						1							E				NE
Rhinobatidae	*Acroteriobatus leucospilus*	Norman, 1926	Greyspot guitarfish	1	1	1										E				EN
Rhinobatidae	*Acroteriobatus ocellatus*	Norman, 1926	Speckled guitarfish	1	1															DD
Rhinobatidae	*Acroteriobatus zanzibarensis*	Norman, 1926	Zanzibar guitarfish			1										E				NT
Rhinobatidae	*Rhinobatos austini**	Ebert & Gon, 2017	Austin's guitarfish	1	1	1			1							E				DD
Rhinobatidae	*Rhinobatos holcorhynchus*	Norman, 1922	Slender guitarfish	1	1	1	1		1							E				DD
Rhinobatidae	*Rhinobatos nudidorsalis*	Last, Compagno, & Nakaya, 2004	Bareback Guitarfish												1	E				DD
TORPEDINIFORMES																				
Narcinidae	*Benthobatis moresbyi*	Alcock, 1898	Moresby's blind ray					1							-					LC
Narcinidae	*Narcine insolita*	Carvalho, Séret, & Compagno, 2002	Madagascar numbfish						1							E				DD
Narcinidae	*Narcine rierai*	(Lloris & Rucabado, 1991)	Mozambique electric ray	-	1	1	1	1								E				DD
Narkidae	*Electrolux addisoni*	Compagno & Heemstra, 2007	Ornate sleeper ray	1												E				LC
Narkidae	*Heteronarce garmani*	Regan, 1921	Natal electric ray	1	1				1											NT
Narkidae	*Heteronarce mollis*	(Lloyd, 1907)	Soft electric ray					1												DD
Narkidae	*Narke capensis*	(Gmelin, 1789)	Onefin electric ray	1	-				1											LC
Torpedinidae	*Torpedo fuscomaculata*	Peters, 1855	Blackspotted electric ray	1	1	1			1	1	1	1	1	1		PM				DD
Torpedinidae	*Torpedo sinuspersici*	Olfers, 1831	Marbled electric ray	1	1	1	1	1	1	1	1	1	1	1						DD
CHIMAERAS																				
CHIMAERIFORMES																				
Callorhinchidae	*Callorhinchus capensis*	Duméril, 1865	St. Joseph	1												M				LC
Chimaeridae	*Chimaera buccanigella**	Clerkin, Ebert & Kemper, 2017	Dark-mouth chimaera												1	E				DD
Chimaeridae	*Chimaera didierae**	Clerkin, Ebert & Kemper, 2017	The Falkor chimaera												1	E				DD
Chimaeridae	*Chimaera willwatchi**	Clerkin, Ebert & Kemper 2017	Seafarer's ghost shark												1	E				DD
Chimaeridae	*Hydrolagus africanus*	(Gilchrist, 1922)	African rabbitfish	1	1	1	1								-					LC
Rhinochimaeridae	*Harriotta raleighana*	Goode & Bean, 1895	Narrownose chimaera	1	1										-					LC
Rhinochimaeridae	*Neoharriotta pumila*	Didier & Stehmann, 1996	Dwarf chimaera					1							-					LC
Rhinochimaeridae	*Rhinochimaera africana*	Compagno, Stehmann, & Ebert, 1990	Paddlenose chimaera	1					1						-					DD
Rhinochimaeridae	*Rhinochimaera atlantica*	Holt & Byrne, 1909	Atlantic longnose chimaera	1	1										-					LC
SHARKS																				
CARCHARHINIFORMES																				
Carcharhinidae	*Carcharhinus albimarginatus*	(Rüppell, 1837)	Silvertip shark	1	1	1	1	1	1	1	1	1	1	1		PM				VU
Carcharhinidae	*Carcharhinus altimus*	(Springer, 1950)	Bignose shark	1	1	1	-	-	1					-		PM				NT
Carcharhinidae	*Carcharhinus amblyrhynchoides*	Whitley 1934	Graceful shark					1				-				M				VU
Carcharhinidae	*Carcharhinus amblyrhynchos*	(Bleeker, 1856)	Grey Reef shark	1	1	1	1	1	1	1	1	1	1	1		PM				EN
Carcharhinidae	*Carcharhinus amboinensis*	(Müller & Henle, 1839)	Pigeye shark	1	1	1	1	1	1	1		1				PM				VU
Carcharhinidae	*Carcharhinus brachyurus*	(Günther, 1870)	Copper shark	1	-				1			1				M				VU
Carcharhinidae	*Carcharhinus brevipinna*	(Valenciennes, 1839)	Spinner shark	1	1				1	1	1	1				M				VU
Carcharhinidae	*Carcharhinus falciformis*	(Müller & Henle, 1839)	Silky shark	1	1	1	1	1	1	1	1	1	1	1	1	M	II	II		VU
Carcharhinidae	*Carcharhinus galapagensis*	(Snodgrass & Heller, 1905)	Galapagos shark		1				1			1			1	PM				LC
Carcharhinidae	*Carcharhinus humani**	White & Weigmann, 2014	Human's whaler shark	1	1	1	1	1	1	1	1	1								DD
Carcharhinidae	*Carcharhinus leucas*	(Valenciennes, 1839)	Bull shark	1	1	1	1	1	1	1	1	1	1	1		M				VU
Carcharhinidae	*Carcharhinus limbatus*	(Valenciennes, 1839)	Blacktip shark	1	1	1	1	1	1	1	1	1	1	1		M				VU
Carcharhinidae	*Carcharhinus longimanus*	(Poey, 1861)	Oceanic whitetip shark	1	1	1	1	1	1	1	1	1	1	1	1	M	II	I	Y	CR
Carcharhinidae	*Carcharhinus macloti*	(Müller & Henle, 1839)	Hardnose shark			1	1	1								M				NT
Carcharhinidae	*Carcharhinus melanopterus*	(Quoy & Gaimard, 1824)	Blacktip reef shark	1	1	1	1	1	1	1	1	1	1	1		PM				VU
Carcharhinidae	*Carcharhinus obscurus*	(Lesueur, 1818)	Dusky shark	1	1	-		1	1						-	M		II		EN
Carcharhinidae	*Carcharhinus plumbeus*	(Nardo, 1827)	Sandbar shark	1	1	1	1	1	1	1	1	1	1	1		M				EN
Carcharhinidae	*Carcharhinus sorrah*	(Valenciennes, 1839)	Spottail shark	1	1	1	1	1	1	1	1	1		1		PM				NT
Carcharhinidae	*Loxodon macrorhinus*	(Müller & Henle, 1839)	Sliteye shark	1	1	1	1	1	1	1	1	1								NT

Family	Species name	Author(s)	Common name	ZA	MZ	TZ	KE	SO	MG	MU	RE	SC	KM	YT	ABNJ	RANGE	CITES	CMS	IOTC	IUCN
Carcharhinidae	*Negaprion acutidens*	(Rüppell, 1837)	Sicklefin lemon shark	1	1	1	1	1	1	1		1	1	1		M				EN
Carcharhinidae	*Prionace glauca*	(Linnaeus, 1758)	Blue shark	1	1	1	1	1	1	1	1	1	1	1	1	M		II		NT
Carcharhinidae	*Rhizoprionodon acutus*	(Rüppell, 1837)	Milk shark	1	1	1	1	1	1	1		1				PM				VU
Carcharhinidae	*Scoliodon laticaudus*	Müller & Henle, 1838	Spadenose shark		-	1	1	1	1											NT
Carcharhinidae	*Triaenodon obesus*	(Rüppell, 1837)	Whitetip reef shark	1	1	1	1	1	1	1	1	1	1	1						VU
Galeocerdidae	*Galeocerdo cuvier*	(Péron & Lesueur, in Lesueur, 1822)	Tiger shark	1	1	1	1	1	1	1	1	1	1	1	1	M				NT
Hemigaleidae	*Hemigaleus microstoma*	Bleeker 1852	Sickelfin weasel shark			1														VU
Hemigaleidae	*Hemipristis elongata*	(Klunzinger, 1871)	Snaggletooth shark	1	1	1	1	1	1			1				PM				VU
Hemigaleidae	*Paragaleus leucolomatus*	Compagno & Smale, 1985	Whitetip weasel shark	1	1	-	-	-	1											VU
Pentanchidae	*Apristurus ampliceps*	Sasahara, Sato, & Nakaya, 2008	Roughskin Catshark												1					LC
Pentanchidae	*Apristurus indicus*	(Brauer, 1906)	Smallbelly catshark					1												LC
Pentanchidae	*Apristurus longicephalus*	Nakaya, 1975	Longhead catshark		1				1			1								LC
Pentanchidae	*Apristurus manocheriani*	Cordova & Ebert 2021	Manocherian's Catshark												1	E				NE
Pentanchidae	*Apristurus melanoasper*	Iglesias, Nakaya, & Stehmann, 2004	Black Roughscale Catshark												1					LC
Pentanchidae	*Apristurus cf. sinensis*	Chu & Hu 1981	South China catshark												1					NE
Pentanchidae	*Bythaelurus bachi**	Weigmann, Ebert, Clerkin, Stehmann & Naylor, 2016	Bach's catshark												1	E				DD
Pentanchidae	*Bythaelurus clevai*	Seret, 1987	Madagascar catshark						1							E				DD
Pentanchidae	*Bythaelurus hispidus*	(Alcock, 1891)	Bristly catshark				1	1												NT
Pentanchidae	*Bythaelurus lutarius*	Springer & D'Aubrey, 1972	Mud catshark		1											E				DD
Pentanchidae	*Bythaelurus naylori**	Ebert & Clerkin 2015	Dusky snout catshark												1	E				DD
Pentanchidae	*Bythaelurus stewarti**	Weigmann, Kaschner & Thiel 2018	Error Seamount catshark												1	E				DD
Pentanchidae	*Bythaelurus tenuicephalus**	Kaschner, Weigmann & Thiel, 2015	Narrowhead catshark		1	1										E				LC
Pentanchidae	*Bythaelurus vivaldii**	Weigmann & Kaschner, 2017	Vavaldi's catshark					1								E				DD
Pentanchidae	*Halaelurus boesemani*	Springer & D'Aubrey, 1972	Speckled catshark				1	1												VU
Pentanchidae	*Halaelurus lineatus*	Bass, D'Aubrey & Kistnasamy, 1975	Lined catshark	1	1											E				LC
Pentanchidae	*Halaelurus natalensis*	(Regan, 1904)	Tiger catshark	1	1															VU
Pentanchidae	*Haploblepharus fuscus*	Smith, 1950	Brown shyshark	1																VU
Pentanchidae	*Haploblepharus kistnasamyi*	Human & Compagno, 2006	Natal shyshark	1																VU
Pentanchidae	*Holohalaelurus favus*	Human, 2006	Honeycomb catshark	1	1											E				EN
Pentanchidae	*Holohalaelurus grennian*	Human, 2006	Grinning spotted izak		1	1	1	1	1							E				DD
Pentanchidae	*Holohalaelurus melanostigma*	(Norman, 1939)	Crying izak catshark			1	1									E				LC
Pentanchidae	*Holohalaelurus punctatus*	(Gilchrist, 1914)	African spotted catshark	1	1				1							E				EN
Pentanchidae	*Holohalaelurus regani*	(Gilchrist, 1922)	Izak catshark	1	-															LC
Proscyllidae	*Ctenacis fehlmanni*	(Springer, 1968)	Harlequin catshark					1												LC
Proscyllidae	*Eridacnis radcliffei*	Smith, 1913	Pygmy ribbontail catshark			1	1	-												LC
Proscyllidae	*Eridacnis sinuans*	(Smith, 1957)	African ribbontail catshark	1	1	1	1									E				LC
Pseudotriakidae	*Pseudotriakis microdon*	Capello, 1868	False catshark						1			-			1					LC
Scyliorhinidae	*Cephaloscyllium sufflans*	(Regan, 1921)	Balloon shark	1	1	-	-	-	1				1		-	E				NT
Scyliorhinidae	*Poroderma africanum*	(Gmelin, 1789)	Striped catshark	1					-	-										LC
Scyliorhinidae	*Poroderma pantherinum*	Müller & Henle, 1838	Leopard catshark	1					-	-										LC
Scyliorhinidae	*Scyliorhinus capensis*	(Smith, in Müller & Henle, 1838)	Yellowspotted catshark	1																NT
Scyliorhinidae	*Scyliorhinus comoroensis*	Compagno, 1988	Comoro catshark						1				1			E				DD
Sphyrnidae	*Sphyrna lewini*	(Griffith & Smith, in Cuvier, Griffith & Smith, 1834)	Scalloped hammerhead shark	1	1	1	1	1	1	1	1	1	1	1	-	M	II	II		CR
Sphyrnidae	*Sphyrna mokarran*	(Rüppell, 1837)	Great hammerhead shark	1	1	1	1	1	1	1	1	1	1	1	-	M	II	II		CR
Sphyrnidae	*Sphyrna zygaena*	(Linnaeus, 1758)	Smooth hammerhead shark	1	1	-		1	1	1	1	1	1		-	M	II	II		VU
Triakidae	*Hypogaleus hyugaensis*	(Miyosi, 1939)	Blacktip topeshark	1	1	1	1													LC
Triakidae	*Mustelus manazo*	Bleeker, 1855	Starspotted smoothhound		-	1	1		-			1								EN
Triakidae	*Mustelus mosis*	Hemprich & Ehrenberg, 1899	Arabian smoothhound	1	1	1	1	1		1	1									NT
Triakidae	*Mustelus mustelus*	(Linnaeus, 1758)	Common smoothhound	1												M				EN
Triakidae	*Mustelus palumbes*	Smith, 1957	Whitespot smoothhound shark	1	1															LC
Triakidae	*Scylliogaleus quecketti*	Boulenger, 1902	Flapnose houndshark	1																VU
Triakidae	*Triakis megalopterus*	(Smith, 1839)	Sharptooth houndshark	1					-											LC
ECHINORHINIFORMES																				
Echinorhinidae	*Echinorhinus brucus*	(Bonnaterre, 1788)	Bramble shark	1	1			1												EN
HETERODONTIFORMES																				
Heterodontidae	*Heterodontus ramalheira*	(Smith, 1949)	Whitespotted bullhead shark	1	1	1	1	1												DD
HEXANCHIFORMES																				
Chlamydoselachidae	*Chlamydoselachus africana*	Ebert & Compagno, 2009	Southern African frilled shark	1	1										1					LC
Hexanchidae	*Heptranchias perlo*	(Bonnaterre, 1788)	Sharpnose sevengill shark	1	1	1		1	1	1	1	1	1	1	-					NT
Hexanchidae	*Hexanchus griseus*	(Bonnaterre, 1788)	Bluntnose sixgill shark	1	1	1		1	1	1	1	1	1	1		M				NT
Hexanchidae	*Hexanchus nakamurai*	Teng, 1962	Bigeyed sixgill shark	1	1	1	1	1	1	1	1	1	1	1						NT
Hexanchidae	*Notorynchus cepedianus*	(Peron, 1807)	Sevengill shark	1												M				VU

Family	Species name	Author(s)	Common name	ZA	MZ	TZ	KE	SO	MG	MU	RE	SC	KM	YT	ABNJ	RANGE	CITES	CMS	IOTC	IUCN
LAMNIFORMES																				
Alopiidae	*Alopias pelagicus*	Nakamura, 1935	Pelagic thresher shark	1	1	1	1	1	1	-	-	1	1	1	-	M	II	II	Y	EN
Alopiidae	*Alopias superciliosus*	(Lowe, 1841)	Bigeye thresher shark	1	1	1	1	1	1	1	1	1	1	1	-	M	II	II	Y	VU
Alopiidae	*Alopias vulpinus*	(Bonnaterre, 1788)	Common thresher shark	1	-	-	-	-	-	-	-	-	-	-	1	M	II	II	Y	VU
Carchariidae	*Carcharias taurus*	Rafinesque, 1810	Ragged-tooth shark	1	1	1		1				-				M				CR
Cetorhinidae	*Cetorhinus maximus*	(Gunnerus, 1765)	Basking shark	1											1	M	II	I, II		EN
Lamnidae	*Carcharodon carcharias*	(Linnaeus, 1758)	Great white shark	1	1	1	1		1	1	1	1	1	1	1	M	II	I, II		VU
Lamnidae	*Isurus oxyrinchus*	Rafinesque, 1810	Shortfin mako shark	1	1	1	1	1	1	1	1	1	1	1	1	M	II	II		EN
Lamnidae	*Isurus paucus*	Guitart Manday, 1966	Longfin mako shark	1	1	1	1	1	1	1	1	1	1	1	1	M	II	II		EN
Mitsukurinidae	*Mitsukurina owstoni*	Jordan, 1898	Goblin shark	1	1										-					LC
Odontaspididae	*Odontaspis ferox*	(Risso, 1810)	Smalltooth sand tiger shark	1	-	1			1			1	1			PM				VU
Odontaspididae	*Odontaspis noronhai*	(Maul, 1955)	Bigeye sand tiger shark							1		-			1	PM				LC
Pseudocarchariidae	*Pseudocarcharias kamoharai*	(Matsubara, 1936)	Crocodile shark	1	1	1	1	1	1	1	1	1	1	1	-	PM				LC
ORECTOLOBIFORMES																				
Ginglymostomatidae	*Nebrius ferrugineus*	(Lesson, 1831)	Tawny nurse shark	1	1	1	1	1	1	1	1	1	1	1		M				VU
Ginglymostomatidae	*Pseudoginglymostoma brevicaudatum*	Günther, 1867	Shorttail nurse shark	1	1	1	1		1							E				CR
Hemiscyllidae	*Chiloscyllium caeruleopunctatum*	Pellegrin, 1914	Bluespotted bambooshark						1							E				DD
Rhincodontidae	*Rhincodon typus*	Smith, 1828	Whale shark	1	1	1	1	1	1	1	1	1	1	1	1	M	II	I, II	Y	EN
Stegostomatidae	*Stegostoma tigrinum*	(Herman, 1783)	Zebra shark	1	1	1	1	1	1	1	1	1		1						EN
PRISTIOPHORIFORMES																				
Pristiophoridae	*Pliotrema annae**	Weigmann, Gon, Leeney & Temple 2020	Anna's sixgill sawshark			1	-	-								E				DD
Pristiophoridae	*Pliotrema kajae**	Weigmann, Gon, Leeney & Temple 2020	Kaja's sixgill sawshark						1	1						E				DD
Pristiophoridae	*Pliotrema warreni*	Regan, 1906	Warren's sixgill sawshark	1	1	1									-					LC
Pristiophoridae	*Pristiophorus nancyae**	Ebert & Caillet, 2011	African Dwarf sawshark		1	1	1	1	1											LC
SQUALIFORMES																				
Centrophoridae	*Centrophorus granulosus*	(Bloch & Schneider, 1801)	Gulper shark	1	1			1	1			1	1	1	1					EN
Centrophoridae	*Centrophorus lesliei**	White, Ebert & Naylor 2017	African gulper shark		1				1											EN
Centrophoridae	*Centrophorus moluccensis*	Bleeker, 1860	Smallfin gulper shark	1	1	1			1			1		1	-					VU
Centrophoridae	*Centrophorus seychellorum*	Baranes, 2003	Seychelles gulper shark									1			-	E				LC
Centrophoridae	*Centrophorus squamosus*	(Bonnaterre, 1788)	Leafscale gulper shark	1	1							1			1					EN
Centrophoridae	*Centrophorus uyato*	(Rafinesque, 1810)	Little gulper shark	1	1	1		1	1	1				1	1					EN
Centrophoridae	*Deania calceus*	(Lowe, 1839)	Birdbeak dogfish	1	-				-						1					NT
Centrophoridae	*Deania profundorum*	(Smith & Radcliffe, 1912)	Arrowhead dogfish	1	-				-						1					NT
Centrophoridae	*Deania quadrispinosa*	(McCulloch, 1915)	Longsnout dogfish	1	1				1											VU
Dalatiidae	*Dalatias licha*	(Bonnaterre, 1788)	Kitefin shark	1	1	1			1						1					VU
Dalatiidae	*Euprotomicrus bispinatus*	(Quoy & Gaimard, 1824)	Pygmy shark	1					1	1	1	1		1	1					LC
Dalatiidae	*Heteroscymnoides marleyi*	Fowler, 1934	Longnose pygmy shark	1																LC
Dalatiidae	*Isistius brasiliensis*	(Quoy & Gaimard, 1824)	Cookiecutter shark	1					1	1	1	-								LC
Dalatiidae	*Squaliolus laticaudus*	Smith & Radcliffe, 1912	Spined pygmy shark					1												LC
Etmopteridae	*Etmopterus alphus**	Ebert, Straube, Leslie, & Weigmann, 2016	Whitecheek lanternshark	1	1										1	E				LC
Etmopteridae	*Etmopterus bigelowi*	Shirai & Tachikawa 1993	Blurred lanternshark	1	-										1					LC
Etmopteridae	*Etmopterus brosei**	Ebert, Leslie, & Weigmann, 2021	Barrie's Lanternshark	1	1										1					NE
Etmopteridae	*Etmopterus compagnoi*	Fricke & Koch, 1990	Brown lanternshark	1	1										1					LC
Etmopteridae	*Etmopterus granulosus*	(Günther, 1880)	Giant southern lanternshark	-	-				1						1					LC
Etmopteridae	*Etmopterus pusillus*	(Lowe, 1839)	Smooth lanternshark	1	-					-	-				1					LC
Etmopteridae	*Etmopterus sculptus**	Ebert, Compagno & De Vries, 2011	Sculpted lanternshark	1	1										1					LC
Etmopteridae	*Etmopterus sentosus*	Bass, D'Aubrey, & Kistnasamy, 1976	Thorny lanternshark	1	1	1			1							E				LC
Oxynotidae	*Oxynotus centrina*	(Linnaeus, 1758)	Angular rough shark		-	-			1						-					EN
Somniosidae	*Centroscymnus coelolepis*	Barbosa du Bocage & de Brito Capello, 1864	Portuguese dogfish	1	1				1			1			1					NT
Somniosidae	*Centroscymnus owstoni*	Gaman, 1906	Roughskin dogfish	-	-				1		1	1		1	1					VU
Somniosidae	*Centroselachus crepidater*	(Barbosa du Bocage & de Brito Capello, 1864)	Longnose velvet dogfish	-	-				1		1	1		1	1					NT
Somniosidae	*Somniosus antarcticus*	Whitley, 1939	Southern sleeper shark						1						1	M				LC
Somniosidae	*Scymnodon macracanthus*	Regan, 1906	Largespine velvet dogfish	-	-										1					DD
Somniosidae	*Zameus squamulosus*	(Günther, 1877)	Velvet dogfish	1	-				1	1	1	1			1					LC
Squalidae	*Cirrhigaleus asper*	(Merrett, 1973)	Roughskin spurdog	1	1	1			1		1	1	1		-					DD
Squalidae	*Squalus acutipinnis*	Regan, 1906	Southern African spiny dogfish	1	-					1	-									NT
Squalidae	*Squalus bassi**	Viana, de Carvalho, & Ebert, 2017	Long-snouted African spurdog	1	1															LC
Squalidae	*Squalus cf. blainville*	under revision by Sarah Viana	Longnose spurdog	1	1				1	1										NE
Squalidae	*Squalus lalannei*	Baranes, 2003	Seychelles spurdog									1				E				LC
Squalidae	*Squalus mahia**	Viana, Lisher, & de Carvalho, 2017	Malagasy skinny spurdog	1	1	-	-	-	1											DD
SQUATINIFORMES																				
Squatinidae	*Squatina africana*	Regan, 1908	African angelshark	1	1	1	1	1	1	1		1								NT

3.3 Chondrichthyan conservation status in the Western Indian Ocean

3.3.1 IUCN Red List of Threatened Species

The allocation of resources and conservation efforts to the most imperilled species requires an objective way to classify species according to their risk of extinction. The *IUCN Red List of Threatened Species* provides a comprehensive inventory of the conservation status of the world's plants and animals (IUCN 2021). Red List assessments provide an objective measure of the extinction risk of each species using quantitative criteria (IUCN 2019). The Red List is thus an important tool to help focus management and biodiversity conservation efforts towards those species most at risk of extinction or in need of concerted research. The Red List places species into one of nine categories, as defined by the *Guidelines for Using the IUCN Red List Categories and Criteria* (IUCN 2019) (Figure 3.1).

The Red List categories of Vulnerable, Endangered and Critically Endangered are considered "threatened" categories, and include species facing a high to extremely high risk of extinction in the wild (IUCN 2019). The proportion of species assessed in one of these categories provides an indication of overall conservation status of that group of species. Near Threatened species are not yet threatened but may become so, if conservation measures are not implemented to reduce the threats they face.

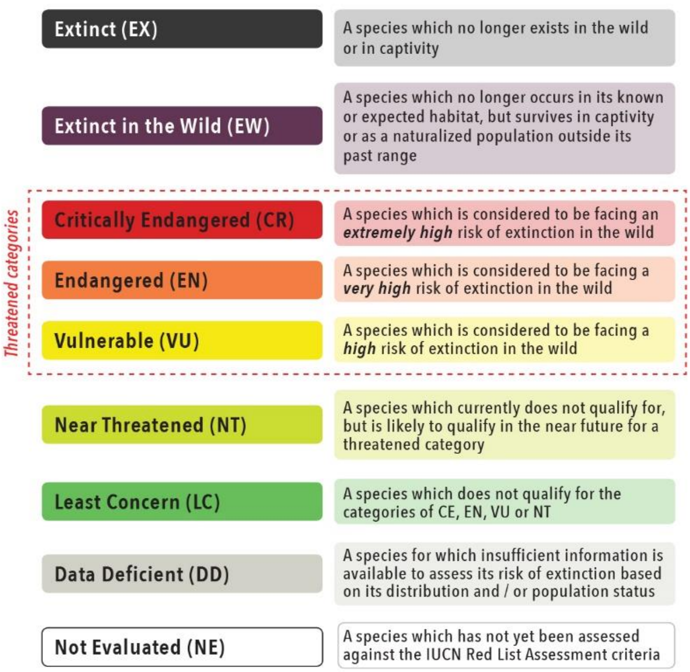


Figure 3.1: Conservation threat categories of the Red List of Threatened Species (International Union for the Conservation of Nature) (IUCN 2019).

3.3.2 Conservation status of chondrichthyans in the Western Indian Ocean

At the time of writing, at least 224 chondrichthyan species are present in the Nairobi Convention area of the WIO, of which 218 (97%) have been assessed according to the IUCN Red List criteria. In total, 89 chondrichthyan species in the WIO (40%) are assessed as threatened (i.e., Critically Endangered, Endangered or Vulnerable) (Figure 3.1; Table 3.3), indicating that two-fifths of all chondrichthyan species present in the WIO are facing a high to extremely high risk of extinction in the wild. As such, the proportion of threatened chondrichthyans in the WIO is higher than at the global scale, as approximately 33% of the world's chondrichthyan species are classified as threatened (Dulvy et al. 2021). Furthermore, chondrichthyan species in the WIO also have a significantly higher proportion (40%) of threatened species than marine species in general (7%) in the WIO region, with the only group that is more threatened being the marine turtles (5 species, 100% threatened) (Bullock et al. 2021), further highlighting the degraded conservation status of WIO chondrichthyans.

The WIO is considered one of four areas globally that is characterized by particularly high proportions of chondrichthyan species classified as Data Deficient (Dulvy et al. 2014). There are currently 37 (17%) Data Deficient chondrichthyan species in the WIO, which is concerning as recent studies have predicted that 55% and 62% of Data Deficient species in the Northeast Atlantic and Mediterranean, respectively, would fall within a threatened category (Walls and Dulvy 2020). Furthermore, 66 (29%) of the chondrichthyan species in the WIO are migratory or possibly migratory, and these species are at a disproportionately higher risk (Fowler 2014), with 48 (73%) of these species already being threatened (Table 3.3).

Similar proportions of batoid (43%) and shark species (41%) are threatened, and similar proportions are classified as Least Concern (24% of batoid species, 30% of shark species); however, considerably more batoid species (21%) are Data Deficient than shark species (12%) (Figure 3.2), highlighting the generally data-poor nature of batoids. Furthermore, a considerably higher proportion of batoids (10%) than sharks (4%) fall within the Critically Endangered category.

There are no threatened species of chimaera in the WIO, with 56% of chimaera species being classified as Least Concern and 44% being classified as Data Deficient (Figure 3.2).

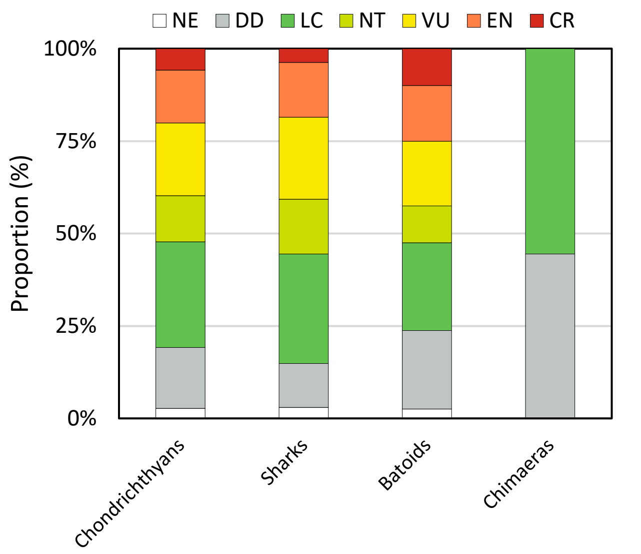


Figure 3.2: Proportions (%) of all chondrichthyans, shark species, batoid species and chimaera species in the Western Indian Ocean region that fall into each IUCN Red List Assessment category. (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient and NE = Not Evaluated).

Trend in conservation status

In the past ten years (i.e., since 2011), 215 chondrichthyan species in the WIO region have been reassessed according to the IUCN Red List Categories. Of these, 47 species remained unchanged (no change in threat status), while 51 were "uplisted" to a higher (worse) threat category and 9 were "downlisted" to a lower threat category (Figure 3.3). Of the Data Deficient species, 32 moved from Data Deficient to a non-threatened category, while 13 species moved to a threatened category and 20 species remained Data Deficient. Of the 42 previously Not Evaluated species, 16 moved into a non-threatened category, 10 moved into a threatened category and 16 went from Not Evaluated to Data Deficient. One species went from being Near Threatened to Data Deficient. The high number of chondrichthyan species uplisted into higher threat categories indicates a general declining trend in chondrichthyan populations, as recorded globally (see Dulvy et al. 2021), again providing evidence of the need for urgent conservation action.

In contrast, the "downlistings" of nine species were not related to real changes in conservation status, but rather to improved data – therefore these cannot be seen as improvements in conservation status.

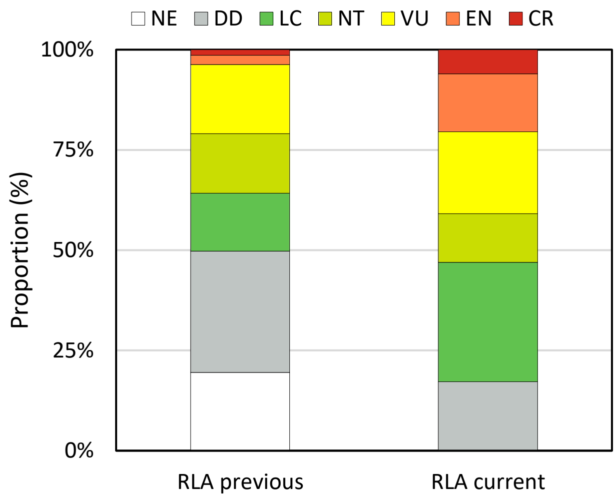


Figure 3.3: Previous and current IUCN Red List Assessments (RLA), for chondrichthyans in the Western Indian Ocean that have undergone a reassessment within the past 10 years (i.e., since 2011), showing proportions (%) of chondrichthyans that fall into each IUCN Red List Assessment category. (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient and NE = Not Evaluated).

National level conservation status of Western Indian Ocean chondrichthyan species

While 40% of chondrichthyans at the WIO regional level are threatened, nationally within each Nairobi Convention Member State (or area) the proportions of threatened species are considerably higher, except for areas beyond national jurisdiction (34% threatened). At least half or more of all chondrichthyan species in 11 of these 12 countries/areas (including Mayotte and La Réunion separately) are threatened (Table 3.4). Mayotte has the highest proportion of threatened chondrichthyan species, at 72%. Mozambique and South Africa have the lowest proportions of threatened chondrichthyan species (50%), although this is still considerably higher than the WIO region as a whole, and globally (Table 3.4). These findings, together with the high percentage of Data Deficient and Near Threatened species, highlight the need for further research and urgent conservation action throughout the WIO.

Table 3.4: Numbers of chondrichthyan species classified in each IUCN Red List Category, by country, in the Western Indian Ocean and globally (IUCN 2021). (ANBJ: areas beyond national jurisdiction; CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data Deficient; NE: Near Threatened. Total Threatened = sum of CR, EN and VU. Categories presented are for global IUCN assessments, not regional assessments).

Country/ Area	NE	DD	LC	NT	Threatened				
					VU	EN	CR	Total	%
ABNJ	3	8	20	6	7	11	1	19	34
Comoros	0	4	2	6	14	9	3	26	68
France									
- La Réunion	0	4	5	10	15	8	6	29	60
- Mayotte	0	2	5	7	18	14	4	36	72
Kenya	0	9	12	11	21	16	10	47	59
Madagascar	3	15	17	17	28	21	7	56	52
Mauritius	1	4	8	11	15	11	6	32	57
Mozambique	3	15	31	17	29	24	12	65	50
Seychelles	0	4	9	10	24	17	5	46	67
Somalia	0	7	10	13	21	18	8	47	61
South Africa	2	14	40	22	37	29	11	77	50
Tanzania	0	14	15	14	25	20	10	55	56
WIO Total	6	37	64	28	44	32	13	89	40
Global Total	~81	155	529	124	180	121	90	391	33

Most threatened chondrichthyan taxa

There are seven batoid families from which all species in the WIO are threatened; Aetobatidae (pelagic eagle rays), Glaucostegidae (giant guitarfishes), Mobulidae (manta and devil rays), Myliobatidae (eagle rays), Pristidae (sawfishes), Rhinidae (wedgefishes) and Rhinopteridae (cownose rays) (Table 3.5). Within the most threatened of these families (Pristidae), two of the five described species (the Critically Endangered largetooth sawfish *Pristis pristis* and green sawfish *P. zijsron*) are known to have occurred throughout East Africa's coastal waters, but are now extirpated or at best extremely depleted in most countries in the WIO (Harrison and Dulvy 2014, Dulvy et al. 2016, Leeney 2017, Braulik et al. 2020). Both species are considered locally extinct within South Africa (Everett et al. 2015).

Rhinidae (wedgefish) and Rhinobatidae (guitarfish) species are caught incidentally and targeted in many WIO countries (Fennessy 1994, Pierce et al. 2008a, Cripps et al. 2015, Kiilu et al. 2019, Daly et al. 2020), and many have been uplisted to higher threat categories in recent years. All Rhinidae species in the WIO are now Critically Endangered (Table 3.5).

There are seven species belonging to the family Mobulidae which occur in the WIO (one Vulnerable and six Endangered; Table 3.5) and are known to be targeted or caught as bycatch in the region (Bianchi 1985, Jiddawi and Stanley 1999, Marshall et al. 2011, Temple et al. 2019). The family Myliobatidae comprises two Critically Endangered and one Endangered species that occur in the WIO, while families Aetobatidae, Glaucostegidae and Rhinopteridae comprise only one species each within the WIO, all of which are threatened (Table 3.5). The batoids within the region require particular attention, in the form of assessments of the impact of fisheries and improved knowledge, as well as a thorough identification and establishment of appropriate conservation and management measures.

Among the most threatened shark families which occur in the WIO region are the Alopiidae (thresher sharks), Carchariidae (sand tiger sharks), Cetorhinidae (basking sharks), Echinorhinidae (bramble sharks), Ginglymostomatidae (nurse sharks), Hemigaleidae (weasel sharks), Lamnidae (mackerel sharks), Oxynotidae (rough sharks), Rhincodontidae (whale sharks), Sphyrnidae (hammerhead sharks) and Stegostomatidae (zebra sharks), of which all species present in the WIO are threatened (Table 3.5). Thresher, mackerel and hammerhead sharks are caught in both industrial and artisanal fisheries (Groeneveld et al. 2014, Mutombene et al. 2015, Temple et al. 2019). Hammerhead sharks, especially scalloped hammerhead sharks *Sphyrna lewini*, are caught in high numbers throughout the WIO, particularly in artisanal fisheries (Cooke 1997, McVean et al. 2006, Kiilu and Ndegwa 2013, Robinson and Sauer 2013, Cripps et al. 2015, Kiilu et al. 2019, Temple et al. 2019). The shorttail nurse shark *Pseudoginglymostoma brevicaudatum*, the single most threatened shark species endemic to the WIO, is caught primarily as bycatch in artisanal fisheries (Shehe and Jiddawi 1997, Temple et al. 2019, Bennett et al. 2021) and targeted live for the aquarium trade (Janse et al. 2017).

Red List categories presented here are global assessments for each species. However, WIO regional-level Red List assessments could be undertaken for particular species, where adequate regional data are available, and where a different (particularly higher) threat category may be suspected.

Table 3.5: Numbers of species, numbers of Vulnerable (VU), Endangered (EN) and Critically Endangered (CR) species, and numbers and proportions (%) of threatened species, within each chondrichthyan family present in the Western Indian Ocean region. IUCN Categories presented are the global IUCN status, not national or regional.

Family	Species	VU	EN	CR	Threatened	
					No.	%
Batoids						
Aetobatidae	1	1			1	100
Anacanthobatidae	3				0	0
Arhynchobatidae	2				0	0
Dasyatidae	16	8	1		8	56
Glaucostegidae	1			1	1	100
Gurgesiellidae	4				0	0
Gymnuridae	2	1			1	50
Hexatrygonidae	1				0	0
Mobulidae	7	1	6		7	100
Myliobatidae	3		1	2	3	100
Narcinidae	3				0	0
Narkidae	4				0	0
Plesiobatidae	1				0	0
Pristidae	2			2	2	100
Rajidae	16	2	2		4	25
Rhinidae	3			3	3	100
Rhinobatidae	8	1	1		2	25
Rhinopteridae	1		1		1	100
Torpedinidae	2				0	0
Chimaeras						
Callorhinchidae	1				0	0
Chimaeridae	4				0	0
Rhinochimaeridae	4				0	0
Sharks						
Alopiidae	3	2	1		3	100
Carcharhinidae	24	11	4	1	16	67
Carchariidae	1			1	1	100
Centrophoridae	9	2	4		6	67
Cetorhinidae	1		1		1	100
Chlamydoselachidae	1				0	0
Dalatiidae	5	1			1	20
Echinorhinidae	1		1		1	100
Etmopteridae	8				0	0
Galeocerdidae	1				0	0
Ginglymostomatidae	2	1		1	2	100
Hemigaleidae	3	3			3	100
Hemiscyllidae	1				0	0
Heterodontidae	1				0	0
Hexanchidae	4	1			1	25
Lamnidae	3	1	2		3	100
Mitsukurinidae	1				0	0
Odontaspididae	2	1			1	50
Oxynotidae	1		1		1	100
Pentanchidae	24	4	2		6	25
Pristiophoridae	4				0	0
Proscyllidae	3				0	0
Pseudocarchariidae	1				0	0
Pseudotriakidae	1				0	0
Rhincodontidae	1		1		1	100
Scyliorhinidae	5				0	0
Somniosidae	6	1			1	17
Sphyrnidae	3	1		2	3	100
Squalidae	6				0	0
Squatinidae	1				0	0
Stegostomatidae	1		1		1	100
Triakidae	7	1	2		3	43

3.3.3 Stock assessments in the Western Indian Ocean

There is limited information on the stock status of the most commonly caught oceanic pelagic sharks in the WIO, with few stock assessments completed. The blue shark *Prionace glauca* was assessed as not overfished nor subject to overfishing in the Indian Ocean, with spawner biomass levels at 72.6% of pristine (Rice 2017a). The shortfin mako shark *Isurus oxyrinchus* was assessed as not currently overfished, but subject to overfishing with biomass trajectories trending towards overfished (Brunel et al. 2018)**.** Several other species have been assessed as having an unknown stock status in the Indian Ocean, including pelagic thresher sharks *Alopias pelagicus,* bigeye thresher sharks *A. superciliosus* (IOTC 2021a), oceanic whitetip sharks *Carcharhinus longimanus* (Rice 2017b), silky sharks *C. falciformis* (IOTC 2019b) and scalloped hammerhead sharks *Sphyrna lewini* (IOTC 2019a).

Most stock and catch assessments are from South Africa, where data have been collected from the pelagic longline fishery and the KwaZulu-Natal Sharks Board bather protection nets (da Silva et al. 2015). Formal stock assessments have been conducted for just five commercially valuable shark species. The smoothhound shark *Mustelus mustelus* and sharptooth houndshark *Triakis megalopterus* were considered overexploited (da Silva 2007, Booth et al. 2011), while the great white shark *Carcharodon carcharias* had not exhibited a marked recovery since protection in 1991 (Towner et al. 2013, Andreotti et al. 2016) and the ragged-tooth shark *Carcharias taurus* had not exhibited any change in population size over the 10 years preceding the assessment (Dicken et al. 2008). Catch assessments on 14 species, using data from 1978–2003, revealed significant declines in the populations of bull sharks *Carcharhinus leucas,* blacktip sharks *C. limbatus*, *Sphyrna lewini* and giant hammerhead sharks *S. mokarran* (Dudley and Simpfendorfer 2006) already by the end of the 20th century, but are now out of date. More recently, catch assessments were conducted in South Africa for 14 chondrichthyan species endemic to southern Africa and found within the WIO, of which half were shown to have stable populations and the other half to have declining populations (Pollom et al. in prep). Species that showed declining populations include the Endangered twineyed skate *Raja ocellifera*; Vulnerable lesser guitarfish *Acroteriobatus annulatus*, tiger catshark *Halaelurus natalensis*, brown shyshark *Haploblepharus fuscus* and yellowspotted skate *Leucoraja wallacei*; and Near Threatened yellowspotted catshark *Scyliorhinus capensis* and bluntnose spurdog *Squalus acutipinnis*; while those that showed stable populations are all Least Concern species, including Izak catshark *Holohalaelurus regani*, whitespot smoothhound *Mustelus palumbes*, Warren's sixgill sawshark *Pliotrema warreni*, pyjama catshark *Poroderma africanum*, leopard catshark *Poroderma pantherinum*, African longnose spurdog *Squalus bassi* and sharptooth houndshark *Triakis megalopterus* (Pollom et al. in press). However, most of these species are south east Atlantic species whose distribution ranges extend only partly into the WIO (north east South Africa or Mozambique only).

Overall, very few quantitative stock assessments have been conducted for chondrichthyan species in the WIO region. This is compounded by limited and unreliable species-specific fisheries catch data, due to low levels of monitoring of both industrial and artisanal fishery catches in many parts of the WIO, and high levels of unreported and illegal catches. Indeed, the East African region has been identified as one of the global regions with some of the worst data reporting (Dulvy et al. 2017), and many WIO States fail to comply with chondrichthyan catch reporting requirements to bodies such as the IOTC and CITES (See Chapter 6). Recognizing the ever-increasing catch trends from this region and the vulnerable life-history strategies of most chondrichthyan species, at current levels of fishing, there is considerable risk to the stock status for many WIO chondrichthyan species. As such, stock assessments of chondrichthyan species known to be caught in fisheries should be prioritized, particularly for threatened species.

At least five chondrichthyan species endemic to the WIO are threatened: Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum*; Endangered greyspot guitarfish *Acroteriobatus leucospilus*, honeycomb Izak catshark *Holohalaelurus favus* and African spotted catshark *Holohalaelurus punctatus*; and Vulnerable Madagascar skate *Dipturus crosnieri* (Table 3.3). The greatest numbers of threatened endemic chondrichthyans are found along the South African east coast, the southern Mozambique coast and the southwest Madagascar coast, and these countries thus share the greatest responsibility to conserve these threatened endemic chondrichthyan species (Pollom et al. in press).

3.4 Chondrichthyan research and the status of biological and ecological knowledge

3.4.1 Chondrichthyan research in the Western Indian Ocean

Chondrichthyan research in the WIO has been slow compared to other regions globally, but has received considerable attention over the past 10 to 20 years. South African scientists and institutions – particularly the KwaZulu-Natal Sharks Board and Oceanographic Research Institute – have conducted the majority of research on chondrichthyans in the region, over the past few decades (Ebert and van Hees 2015), although the number of organizations now conducting chondrichthyan research in the WIO is considerably greater. In general, research on batoids has been limited throughout the WIO, and very little research has been conducted on chimaeras, with most chondrichthyan research focusing on shark species.

Research has largely focused on the larger, charismatic chondrichthyans, such as whale sharks in Tanzania (Cagua et al. 2013, Rohner et al. 2015), Mozambique (Rohner et al. 2013, Haskell et al. 2015), Madagascar (Diamant et al. 2018) and Seychelles (Rowat et al. 2009; see Rowat (2007) for review of whale sharks in the WIO); white sharks *Carcharodon carcharias*, bull sharks *Carcharhinus leucas* and tiger sharks *Galeocerdo cuvier* in South Africa, Mozambique and Seychelles (Dudley 2012, Jaquemet et al. 2012, Daly et al. 2014, 2018, Jewell et al. 2014, Lea et al. 2015, Pirog et al. 2015, 2019b, 2019a, 2019c, Andreotti et al. 2016, Dicken et al. 2016, Barkley et al. 2019); and reef and giant manta rays *Mobula alfredi* and *M. birostris* in Mozambique (Marshall et al. 2011, Rohner et al. 2013) and Seychelles (Peel et al. 2019a, 2019b, 2020).

Several studies have used acoustic telemetry, satellite technology (e.g. Daly et al. 2014, 2018, Hussey et al. 2015, Lea et al. 2015, Barkley et al. 2019, Peel et al. 2019b, 2020, Venables et al. 2020, Filmalter et al. 2021) or photo-identification (e.g. Brooks et al. 2010, Rohner et al. 2013, 2020, Andrzejaczek et al. 2016, Diamant et al. 2018, Prebble et al. 2018, Boggio-Pasqua et al. 2019, Peel et al. 2020) to reveal movements, habitat use, trophic interactions and natal philopatry of chondrichthyans in the WIO. In South Africa, the Acoustic Tracking Array Platform (ATAP) provides a valuable network of acoustic receivers to monitor chondrichthyan movement along the South African coast, into southern Mozambique (Cowley et al. 2017) The Oceanographic Research Institute's Cooperative Fish Tagging Project[25] has been tagging chondrichthyan species and monitoring their movements along the South African and Mozambican coastlines since 1984 (Dunlop et al. 2013).

Genetic studies assessing chondrichthyan geographic population connectivity and biogeography in the region have also grown in number, particularly in the last decade, providing valuable information on the connectivity both within the WIO and between the WIO and other regions. Again, these have focused predominantly on large, charismatic coastal species, such as ragged-tooth sharks *Carcharias taurus* (Stow et al. 2006, Klein et al. 2020), whale sharks (Vignaud et al. 2014), white sharks *Carcharodon carcharias* (Andreotti et al. 2016), bull sharks *Carcharhinus leucas* (Pirog et al. 2019c), tiger sharks *Galeocerdo cuvier* (Pirog et al. 2019a), reef manta rays *Mobula alfredi* (Venables et al. 2021), scalloped hammerhead sharks *Sphyrna lewini* (Hadi et al. 2020) and smooth hammerhead sharks *S. zygaena* (Kuguru et al. 2019, da Silva Ferrette et al. 2021). However, some studies have assessed the population genetics of oceanic and deepwater chondrichthyan species, many of which are less well known and/or species that form important components of commercial fisheries, such as angel sharks from the genus *Squatina* (Stelbrink et al. 2010), crocodile sharks *Pseudocarcharias kamoharai* (da Silva Ferrette et al. 2015), soupfin/tope sharks *Galeorhinus galeus* (Bester-van der Merwe et al. 2017), several houndshark species (Family Triakidae) (Maduna et al. 2016, 2017) and shortfin mako sharks *Isurus oxyrinchus* (Corrigan et al. 2018).

Baited remote underwater video (BRUV) surveys are used throughout the WIO to record chondrichthyan and fish diversity and abundance (MacNeil et al. 2020, Sancelme et al. 2020, Bennett et al. 2021, Dalton et al. 2021, SAIAB and WCS unpublished data).

There have also been advances in other research techniques which have been applied to the study of chondrichthyans in the region, such as the use of bomb radiocarbon dating to estimate age and growth of chondrichthyan species (e.g., Christiansen et al. 2016) and the use of environmental DNA (eDNA) which has led to the discovery of new chondrichthyan species distributions in the WIO (e.g., Mariani et al. 2021). Local ecological knowledge and historical records assessments have been used to assess contemporary (or recent) presence of the Critically Endangered largetooth sawfish *Pristis pristis* and green sawfish *P. zijsron* in the WIO, revealing that one or both of these species are likely locally extinct at least in South Africa (Everett et al. 2015), Mozambique and Madagascar (Leeney 2017, Yan et al. 2021), with *P. zijsron* refuted from Tanzania (Braulik et al. 2020).

Assessments of chondrichthyan catch are also beginning to provide insight into the species present in the WIO and the threats they face. For example, the Southwest Indian Ocean Fisheries Project (SWIOFP) focused on transboundary fish stocks and supported notable studies including assessments of data availability and impacts of offshore fisheries on vulnerable species (van der Elst et al. 2012, van der Elst and Everett 2015). Its sister project, the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) project, gathered data through oceanographic cruises and conducted a transboundary diagnostic analysis of the Large Marine Ecosystems in the region, which improved the knowledge and understanding of chondrichthyans in the WIO (ASCLME/SWIOFP 2012). Chondrichthyan catches have also been monitored in artisanal fishery surveys in several WIO countries (e.g., Sheik Heile and Glaser 2020, CORDIO East Africa unpublished data, WCS unpublished data).

Bycatch impacts and potential methods of mitigation have been investigated for various fisheries, through organizations and institutions such as the Marine Biodiversity Exploitation and Conservation (MARBEC) research unit (at IFREMER), and the BYCAM Project, which have explored ways of assessing bycatch and developing methods for mitigation of the catch of non-target megafauna species (including chondrichthyans) in artisanal, small-scale commercial and semi-industrial fisheries in the WIO (Fennessy et al. 2015,

[25] www.oritag.org.za

Temple et al. 2018, 2019). The Indian Ocean Tuna Commission (IOTC) has also implemented species-level catch recording requirements, to assess the level of shark and ray catch in the tuna-associated fisheries.

The Western Indian Ocean Fisheries database (WIOFish), a partnership among Nairobi Convention Member States (excluding Somalia and France), provides a systematic overview of fishing activities in the region (e.g., gears used, species caught, habitats fished) and, based on a scoring system, highlights areas of fisheries that are data-rich or data-poor (Everett et al. 2017). This platform has the potential to support regional management efforts and could possibly be modified for use as a common data collection and recording system in the region (pers. comm., Sabine Wintner, formerly KZNSB, April 2017).

3.4.2 Status of biological and ecological knowledge and research priorities for chondrichthyan species in the Western Indian Ocean

The WIO regional species checklist (presented in section 3.2) was expanded into a database, to include available biological and ecological information on all chondrichthyan species recorded in the WIO (WCS, unpublished data). The aim of the process was to identify gaps in the available biological and ecological information on chondrichthyan species, relative to the types of information needed for informing effective management. The intention was to identify priority biological and ecological aspects, as well as priority chondrichthyan taxa, for future research.

Biological and ecological information categories (and sub-categories) assessed are outlined in Table 3.6. These focused on biological and ecological information most informative for species-level management, including age-and-growth aspects and reproduction (which provide information useful for setting size-based catch limits, and assessing vulnerability to fisheries), and movement patterns (to identify ecologically important areas to inform area-based management or seasonal movement patterns to inform temporal protection measures). Information on species distribution ranges (important for inferring potential interactions with fisheries and impacts of habitat degradation) was also assessed. Information on fishery catches and mortality are not included here but addressed separately in the subsequent chapter.

Information was sourced for each species through an extensive search of peer-reviewed literature in Google Scholar, grey literature, online databases such as FishBase (Froese and Pauly 2021), and from each species' IUCN Red List Assessment (IUCN 2021). Current taxonomic classifications were verified using Eschmeyer's Catalog of Fishes (Fricke et al. 2021).

Table 3.6: Categories of biological and ecological information assessed to determine availability of key information needed to inform chondrichthyan management.

Category	Subcategory
Age and growth	Size at birth Male and female size at maturity Age at maturity Maximum length Maximum age Generation length
Movement/area use	Migratory status Population connectivity Aggregation sites Breeding localities Parturition localities Nursery localities
Reproduction	Reproductive periodicity Gestation period Litter size/number of eggs Breeding season Parturition season

The assessment revealed notable differences in available information both among information categories and among taxa, regarding the various aspects of chondrichthyan biology and ecology in the WIO. Information is readily available for the majority of age and growth categories, with maximum length, male and female sizes at maturity and size at birth information being available for at least 70% of WIO chondrichthyan species (Figure 3.4). In contrast, other than information on litter size/number of eggs, there is currently very little information available for the majority of reproduction categories, i.e., reproductive periodicity, gestation period, breeding season and parturition season, with such information available for less than 30% of species (Figure 3.4). Similarly, little is known regarding movement behaviour of chondrichthyan species in the WIO, i.e., migratory status, connectivity (including genetic connectivity), aggregation sites, and nursery, parturition and breeding localities, with information in most of these categories available for less than 20% of species (Figure 3.4).

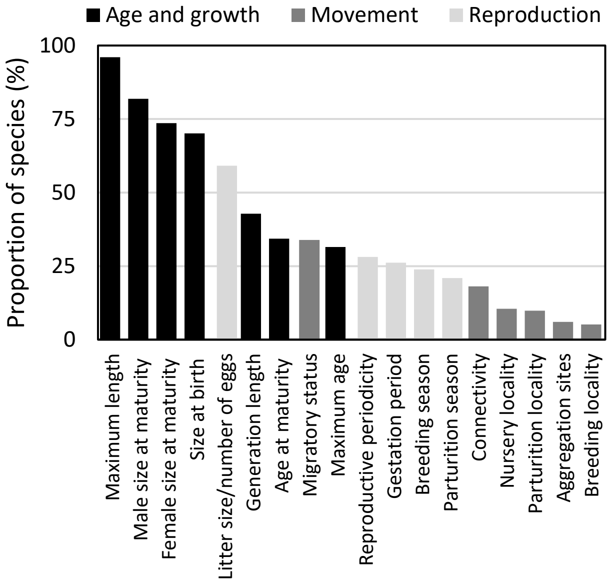


Figure 3.4: Status of available knowledge (percentage of species with available information) within each biological and ecological category for all 224 chondrichthyan species present within the Western Indian Ocean. Information categories are grouped into the general themes of Age and growth (black bars), Movement (dark grey bars) and Reproduction (pale grey bars).

Age and growth information

The general availability of age and growth information is noteworthy, as this information is used for assessing the threat categories of species and informing size limits in fisheries. Validated age and growth estimates are necessary for developing realistic age-structured population dynamic models for chondrichthyans, particularly those which are exploited (Cailliet et al. 2006). The status of exploited chondrichthyan stocks and their propensity to recover from periods of overfishing can also be evaluated using reliable age and growth estimates (McAuley et al. 2006). Age at sexual maturity is an essential factor in population assessments (Passerotti et al. 2014) as it is used to calculate generation length (the mean age of parents in a cohort), which represents the turnover rate of reproducing individuals in a population (IUCN 2019). As such, generation length is a key component of the IUCN Red List Assessment process (IUCN 2019) and is therefore an important tool for assessing the conservation status of chondrichthyans. Age at maturity is also important information for management, as it determines the age at which an individual is able to start reproducing and thus affects the species' reproductive potential (Cameron et al. 2014). This is an important factor when evaluating the age (and associated size) at which a species should first recruit into a fishery and can therefore inform the setting of minimum size limits. Understanding aspects of the age and growth of chondrichthyan species can thus help to inform management measures to reduce their susceptibility to capture in various fisheries, particularly through minimum or maximum allowed size limits. While there is age and growth information available for most chondrichthyan species in the WIO, there remain certain species for which this information is not available, particularly several threatened species, as highlighted in a subsequent threatened species section.

Movement/area use information

The limited information available on chondrichthyan movement and critical areas for reproduction (breeding, parturition and nursery localities) (Figure 3.4) is problematic. Movement behaviour informs whether or not chondrichthyan species aggregate in known areas at predictable times of year, which can make them vulnerable to capture in high numbers. As such, these aggregation sites warrant strict protection from fisheries. Cases in point are the aggregations of reef and giant manta rays *Mobula alfredi* and *M. birostris* in southern Mozambique, as sightings of these species over a 14-year period declined by 90%, largely attributable to increased mortality from fisheries (Rohner et al. 2017). Similarly, breeding, parturition and nursery localities are crucial areas for reproductive success. The capture of individuals during breeding and parturition events reduces the reproductive potential of the population, while mortality of a pregnant female is effectively mortality of multiple individuals, and both of these impacts affect the population's sustainability. Similarly, the capture of neonates and juveniles in nursery areas removes individuals during their most vulnerable life stage, while they are present in large numbers in areas which have historically been beneficial for their feeding and growth, and within which they receive protection from predators (Heupel et al. 2018). The capture of individuals in any of these areas will have detrimental effects on population decline, as they are removed before they are able to contribute to population growth.

Marine protected area effectiveness is largely dependent on the extent to which the protected area covers the species' distribution range (or individual home ranges), or at least incorporates an area which is crucial to their life history, such as key areas for their reproduction (Rigby et al. 2019). This is particularly important for migratory and potentially migratory species, as their mobile nature means that MPAs may not be the most effective management approach (Simpfendorfer et al. 2011), as individuals of most of these species will likely have home ranges considerably exceeding the geographic area of most MPAs. However, understanding aspects of shark and ray spatial ecology (such as habitat use, migration routes, times and locations), can inform spatial and temporal management measures, such as spatial protection that covers a critical habitat (e.g., a nursery site), seasonal closures to protect a species during an important life-history event (such as parturition), or a combination (spatio-temporal measures) that protect a certain habitat at a certain time of year, which could greatly benefit the species during critical or vulnerable life-history phases. Such management measures can be crucial for wide-ranging species, as they are at a disproportionately higher risk from being exposed to variable management regulations and multiple fisheries in different areas. As such, fine-scale movement information for threatened shark and batoid species should be prioritized, through sampling techniques such as satellite tagging and acoustic telemetry. Such information would help to elucidate core home ranges and hotspot areas for the most threatened shark and ray species, and inform spatial protection measures, such as closed areas for fishing or area-specific gear restrictions, thus contributing to the planning and efficacy of future MPAs (Rigby et al. 2019). Research regarding these important aspects relating to movement behaviour should thus be prioritized.

One specific category (incorporated under movement in this assessment) is population connectivity. The levels of genetic connectivity and population structure of chondrichthyan species in the WIO are also poorly understood, with such information available for less than 20% of WIO chondrichthyan species (Figure 3.4). The limited knowledge on these aspects inhibits the effective management of WIO chondrichthyan species. A lack of connectivity among populations or coastal areas could render the species (or one or more populations) more at risk of localised depletion, and may require different management strategies, depending on the area and threats faced. In contrast, higher connectivity can provide a lifeline for depleted stocks in one area from seeding stocks in other areas, but simultaneously means that poor management or overexploitation in one area can have negative consequences in other areas, thereby necessitating more regional (multinational) management measures for such a species or population. Therefore, research to provide information on population connectivity, particularly for threatened migratory and possibly migratory species, should be prioritized.

Reproduction information

Information relating to reproductive periodicity, gestation period, and breeding and parturition seasons is also limited for chondrichthyans in the WIO (Figure 3.4). Reproductive periodicity, gestation period and litter size/number of eggs determine reproductive rates and the rate at which a population can grow. Information on breeding, parturition and nursery periods is crucial for informing temporal protection measures, such as seasonal closures, as capture during these times could negatively impact reproductive success. Together with information on movement patterns and habitat use, knowledge regarding the reproductive timing of each species can help to inform where shark- and ray-specific MPAs should be located, the required spatial coverage to adequately protect these species from fisheries and other threats, and times when exploitation of specific species should be prohibited (Rigby et al. 2019).

Considering the renewed focus this decade to protect 30% of land and ocean by 2030, the establishment of MPAs which consider the unique characteristics of threatened species of chondrichthyans can ensure that MPAs play a vital role in safeguarding and conserving these populations (Rigby et al. 2019). Therefore, research on chondrichthyan movement patterns and reproductive biology and ecology need to be prioritized in the WIO to ensure that future MPAs provide improved protection for chondrichthyan species in the region.

Taxonomic clarification and species distributions

There are numerous uncertainties regarding chondrichthyan species distributions in the WIO, particularly for less common species, such as the nurse sharks (Ginglymostomatidae), and deepwater species that are encountered less frequently, such as gulper sharks (Centrophoridae) and dogfish sharks (Squalidae). Understanding the spatial ecology of chondrichthyans is essential for understanding the risks they face and is thus important for informing species-specific management decisions (Hefley and Hooten 2016). This includes uncertainly regarding the overlap in distribution ranges of similar-looking species, such as the thresher sharks (Alopiidae), requiem sharks (Carcharhinidae) and hammerhead sharks (Sphyrnidae), within each of which there is considerable potential for misidentification, which in turn may lead to inaccurate assessment of distribution ranges. Similar-looking and closely related species can have different life-histories, thus necessitating different management strategies. As such, knowledge on species distribution is a key requirement for informing effective MPA design (Rigby et al. 2019) and other management measures. Knowledge on distribution is particularly important for migratory and potentially migratory species, which comprise 29% of chondrichthyan species in the WIO (Fowler 2014).

Furthermore, there remain several taxonomic uncertainties in the WIO, which in turn have implications for the accuracy of species distributions. The genus *Himantura* (Dasyatidae) represents a species complex, which in the WIO comprises the leopard whipray *Himantura leoparda,* honeycomb stingray *Himantura uarnak* and possibly other species, which complicates accurate species identification. Similarly, the so-called “brown rays” comprise what is thought to be Baraka’s whipray *Maculabatis ambigua*, the pink whipray *Pateobatis fai*, and potentially one or more other species. These two groups of rays within the family Dasyatidae therefore require taxonomic clarification and validation of geographic distributions within the WIO. Similarly, the Rhinopristiformes (sawfishes, wedgefishes, guitarfishes and giant guitarfishes) require confirmation of their taxonomic makeup and distributions in the WIO, particularly the wedgefish family (Rhinidae) and the guitarfish genera *Acroteriobatus* and *Rhinobatos*. The taxonomy and species distributions of the '*Rhynchobatus djiddensis*' species complex, which includes at least two wedgefish species – *R. djiddensis* and *R. australiae* – and potentially others, is not fully understood, therefore the known distribution ranges of whitespotted wedgefish *R. djiddensis* and other *Rhynchobatus* species (all of which are Critically Endangered) may change as new information becomes available (Kyne et al. 2019). There is also taxonomic confusion among some of the deepwater shark species, including the families Centrophoridae, Etmopteridae and Squalidae. Clarification of these taxonomic issues and species distribution ranges should be priorities to ensure that species-specific management plans can be formulated for these species. This is particularly important for threatened chondrichthyan species in the WIO.

3.4.3 Status of knowledge on threatened shark species in the Western Indian Ocean

There are 55 threatened shark species in the WIO (Table 3.7). For the majority (69%) of these species, there is information available in at least 50% of the biological and ecological information categories assessed (Figure 3.5) and therefore a fair amount of information available for informing their conservation and management. There are, however, 17 species for which information is available in fewer than 50% of the information categories assessed, including the Endangered little gulper shark *Centrophorus uyato* and angular rough shark *Oxynotus centrina*; and the Vulnerable smallfin gulper shark *Centrophorus moluccensis*, roughskin dogfish *Centroscymnus owstoni*, kitefin shark *Dalatias licha*, longsnout dogfish *Deania quadrispinosa*, brown shyshark *Haploblepharus fuscus*, sicklefin weasel shark *Hemigaleus microstoma*, tawny nurse shark *Nebrius ferrugineus*, and flapnose houndshark *Scylliogaleus quecketti* (Figure 3.5; Table 3.7). Seven shark species have information available in fewer than 25% of the information categories assessed, including the Endangered African gulper shark *Centrophorus lesliei*, honeycomb catshark *Holohalaelurus favus*, and African spotted catshark *H. punctatus*; and the Vulnerable speckled catshark *Halaelurus boesemani*, tiger catshark *H. natalensis*, Natal shyshark *Haploblepharus kistnasamyi*, and whitetip weasel shark *Paragaleus leucolomatus* (Figure 3.5).

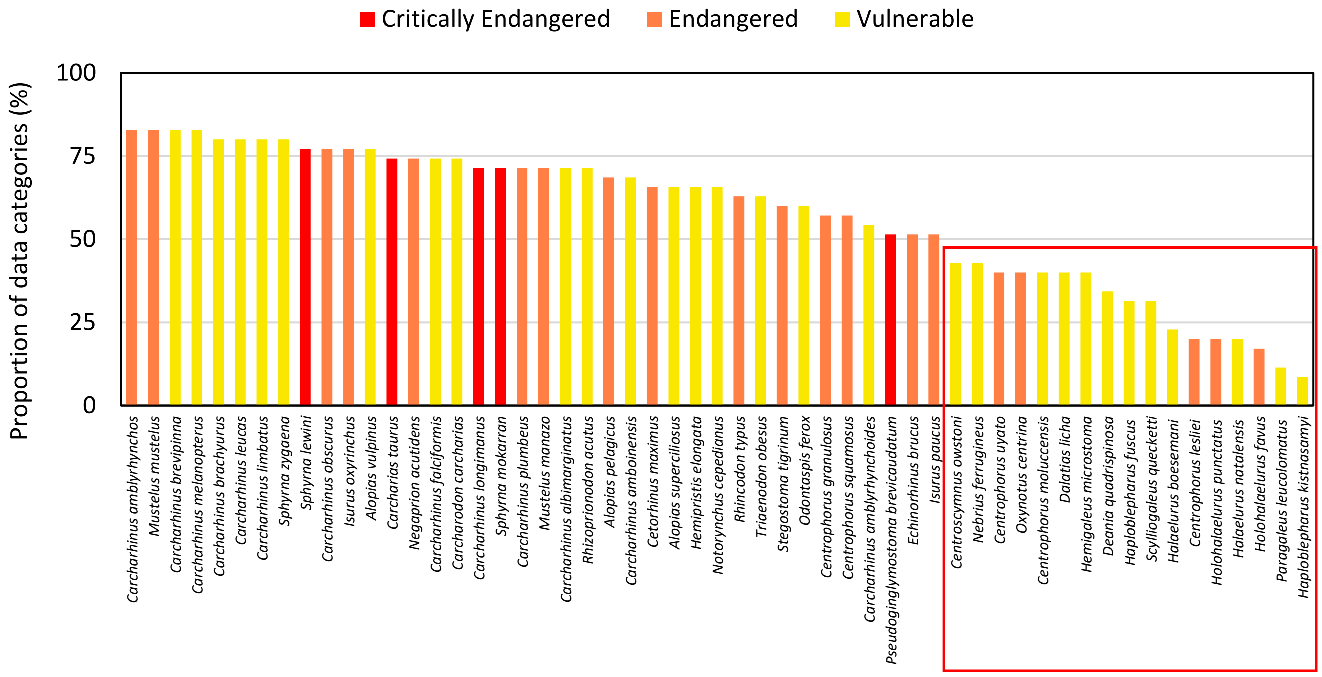


Figure 3.5: Status of available knowledge (percentage of data categories with available information, per species) on aspects of biology and ecology (i.e., reproductive periodicity, gestation period, litter size/number of eggs, breeding locality, breeding season, parturition locality, parturition season, nursery locality, migratory status, connectivity, aggregation sites, size at birth, male and female size at maturity, age at maturity, maximum length, maximum age and generation length) for each threatened shark species in the Western Indian Ocean. Red box indicates data-poor species (those shark species for which information is available in less than 50% of the information categories needed to inform their conservation and management).

In general, the majority of threatened shark species in the WIO lack information relating to breeding, parturition and nursery localities, and connectivity and aggregation sites (Table 3.7). Information relating to reproduction is also lacking for most threatened shark species in the categories of breeding and parturition season (Table 3.7). Therefore, future research in the WIO should focus on these aspects of shark biology and ecology.

More specifically, of the 17 data-poor threatened shark species (i.e., species for which information is available in fewer than 50% of the information categories assessed), nine are primarily coastal (i.e., inhabiting waters less than 200 m deep) and are thus exposed to coastal fisheries and other coastal threats, while eight inhabit primarily deepwater habitats (>200 m). Six of these 17 threatened shark species (35%) belong to the family Pentanchidae (notably all six species which are threatened and belong to the family Pentanchidae are data-poor), and four species (24%) belong to the family Centrophoridae (Table 3.7), and thus these two shark families comprise over half of the threatened, data-poor shark species in the WIO.

These shark species should be prioritized for future research, primarily on aspects relating to movement and reproduction for the species belonging to the family Centrophoridae, and on all aspects (i.e., including age and growth) for all threatened species belonging to the family Pentanchidae (Table 3.7).

Of the remaining seven data-poor threatened shark species, *Centroscymnus owstoni, Dalatias licha*, *Hemigaleus microstoma, Nebrius ferrugineus* and *Oxynotus centrina* primarily require research relating to movement and reproduction (Table 3.7). Although age-and-growth information is available for most chondrichthyans in the WIO (Figure 3.4), these aspects are poorly known for the data-poor *Paragaleus leucolomatus* and *Scylliogaleus quecketti*, in addition to most of the movement and reproduction categories (Table 3.7); as such these aspects should be prioritized for future research on these species.

Of note is that there are no data-poor Critically Endangered shark species in the WIO. However, the oceanic whitetip shark *Carcharhinus longimanus*, ragged-tooth shark *Carcharias taurus,* shorttail nurse shark *Pseudoginglymostoma brevicaudatum* (which is the single most threatened WIO endemic shark species), and the scalloped and great hammerhead sharks *Sphyrna lewini* and *S. mokarran* are assessed as Critically Endangered on the IUCN Red List, and therefore face an extremely high risk of extinction in the wild. These species are also caught in artisanal and commercial fisheries throughout their range in the WIO, and therefore require urgent management intervention. However, there remain several gaps in the biological and ecological knowledge on these species, including aspects such as reproductive periodicity, breeding season and locality, parturition season and locality, nursery localities, connectivity and aggregation sites (Table 3.7), which impedes their effective management. These aspects should thus be prioritized for future research on these Critically Endangered shark species.

Table 3.7: Age and growth, movement/area use and reproduction information categories for threatened shark and batoid species in the Western Indian Ocean. Categories marked with an "x" indicate that information is available in that category for that particular species, while blank spaces indicate that information is lacking or incomprehensive in that category and therefore future research is necessary to fill that knowledge gap. "*" indicates species for which information is available in less than 50% of the categories assessed.

			Age and growth							Movement/Area use						Reproduction				
Family	Species name	IUCN Red List Status	Size at birth	Male size at maturity	Female size at maturity	Age at maturity	Maximum length	Maximum age	Generation length	Breeding Locality	Parturition locality	Nursery locality	Migratory status	Connectivity	Aggregation sites	Gestation period	Reproductive periodicity	Litter size/# eggs	Breeding Season	Parturition season
Batoids																				
Aetobatidae	*Aetobatus ocellatus*	VU	x	x	x	x	x		x				x			x		x		
Dasyatidae	*Bathytoshia lata*	VU	x	x	x	x	x	x	x							x		x		
Dasyatidae	*Himantura leoparda**	VU	x	x			x		x											
Dasyatidae	*Himantura uarnak**	EN	x	x			x		x				x			x		x	x	
Dasyatidae	*Pastinachus ater**	VU	x				x		x									x		
Dasyatidae	*Pateobatis fai**	VU	x	x			x		x				x							
Dasyatidae	*Pateobatis jenkinsii**	VU	x	x			x		x											
Dasyatidae	*Taeniurops meyeni**	VU	x	x			x		x									x		
Dasyatidae	*Urogymnus asperrimus**	VU		x	x		x		x											
Dasyatidae	*Urogymnus granulatus**	VU	x	x			x		x											
Glaucostegidae	*Glaucostegus halavi**	CR	x	x	x		x		x									x		
Gymnuridae	*Gymnura poecilura**	VU	x	x	x		x		x								x	x	x	x
Mobulidae	*Mobula alfredi*	VU	x	x	x	x	x	x	x				x	x		x	x	x	x	x
Mobulidae	*Mobula birostris*	EN	x	x	x	x	x	x	x				x					x		
Mobulidae	*Mobula eregoodoo**	EN	x	x	x		x		x				x			x		x		
Mobulidae	*Mobula kuhlii**	EN	x	x	x		x		x				x			x		x		
Mobulidae	*Mobula mobular*	EN	x	x	x	x	x	x	x				x			x	x	x		
Mobulidae	*Mobula tarapacana**	EN	x	x	x		x		x				x					x		
Mobulidae	*Mobula thurstoni*	EN	x	x	x		x		x				x			x	x	x	x	
Myliobatidae	*Aetomylaeus bovinus**	CR	x	x	x	x	x		x				x			x		x		
Myliobatidae	*Aetomylaeus vespertilio**	EN		x			x		x				x					x		
Myliobatidae	*Myliobatis aquila**	CR	x	x	x		x		x				x			x		x		
Pristidae	*Pristis pristis*	CR	x	x	x	x	x	x	x				x			x		x		
Pristidae	*Pristis zijsron**	CR	x		x	x	x		x											
Rajidae	*Dipturus crosnieri**	VU		x	x		x		x									x		
Rajidae	*Leucoraja wallacei**	VU	x	x	x	x	x	x	x										x	
Rajidae	*Raja ocellifera**	EN					x		x											
Rajidae	*Rostroraja alba*	EN		x	x	x	x	x					x			x		x	x	
Rhinidae	*Rhina ancylostomus**	CR	x	x	x		x		x									x		
Rhinidae	*Rhynchobatus australiae**	CR	x	x	x		x		x									x		
Rhinidae	*Rhynchobatus djiddensis*	CR	x	x	x	x	x	x	x				x					x	x	x
Rhinobatidae	*Acroteriobatus annulatus*	VU	x	x	x	x	x	x	x				x					x		x
Rhinobatidae	*Acroteriobatus leucospilus**	EN	x	x	x		x		x				x					x		
Rhinopteridae	*Rhinoptera jayakari**	EN		x			x		x									x		

Table 3.7 continued

			Age and growth							Movement/Area use						Reproduction				
Family	Species name	IUCN Red List Status	Size at birth	Male size at maturity	Female size at maturity	Age at maturity	Max length	Max age	Generation length	Breeding Locality	Parturition locality	Nursery locality	Migratory status	Connectivity	Aggregation sites	Gestation period	Reproductive periodicity	Litter size/# eggs	Breeding Season	Parturition season
Sharks																				
Alopiidae	*Alopias pelagicus*	EN	x	x	x	x	x	x	x				x				x	x		x
Alopiidae	*Alopias superciliosus*	VU	x	x	x	x	x	x	x				x			x		x	x	
Alopiidae	*Alopias vulpinus*	VU	x	x	x	x	x	x	x				x			x	x	x	x	x
Carcharhinidae	*Carcharhinus albimarginatus*	VU	x	x	x	x	x		x				x			x	x	x	x	X
Carcharhinidae	*Carcharhinus amblyrhynchoides*	VU	x	x	x		x		x				x			x		x		X
Carcharhinidae	*Carcharhinus amboinensis*	VU	x	x	x	x	x		x				x			x	x	x	x	
Carcharhinidae	*Carcharhinus amblyrhynchos*	EN	x	x	x	x	x	x	x				x			x	x	x	x	x
Carcharhinidae	*Carcharhinus brachyurus*	VU	x	x	x	x	x	x	x				x					x	x	x
Carcharhinidae	*Carcharhinus brevipinna*	VU	x	x	x	x	x	x	x				x			x	x	x	x	x
Carcharhinidae	*Carcharhinus falciformis*	VU	x	x	x	x	x	x	x				x			x	x	x	x	
Carcharhinidae	*Carcharhinus leucas*	VU	x	x	x	x	x		x				x	x		x		x		x
Carcharhinidae	*Carcharhinus limbatus*	VU	x	x	x	x	x	x	x				x			x	x	x	x	x
Carcharhinidae	*Carcharhinus longimanus*	CR	x	x	x	x	x	x	x				x			x	x	x		
Carcharhinidae	*Carcharhinus melanopterus*	VU	x	x	x	x	x	x	x				x				x	x	x	x
Carcharhinidae	*Carcharhinus obscurus*	EN	x	x	x	x	x	x	x				x			x	x	x		
Carcharhinidae	*Carcharhinus plumbeus*	EN	x	x	x	x	x	x	x				x			x	x	x		
Carcharhinidae	*Negaprion acutidens*	EN	x	x	x		x		x				x			x	x	x	x	x
Carcharhinidae	*Rhizoprionodon acutus*	VU	x	x	x	x	x	x	x				x				x	x	x	x
Carcharhinidae	*Triaenodon obesus*	VU	x	x	x	x	x	x	x				x			x	x	x		
Carchariidae	*Carcharias taurus*	CR	x	x	x	x	x	x	x				x			x		x	x	
Centrophoridae	*Centrophorus granulosus*	EN	x	x	x	x	x	x	x								x	x	x	
Centrophoridae	*Centrophorus lesliei**	EN		x	x		x		x											
Centrophoridae	*Centrophorus moluccensis**	VU	x	x	x		x		x								x	x		
Centrophoridae	*Centrophorus squamosus*	EN	x	x	x	x	x	x	x					x			x	x		
Centrophoridae	*Centrophorus uyato**	EN	x	x	x		x		x								x	x		
Centrophoridae	*Deania quadrispinosa**	VU	x	x	x		x		x									x		
Cetorhinidae	*Cetorhinus maximus*	EN	x	x	x	x	x	x	x				x	x		x			x	
Dalatiidae	*Dalatias licha**	VU	x	x	x		x		x									x		
Echinorhinidae	*Echinorhinus brucus**	EN	x	x	x	x	x	x	x									x		
Ginglymostomatidae	*Nebrius ferrugineus**	VU	x	x	x		x		x				x						x	
Ginglymostomatidae	*Pseudoginglymostoma brevicaudatum*	CR	x	x	x		x	x	x							x		x		
Hemigaleidae	*Hemigaleus microstoma**	VU	x	x	x		x		x									x		
Hemigaleidae	*Hemipristis elongata*	VU	x	x	x	x	x	x	x				x			x		x	x	x
Hemigaleidae	*Paragaleus leucolomatus**	VU					x		x									x		
Hexanchidae	*Notorynchus cepedianus*	VU	x	x	x	x	x	x	x				x					x		x
Lamnidae	*Carcharodon carcharias*	VU	x	x	x	x	x	x	x				x	x			x	x		x
Lamnidae	*Isurus oxyrinchus*	EN	x	x	x	x	x	x	x				x	x		x	x	x		x
Lamnidae	*Isurus paucus*	EN	x	x	x		x	x	x				x					x		
Odontaspididae	*Odontaspis ferox*	VU	x	x	x	x	x	x	x				x			x		x		
Oxynotidae	*Oxynotus centrina**	EN	x	x	x		x		x								x	x		
Pentanchidae	*Halaelurus boesemani**	VU	x	x	x		x													
Pentanchidae	*Halaelurus natalensis**	VU					x		x				x					x		
Pentanchidae	*Haploblepharus fuscus**	VU		x	x		x		x				x					x		
Pentanchidae	*Haploblepharus kistnasamyi**	VU					x						x							
Pentanchidae	*Holohalaelurus favus**	EN			x		x		x											
Pentanchidae	*Holohalaelurus punctatus**	EN		x	x		x		x											
Rhincodontidae	*Rhincodon typus*	EN	x	x	x	x	x	x	x				x		x			x		
Somniosidae	*Centroscymnus owstoni**	VU	x	x	x		x		x									x	x	
Sphyrnidae	*Sphyrna lewini*	CR	x	x	x	x	x	x	x				x			x	x	x		x
Sphyrnidae	*Sphyrna mokarran*	CR	x	x	x	x	x	x	x				x			x	x	x		
Sphyrnidae	*Sphyrna zygaena*	VU	x	x	x	x	x	x	x				x			x	x	x	x	
Stegostomatidae	*Stegostoma tigrinum*	EN	x	x	x	x	x	x	x							x	x	x		
Triakidae	*Mustelus manazo*	EN	x	x	x	x	x	x	x							x	x	x	x	x
Triakidae	*Mustelus mustelus*	EN	x	x	x	x	x	x	x				x			x	x	x	x	x
Triakidae	*Scylliogaleus quecketti**	VU	x				x									x	x	x		

3.4.4 Status of knowledge on threatened batoid species in the Western Indian Ocean

Proportionally, there are considerably more threatened batoid species (71%) than threatened shark species (31%) that are data-poor (Table 3.7), and thus research on various aspects of batoid biology and ecology is desperately needed to inform their conservation and management. The batoid species for which biological and ecological information is most limited represent at least 10 batoid families; as such, all threatened batoid families should be prioritized for further research. There are 34 threatened batoid species in the WIO, of which 24 species (71%) have information available in fewer than 50% of the information categories assessed, including the Critically Endangered duckbill ray *Aetomylaeus bovinus*, common eagle ray *Myliobatis aquila*, Halavi guitarfish *Glaucostegus halavi*, green sawfish *Pristis zijsron*, bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*; the Endangered greyspot guitarfish *Acroteriobatus leucospilus*, honeycomb stingray *Himantura uarnak*, longhorned pygmy devil ray *Mobula eregoodoo*, shortfin devil ray *M. kuhlii* and sicklefin devil ray *M. tarapacana*; and the Vulnerable Madagascar skate *Dipturus crosnieri*, yellowspot skate *Leucoraja wallacei*, longtail butterfly ray *Gymnura poecilura*, pink whipray *Pateobatis fai*, blotched stingray *Taeniurops meyeni*, porcupine ray *Urogymnus asperrimus* and mangrove whipray *U. granulatus* (Figure 3.6; Table 3.7).

Six of these data-poor, threatened batoid species have information available in less than 25% of the information categories, including the Endangered ornate eagle ray *Aetomylaeus vespertilio*, shorttail cownose ray *Rhinoptera jayakari* and twineyed skate *Raja ocellifera*; and Vulnerable leopard whipray *Himantura leoparda,* broad cowtail ray *Pastinachus ater* and Jenkins whipray *Pateobatis jenkinsii* (Figure 3.6).

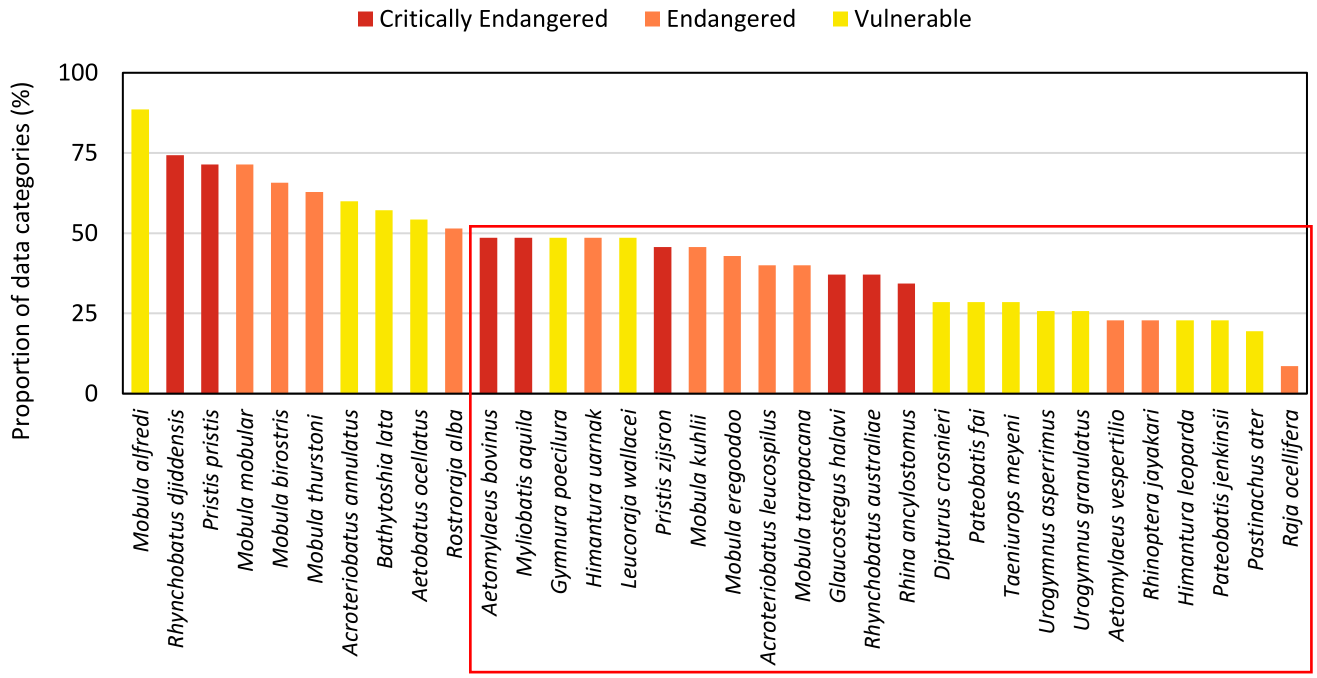


Figure 3.6: Status of available knowledge (percentage of data categories with available information, per species) on aspects of biology and ecology (i.e., reproductive periodicity, gestation period, litter size/number of eggs, breeding locality, breeding season, parturition locality, parturition season, nursery locality, migratory status, connectivity, aggregation sites, size at birth, male and female size at maturity, age at maturity, maximum length, maximum age and generation length) for each threatened batoid species in the Western Indian Ocean. Red box indicates data-poor species (those batoid species for which information is available in less than 50% of the information categories needed to inform their conservation and management).

Aside from *Pastinachus ater* and *Rhinoptera jayakari*, which lack information in most age and growth categories, including female size at maturity, the above-mentioned species generally have information available in the majority of age and growth categories, but lack information in most of the movement and reproduction categories (Table 3.7). Future research on these batoid species should focus particularly on age at maturity, maximum age, generation length and all aspects of movement and reproduction, as these species face a high to extremely high risk of extinction in the wild, yet there is very little information available in any of the information categories to inform their effective conservation and management.

In comparison to threatened shark species, 22 (92%) of these 24 data-poor threatened batoid species in the WIO are coastal, and therefore likely threatened by artisanal fisheries, which are known to primarily operate in the coastal zone. The main data gaps for these species include information related to age at sexual maturity, maximum age, breeding, parturition and nursery localities, migratory status, connectivity, aggregation sites, gestation period, reproductive periodicity and breeding and parturition seasons (Table 3.7). It is vital that research is prioritized for these species in each of these information categories, particularly for the coastal species, as they would benefit from appropriately designed gear restrictions, and spatial and temporal protection measures.

In addition to these data-poor, threatened batoid species, the whitespotted wedgefish *Rhynchobatus djiddensis* is also Critically Endangered (Kyne et al. 2019) and a confirmed target in the shark fin trade within the WIO, with a recent assessment highlighting a significant population decline in South Africa over the past three decades (Daly et al. 2020). Although information is available for this species in 74% of the information categories assessed, there remain considerable knowledge gaps that impede the effective management of this species, including taxonomic clarification and confirmation of its distribution range, genetic connectivity and nursery localities, which should all be considered research priorities.

3.4.5 Research on IUCN Data Deficient species

The species identified here as being data-poor are threatened species, for which there is limited available ecological and biological information that could inform their management. They should not be confused with Data Deficient species, defined by the IUCN Red List of Threatened Species as species for which insufficient information is available to assess the risk of extinction based on their distribution and/or population status (IUCN 2019).

Research should also be prioritized for all Data Deficient chondrichthyans (i.e., classified by the IUCN), particularly those species known to be caught in one or more fisheries. At least half of the Data Deficient chondrichthyan species in the Northeast Atlantic and Mediterranean have been predicted to fall within a threatened Red List category (Walls and Dulvy 2020). There are 17 batoid, 16 shark and four chimera species classified as Data Deficient in the WIO, therefore there is a strong possibility that some of these species would fall within a threatened category, and therefore research on these species should be prioritized.

3.5 Conclusions

The WIO is considered a global hotspot for chondrichthyan evolutionary distinctiveness, species richness and endemism (Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020) and, unfortunately, a global hotspot for threatened chondrichthyan species. These factors make the WIO a priority area for chondrichthyan conservation to ensure these unique lineages are not lost (Stein et al. 2018). Chondrichthyan species also perform important ecological roles that help to maintain the functioning of the ecosystems in which they are found, and imbalances caused by the removal of these apex and mesopredators can have severe negative impacts on other components of the ecosystems, such as the stocks of more resilient fish species on which fisheries depend (particularly artisanal fisheries in coastal areas). Chondrichthyan populations therefore need to be very carefully managed, to ensure their sustainability and the balance of the ecosystems around them.

However, the importance of the region for global chondrichthyan fisheries catches and the extent of artisanal fisheries landing these species from nearshore areas (which harbour the greatest diversity) cannot be understated. The impacts of intensive fishing operations in the WIO on the vulnerable life-history strategies of chondrichthyan species have resulted in considerable population declines, with two fifths (40%) of the 224 known WIO chondrichthyan species now considered threatened. A global assessment of reef shark abundance using BRUV surveys highlighted the WIO (Kenya and Tanzania in particular) as having some of the lowest reef shark abundances globally (MacNeil et al. 2020). At current levels of fishing pressure and without effective management interventions, further declines in stock status are inevitable for many WIO chondrichthyan species, and further local extinctions are likely. Improved management measures and conservation efforts (particularly reduction of fishing mortality) are therefore urgent (Dulvy et al. 2021).

Effective management and conservation depend, *inter alia*, on robust scientific information, the level of which is currently inadequate for most WIO chondrichthyan species. Further research is critical for filling relevant data gaps, if management is to be improved. Research priorities include: stock assessments for chondrichthyan species known to be caught in fisheries; confirmation of species distributions; movement behaviour including migratory patterns, temporal movement patterns, fine-scale movements, habitat use and the identification of aggregation, mating, parturition and nursery areas; genetic connectivity; reproductive biology and ecology; and (for fewer species) age and growth aspects such as age at maturity and maximum age. Such information will help to elucidate critical habitats and hotspot areas for the most threatened chondrichthyan species, and inform spatial and temporal protection measures, such as closed areas and closed seasons. The clarification of taxonomic uncertainties should also be seen as a priority.

Information gaps are particularly problematic for threatened species, as such species are the priority taxa requiring urgent management intervention. The family Pristidae (sawfishes) is the most threatened chondrichthyan family, with both species known from the WIO now potentially extirpated from much of the WIO region; however, while this family requires conservation, the allocation of conservation and research resources to these species should be balanced against the needs of other threatened species, which still have viable populations in the WIO and may still be prevented from further declines and local extirpations. Aside from the Pristidae, the most threatened families in the WIO include the Rhinidae (wedgefishes), Sphyrnidae (hammerhead sharks), Glaucostegidae (giant guitarfishes), Rhinobatidae (guitarfishes), Rhinopteridae (cownose rays), Mobulidae (manta and devil rays), Myliobatidae (eagle rays), Alopiidae (thresher sharks), Lamnidae (mackerel sharks) and Centrophoridae (gulper sharks), which should all be considered as priorities for research. This is not a finite list of priority taxa, and there are other data-poor threatened chondrichthyan species in the WIO (e.g., in the families Dasyatidae, Carcharhinidae and Pentanchidae). The research needs of such species should also be prioritized.

The chondrichthyan families most at risk in the WIO are largely the same as those identified as being globally at risk (Dulvy et al. 2021); these being predominantly larger-bodied sharks and batoids, particularly those of fishery value or value to the global shark fin trade (which also includes shark-like rays – wedgefishes, guitarfishes, sawfishes) and the mobulid gill plate trade. Species that occupy shallow coastal waters and which are consequently accessible to multiple fisheries, from artisanal to industrial fisheries, are under severe threat (Dulvy et al. 2014). Fishing impacts on a species are likely to differ among fisheries and fishery sectors, due to differential fishing gears, fisher behaviours, depths fished and numerous other factors that may vary, which may result in the capture of different size classes, or during different life-history stages. The combined impacts of multiple fisheries on a species are therefore likely to have significantly greater consequences (Cashion et al. 2018), and bring about conflict among fisheries, and such species therefore require careful management attention, particularly if they are threatened, or Data Deficient.

Finally, other information essential for improved management is the level of fishery mortality, and fishery catch rates, to understand the impacts of fishing. These are addressed in the following chapter.

CHAPTER 4

Chondrichthyan Fisheries and Trade in the Western Indian Ocean

4.1 Compilation of chondrichthyan catch and trade data for the Western Indian Ocean

4.1.1 Chondrichthyan catch and trade

International market demand for chondrichthyan products in all forms (meat, fins and derivatives) has been a key driver of chondrichthyan fishing worldwide for several decades and has an estimated total declared value of USD1 billion (Dulvy et al. 2014, Dent and Clarke 2015). The lucrative trade in fins from sharks – and from shark-like rays such as the Pristidae (sawfishes), Rhinobatidae (guitarfishes) and Rhinidae (wedgefishes), and chimaeras – remains largely unregulated across the more than 80 countries and territories that are known to export fins, primarily to Hong Kong Special Administrative Region (hereinafter Hong Kong) and other East Asian countries (Dulvy et al. 2014, Eriksson and Clarke 2015). The fin trade supports the demand for the highly valuable ceratotrichia – keratin-based fibres found in shark fins and which form the basis of shark fin soup. At least 76 chondrichthyan species are known from the Hong Kong shark fin trade, but dominant species include blue sharks *Prionace glauca,* silky sharks *Carcharhinus falciformis,* blacktip sharks *C. limbatus*, shortfin mako sharks *Isurus oxyrinchus,* scalloped hammerhead sharks *Sphyrna lewini* and smooth hammerhead sharks *S. zygaena* (Fields et al. 2018), most of which are threatened and/or CITES-listed.

In the Nairobi Convention Area of the Western Indian Ocean (WIO), fisheries play key roles in livelihoods, food security and revenue generation for most countries. Extensive fishing operations exist in all Nairobi Convention Member States, including small-scale (subsistence, traditional and artisanal), semi-commercial, commercial and industrial fisheries, foreign fleets and illegal, unreported and unregulated (IUU) fisheries. Many of these fisheries take chondrichthyans as target or bycatch species, and many contribute to global trade in their products. However, most of these fisheries in the WIO are characterized by poor or inadequate monitoring and reporting, leaving generally poor estimates of the overall impact on chondrichthyan species. However, several monitoring and reporting mechanisms are in place to monitor catch and trade quantities. This chapter provides an overview of available chondrichthyan catch and trade information from the Nairobi Convention Member States and the WIO.

4.1.2 Compilation of chondrichthyan catch data

Nominal catch data (i.e., not including unreported discards, hereinafter referred to as 'catch') in metric tonnes (t) were sourced from the Global Catch production dataset in FishStatJ[26] (FAO 2021), hosted by the Food and Agriculture Organization (FAO) of the United Nations. Since catch data were, at the time of writing, unavailable beyond 2019, catch data are presented for the period 2012–2019. 2012 was chosen as the starting year, to match availability of trade data (see later section). Official catch statistics were sourced for global chondrichthyan catch and chondrichthyan catch by each of the ten Nairobi Convention Member States. Temporal trends were plotted for catches and comparisons were made among the ten States.

It is not possible to disaggregate the fisheries catch data provided by the FAO into specific catch locations, other than broad geographic fishing areas designated by the FAO as Major Fishing Areas[27]. Therefore, all nominal catch data sourced from the Global Catch production dataset in FishStatJ (FAO 2021) are presented at this scale; data are thereby presented throughout this chapter for FAO Major Fishing Area 51 (hereinafter FAO Area 51; see Figure 2.1 in Chapter 2). Note that the term Western Indian Ocean (WIO), when used in this chapter, is in reference to the focus area of this report (see section 2.3.2 in Chapter 2 for relevant definitions).

[26] https://www.fao.org/fishery/statistics/software/fishstatj/en

[27] www.fao.org/fishery/area/search/en

The FAO is responsible for compiling international fisheries catch statistics, but these are based on the voluntary reporting of catch statistics by each country. In most countries, chondrichthyan species landed are reported together in broader groups such as 'Sharks, rays, skates, etc. nei[28]' and 'Rays, stingrays, mantas nei'. To determine the composition of chondrichthyan catch by the Nairobi Convention Member States relative to the global chondrichthyan catch, the following analyses were undertaken:

1) Global chondrichthyan catch was plotted as chondrichthyan catch (all species) from all oceans;
2) The contribution of the total chondrichthyan catch of the Nairobi Convention Member States to global catch was calculated for all oceans and for the FAO Major Fishing Area 51[29].

4.1.3 Compilation of chondrichthyan trade data

Trade statistics from several official sources were collected and analysed for each of the ten Nairobi Convention Member States. Decadal trends were plotted for exports and reported imports, and direct comparisons were made among all ten States.

Data on the trade in chondrichthyan products (import and export mass in kg (converted to t), and values in United States Dollars, USD) were sourced from the United Nations International Trade Statistics Database[30] (UN Comtrade) for each of the Nairobi Convention Member States. UN Comtrade contains import and export records reported by statistical authorities around the world. All traded commodities are recorded internationally using standardized trade codes. The Harmonized System (HS) is the system used most commonly for fisheries products; hence, HS codes were used to obtain data on global exports of all chondrichthyan products, by performing a search for all chondrichthyan exports from Nairobi Convention Member States to the world, in addition to imports reported by all countries as originating in Nairobi Convention Member States. The HS codes and their descriptions for traded chondrichthyan products used to source country-specific trade data from UN Comtrade are presented in Table 4.1. As fin-specific codes for sharks and batoids were introduced in 2012, trade data are presented for the period 2012–2019 (ending in 2019 to align with the available catch data).

Table 4.1: World Customs Organization Harmonized System (HS) codes and their descriptions for traded chondrichthyan products used to source country-specific trade data for Nairobi Convention Member States from UN Comtrade from 2012–2019 (*specific codes for shark fins were available only from 2012).

HS Code	Meat description
030265	Dogfish & other sharks, fresh/chilled (excl. fillets/other fish meat of 03.04/livers & roes)
030281	Fish; fresh or chilled, dogfish and other sharks, excluding fillets, livers, roes, and other fish meat of heading 0304
030282	Fish; fresh or chilled, rays and skates (Rajidae), excluding fillets, livers, roes, and other fish meat of heading 0304
030375	Dogfish & other sharks, frozen (excl. fillets/other fish meat of 03.04/livers & roes)
030381	Fish; frozen, dogfish and other sharks, excluding fillets, livers, roes, and other fish meat of heading 0304
030382	Fish; frozen, rays and skates (Rajidae), excluding fillets, livers, roes, and other fish meat of heading 0304
030447	Fish fillets; fresh or chilled, dogfish and other sharks
030448	Fish fillets; fresh or chilled, rays and skates (Rajidae)
030456	Fish meat; excluding fillets, whether or not minced; fresh or chilled, dogfish and other sharks
030457	Fish meat; excluding fillets, whether or not minced, fresh or chilled, rays and skates (Rajidae)
030488	Fish fillets; frozen, dogfish, other sharks, rays and skates (Rajidae)
030496	Fish meat, excluding fillets, whether or not minced; frozen, dogfish and other sharks
030497	Fish meat, excluding fillets, whether or not minced; frozen, rays and skates (Rajidae)
HS Code	**Fins description***
030292	Fish; fresh or chilled, shark fins
030392	Fish; frozen, shark fins
030571	Fish; edible offal, shark fins
160418	Fish preparations; shark fins, prepared or preserved, whole or in pieces (but not minced)

[28] Nei refers to "*not elsewhere included*", i.e., volumes of catches for species not specified at a more specific level
[29] South Africa is the only Nairobi Convention Member State with two oceans and, where possible, statistics were differentiated between the two. When they could be differentiated, data were presented for both oceans for contextual purposes.
[30] www.comtrade.un.org

The trade dynamics and consumer markets for meat and fin products are quite different and are therefore summarized separately here. More detailed trade codes are available from Hong Kong (Table 4.2), therefore data on the shark fin trade were also sourced from the Interactive Data Dissemination Service for Trade Statistics[31] (Trade – IDDS) which captures import and export data reported by the Census and Statistics Department of Hong Kong.

Table 4.2: Hong Kong's 8-digit codes and their descriptions for traded chondrichthyan products used to source country-specific trade data for Nairobi Convention Member States from the Interactive Data Dissemination Service for Trade Statistics from 2012–2019.

Code	Description:
3029200	Shark fins, fresh or chilled
3039200	Shark fins, frozen
3057111	Shark fins, dried, salted, with or without skin, with cartilage
16041800	Shark fins, prepared or preserved, whole or in pieces, but not minced

To determine the level of chondrichthyan trade from Nairobi Convention Members States in relation to the global chondrichthyan trade, the following analyses were undertaken:

1) Chondrichthyan exports globally and by Nairobi Convention Member States were plotted for the period 2012 to 2019;
2) Exported volumes (total and per product) of each Nairobi Convention Member State were plotted.

It should be noted that although catch data were available for Tanzania and Zanzibar separately, trade data were for available only for the United Republic of Tanzania (i.e., not disaggregated between Zanzibar and Tanzania). Similarly, although the French Departments of Mayotte and La Réunion are presented separately in the UN Comtrade database, data were not available for either Department.

4.2 Chondrichthyan fisheries and catch statistics in the Western Indian Ocean

4.2.1 Fisheries in the Western Indian Ocean

Reported chondrichthyan catch levels in FAO Area 51 were reported to be the third highest of all FAO Major Fishing Areas globally, from 1990–2019, after the Western Central Pacific Ocean and the Eastern Indian Ocean (FAO 2021). However, catches in Area 51 have declined drastically in the last two decades, after reaching a peak of 180,000 t in 1996, with an average of 87,763 t reported annually from 2009 to 2019 (FAO 2021), despite more widespread monitoring and improved reporting throughout the region (Kiszka and van der Elst 2015).

This decline may be a result of reduced targeting of chondrichthyan species due to stricter catch regulations (e.g., those adopted by the Indian Ocean Tuna Commission, IOTC) or trade controls (such as those adopted by CITES), and/or may reflect actual population declines. The latter should raise alarms for chondrichthyan management in the WIO. The reported declines may also have resulted from reduced reporting of catches (with no real change in catch level) of species now subject to catch or trade controls, making it impossible to discern whether or not there have been actual declines in the mortality level of these species.

In addition to reported catches, chondrichthyans are also taken in illegal, unreported and unregulated (IUU) fisheries, with experts and reconstructed catches suggesting that the true total chondrichthyan catch in the WIO is likely to be three to four times greater than reported (Clarke et al. 2006, Worm et al. 2013). This is caused by many countries not submitting data on chondrichthyan catches and trade to the FAO, many fisheries being unregulated, catches in many fisheries not being recorded fully or at all, some products (such as low value chondrichthyan meat) being discarded at

[31] www.censtatd.gov.hk/en/Interactive_Statistics.html

sea, and misidentifications or aggregations of species catch data; the result being a dearth of species-specific catch data that are essential for effective management (Barker and Schluessel 2005, Clarke et al. 2006, Iglésias et al. 2010, Bornatowski et al. 2013).

Industrial fisheries

Longlines, purse seines and pelagic drift nets are used to catch tuna and swordfish, but also chondrichthyans, in FAO Area 51 (Oliver et al. 2015). At least 15 species of chondrichthyan are caught by industrial fisheries here, either incidentally or as targeted catch (Table 4.3). These fisheries are among the most significant causes of chondrichthyan mortality in this region. The main families taken are the Alopiidae (thresher sharks), Carcharhinidae (requiem sharks), Lamnidae (mackerel sharks), and Mobulidae (manta and devil rays), and the most commonly caught species are blue sharks *Prionace glauca*, shortfin mako sharks *Isurus oxyrinchus,* milk sharks *Rhizoprionodon acutus* and silky sharks *Carcharhinus falciformis* (FAO 2021).

Observer programs for industrial fisheries operating in the WIO are inadequate, despite observer coverage of at least 5% of each fishery type being mandated by the IOTC for Contracting Parties and Cooperating Non-Contracting Parties fishing in the IOTC area of competence (IOTC 2011). The inadequate observer coverage has limited data, prevented effective stock assessments, and led to poor understanding of pelagic shark catches in the region (van der Elst et al. 2012).

Table 4.3: Reported total weight (t) by species, of the most commonly caught chondrichthyan species in FAO Major Fishing Area 51 from 2012–2019, as reported to and published by the FAO (FAO 2021).

Family name	Species name	Common name	Annual catch (t) from 2012–2019
Carcharhinidae	*Prionace glauca*	Blue shark	68,767
Lamnidae	*Isurus oxyrinchus*	Shortfin mako	17,257
Carcharhinidae	*Rhizoprionodon acutus*	Milk shark	18,244
Carcharhinidae	*Carcharhinus falciformis*	Silky shark	18,106
Dalatiidae	*Dalatias licha*	Kitefin shark	8,223
Carcharhinidae	*Carcharhinus sorrah*	Spottail shark	4,669
Carcharhinidae	*Carcharhinus dussumieri* *	Whitecheek shark	4,289
Alopiidae	*Alopias pelagicus*	Pelagic thresher	2,427
Rhinidae	*Rhynchobatus spp.*	Giant guitarfish	2,062
Mobulidae	*Mobula mobular*	Spinetail mobula	1,748
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	802
Somniosidae	*Centroscymnus coelolepis*	Portuguese dogfish	770
Mobulidae	*Mobula birostris*	Giant manta	555
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead	381
Dasyatidae	*Himantura gerrardi* **	Sharpnose stingray	380
Total			**148,680**

* *Carcharhinus dussumieri* is not considered present in the WIO (as defined in this report), therefore this indicates misidentification or catches taken within FAO Major Fishing Area 51 but outside of the WIO as defined herein, or indicates misidentification.

** *Himantura gerrardi* is a synonym of the currently valid *Maculabatis gerrardi*, whose presence is currently questionable in the WIO. This may be a misidentification of the species *Maculabatis ambigua*, considered common in the WIO. Further taxonomic research is needed to clarify this query.

Gillnets (drifting and demersal) have major impacts on chondrichthyans. Pelagic/drifting gillnets contribute more than half of the total shark bycatch reported to the IOTC, with the main species affected being smooth hammerhead sharks *Sphyrna zygaena*, crocodile sharks *Pseudocarcharias kamoharai*, pelagic thresher sharks *Alopias pelagicus*, silky sharks *C. falciformis*, scalloped hammerheads *S. lewini* and longfin mako sharks *Isurus paucus* (Murua et al. 2018).

Longline fisheries cause some of the greatest proportions of incidental catch and discards in Indian Ocean tuna fisheries (Ardill et al. 2013), with blue sharks *Prionace glauca* dominating chondrichthyan catches (Oliver et al. 2015). The actual chondrichthyan catch of FAO Area 51 longline fleets (not targeting chondrichthyans) is estimated to be up to three times that reported to the FAO (Ardill et al. 2013). Even when chondrichthyans are released alive, post-release survival rates may be low (Poisson et al. 2011, 2012, Ellis et al. 2017). The type of leader or trace used affects survival rate. The Portuguese fleet uses wire leaders and records high mortality levels of thresher sharks *Alopias* spp., silky sharks *C. falciformis*, oceanic whitetips *C. longimanus,* mako sharks *Isurus* spp., and blue sharks *P. glauca*, although 75% of *P. glauca* and most batoids appear to survive. The France-Réunion fleet reported an 80% reduction in the number of sharks caught after switching from wire to nylon leaders. Mortality of *C. falciformis* and *C. longimanus* can be reduced by up to 24% and 37%, respectively, with the use of nylon traces (Harley and Pilling 2016).

The purse seine fishery operating in the WIO, which deploys Fish Aggregation Devices (FADs), catches *C. falciformis* incidentally (this is the dominant chondrichthyan), with the highest catch rates observed in the northern fishing grounds (2°N, 53°E), north of the Seychelles (Amandè et al. 2008, 2011). The use of FADs causes direct fishery mortality of *C. falciformis* in purse seine fisheries but also “hidden” mortality from *C. falciformis* entanglement beneath the FADs (Filmalter et al. 2013b). It is estimated that *C. falciformis* entanglement mortality in the Indian Ocean is approximately 5–10 times greater than the known bycatch of this species from purse-seine fleets operating in the region, and at an estimated 480,000–960,000 entangled individuals, reflects the total catch of this species from global fisheries (Filmalter et al. 2013b). An experiment in the Western and Central Pacific found that setting purse-seines on free-swimming tuna schools resulted in substantial reductions in estimated catches of *C. falciformis* (by 83%) and oceanic whitetip sharks *C. longimanus* (by 57%; Peatman and Pilling 2016), while a study in the Eastern Central Pacific found that purse seines set on free-swimming tuna schools result in considerably greater incidental catch of mobulid rays than when nets are set on FADs (Lezama-Ochoa et al. 2017). Mobulids make up the greatest proportion of batoids caught in the Indian Ocean purse seine fishery (Oliver et al. 2015). As such, research should be conducted in the WIO to determine which purse-seine deployment methods would minimize the amount of bycatch in both of these species groups.

Demersal fisheries (predominantly industrial) have major impacts on deepwater chondrichthyan species. Several WIO countries have active demersal fisheries, such as the targeted demersal gillnet fishery for gulper sharks (*Centrophorus* species) in Mozambique and the demersal longline fisheries in South Africa.

Trawl fisheries generally have high proportions of incidental catch, including chondrichthyans, and the mortality of incidentally taken animals is very high (Fennessy and Everett 2015, Oliver et al. 2015). Bottom-trawling is one of the greatest threats to Critically Endangered sawfish (family Pristidae; Harrison and Dulvy 2014), while catches of juvenile sharks (particularly *S. lewini*) can be high when nursery grounds are trawled (Fennessy 1994, Kiilu and Ndegwa 2013). Pelagic trawls pose a much lower threat to chondrichthyans. Experiments indicate that “bycatch reduction devices” (BRDs) can substantially reduce incidental elasmobranch catch in prawn trawl fisheries, but implementation of these measures in the WIO has predominantly been in South Africa and Madagascar only (Fennessy et al. 2008, Kiszka and van der Elst 2015).

Small-scale and artisanal fisheries

Small-scale fisheries are widespread in coastal waters, operating in a diversity of coastal and nearshore habitats, therefore the threats from such fisheries are greatest on coastal species. Gillnets, beach seines, and other non-selective gears are the primary causes of excessive chondrichthyan mortality in near-shore waters in the WIO, with drift gillnets often used to target sharks and bottomset gillnets to target batoids (Kiszka 2012, Temple et al. 2018, 2019, Osuka et al. 2021). However, the extent of incidental and directed take of chondrichthyans in WIO artisanal fisheries is difficult to quantify, as data on these fisheries are limited. Data availability appears to be best in Kenya, Madagascar, Mozambique, Seychelles and Tanzania (e.g., Schaeffer 2004, McVean et al. 2006, Doukakis et al. 2007, Kiszka 2012, Robinson and Sauer 2013, SFA 2016, Temple et al. 2019).

Several studies have assessed chondrichthyan catches in artisanal FAD fisheries (Osuka et al. 2016) and gillnet fisheries in Kenya, with policy recommendations to phase out the use of gillnets with mesh sizes between 20.3 cm and 25.4 cm due to their propensity for catching sharks and batoids (Osuka et al. 2021).

Monitoring of artisanal chondrichthyan catches at selected landing sites in Kenya, Madagascar, Mozambique and Tanzania has also been ongoing since at least 2018. This monitoring has revealed high levels of threatened chondrichthyan species in the catches, with 39%, 43% and 53% of total chondrichthyan catch in Mozambique, Kenya and Pemba Island (Tanzania), respectively, comprised of threatened species (WCS, unpublished data). Similar monitoring programs have been implemented in Somalia, Seychelles and other countries, over certain periods. There is also evidence of high proportions of juveniles of some species, and pregnant females, being caught, including the Critically Endangered scalloped hammerhead shark *S. lewini*. Many species caught are also listed on an Appendix of CITES and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS) or have retention bans imposed by the IOTC, such as thresher sharks *Alopias* spp., silky sharks *C. falciformis*, oceanic whitetip sharks *C. longimanus*, manta and devil rays *Mobula* spp., mako sharks *Isurus* spp., wedgefishes (family Rhinidae) and hammerhead sharks *Sphyrna* spp.

WIOFish (Western Indian Ocean Fisheries), a partnership among most of the Nairobi Convention Member States (excluding France and Somalia), has developed a database that provides a systematic overview of fishing activities (e.g., gears, species, habitats) in the region and, based on a scoring system, highlights areas of fisheries that are data-rich and data-poor (Everett et al. 2017). This platform has potential to support regional management efforts and could even be modified for use as a common data collection and recording system in the region (pers. comm., Sabine Wintner, formerly KZNSB, April 2017).

Few formal stock assessments of chondrichthyan populations have been conducted in the WIO region. Those that have been conducted have primarily relied on catch datasets from South Africa's demersal trawl and pelagic longline fisheries, and the bather protection nets managed by the KwaZulu-Natal Sharks Board. Some stock assessments have also been developed through the IOTC for selected pelagic shark species, however there is generally much uncertainty regarding the results from these assessments (Murua et al. 2018, IOTC 2021a) due to a paucity of good quality data, further highlighting the need for better catch monitoring and reporting.

4.2.2 Official chondrichthyan catch statistics

Global chondrichthyan catches

On average, the annual global reported catch of chondrichthyans in all oceans was 735,761 t per year, for the period from 2012 to 2019. Combined, the Nairobi Convention Member States contributed an annual average of 5% (38,998 t) to this reported catch and, apart from a slight decline from 2018 to 2019, the Nairobi Convention Member State proportion of total catch showed a slight increase since 2012 (Figure 4.1a).

The majority of the global chondrichthyan catch recorded by the FAO for the period 2012–2019 was reported from the Atlantic (37%), Western Central Pacific (15%), Eastern Indian (13%) and Western Indian (i.e., FAO Major Fishing Area 51; 12%) oceans, illustrating that the WIO remains one of the FAO Major Fishing Areas with the highest chondrichthyan catches.

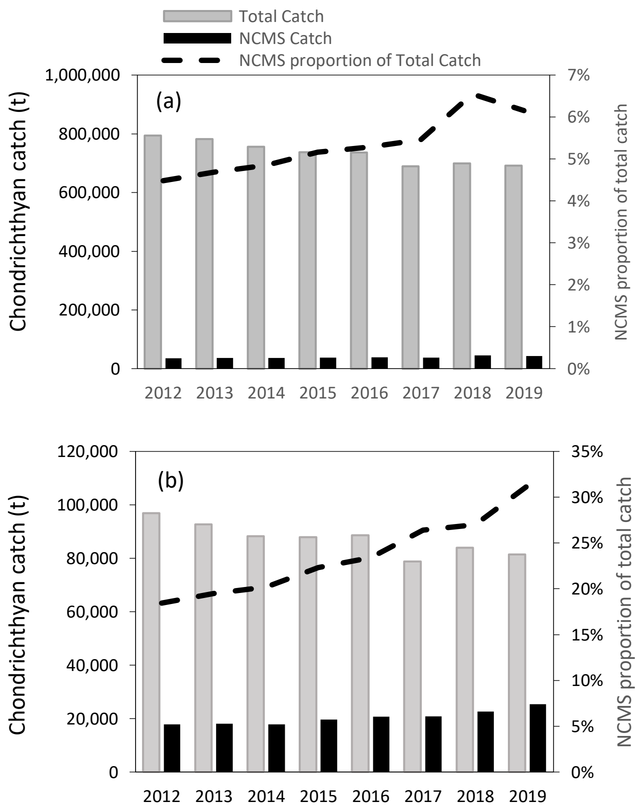


Figure 4.1: Total global and Nairobi Convention Member State (NCMS) chondrichthyan catch (metric tonnes), and contribution (%) of NCMS catch to global catch, reported from a) all oceans and b) FAO Major Fishing Area 51 (2012–2019; FAO 2021).

Chondrichthyan catches in FAO Major Fishing Area 51

From 2012 to 2019, 39 States (including Tanzania and Zanzibar separately) reported chondrichthyan landings from FAO Area 51, totalling 698,576 t (FAO 2021; Table 4.4). This represents approximately 12% of the total global catch of chondrichthyans reported to the FAO during this period (5,867,805 t).

Table 4.4: Countries that reported chondrichthyan landings from FAO Major Fishing Area 51 from 2012–2019, in order of greatest total weight of chondrichthyans caught by each country. Nairobi Convention Member States are highlighted in boldface.

Country	Catch (t)	% of total catch from FAO Area 51
India	123,844	17.73
Iran	99,498	14.24
Tanzania	**74,315**	**10.64**
Yemen	72,878	10.43
Pakistan	66,514	9.52
Oman	61,356	8.78
Madagascar	**39,861**	**5.71**
Taiwan	38,907	5.57
Spain	37,949	5.43
Mozambique	**15,362**	**2.20**
Zanzibar	**13,719**	**1.96**
Kenya	**10,149**	**1.45**
Saudi Arabia	8,604	1.23
Portugal	8,466	1.21
Seychelles	**5,194**	**0.74**
South Africa	**3,822**	**0.55**
United Arab Emirates	3,294	0.47
Japan	3,017	0.43
Republic of Korea	2,190	0.31
United Kingdom	2,004	0.29
Other nei	1,978	0.28
Eritrea	1,369	0.20
China	1,119	0.16
Djibouti	890	0.13
Comoros	**426**	**0.06**
Qatar	402	0.06
Sudan	237	0.03
Bahrain	220	0.03
La Réunion	**196**	**0.03**
Maldives	193	0.03
Sri Lanka	169	0.02
Thailand	133	0.02
Mauritius	**91**	**0.01**
France	67	0.01
Philippines	56	0.01
Mayotte	**47**	**0.01**
Belize	25	0.00
Egypt	9	0.00
Malaysia	5	0.00
Total	698,576	

The majority of chondrichthyan catch in FAO Area 51 is taken by fleets flagged to countries that are not Nairobi Convention Member States (Table 4.4). The country with the highest chondrichthyan catch in FAO Area 51 during this time period was India (123,844 t and 17.73% of catch from this Fishing Area), followed by Iran (99,498 t; 14.24% of catch) and Tanzania (74,315 t; 10.64% of catch) (Table 4.4). Interestingly, Somalia did not report any chondrichthyan catch from this Fishing Area during the 2012–2019 period. It should be noted that these figures represent catch data made available through the FAO, for its Fishing Area 51, which spans a larger area than the Nairobi Convention Member States, or the WIO as defined for this report (see Chapter 2).

The global annual reported catch of all chondrichthyans from FAO Area 51 alone is presented in Figure 4.1b. The average annual chondrichthyan catch in this Fishing Area for the period 2012–2019 was 87,322 t. The Nairobi Convention Member States contributed an average of ~23% to all chondrichthyan catches reported from this fishing area over the same period (combined annual average of 20,397 t). The Nairobi Convention Member State catch showed a slight increase over that period, while the total catches reported by other countries in this fishing area declined during this period. The majority of chondrichthyan catches reported from FAO Area 51 by all countries (68%), and by Nairobi Convention Member States (87%), were reported in the general categories of 'Sharks, rays, skates etc. nei' and 'Rays, stingrays, mantas nei', highlighting the lack of species-level reporting.

Despite 39 States having reported chondrichthyan catches in FAO Area 51 over the 2012–2019 period, just ten States accounted for 90% of the total combined chondrichthyan catch in this area over this period (Figure 4.2a). Madagascar, Mozambique and Tanzania are the only Nairobi Convention Member States in this "top 10" list of countries, contributing a combined 20% to the total chondrichthyan catch reported from this Fishing Area. This finding indicates that most Nairobi Convention Member States fishing in FAO Area 51 are catching negligible quantities of chondrichthyans relative to the top 10 chondrichthyan-catching countries in this Area, or it could reflect poor reporting on chondrichthyan catches by other Nairobi Convention Member States.

India reported the highest levels of chondrichthyan catch from FAO Area 51 for 2012–2019 for all years other than 2018, followed by Iran, while Mozambique caught the lowest chondrichthyan catch of the top-ten countries for all years for 2012–2019 other than 2019 (Figure 4.2b). Interestingly, Mozambique and Tanzania were the only top 10 countries that showed increasing catch trends over this period, while the seven non-Nairobi Convention Member States showed decreasing catch trends, or stable catches (Figure 4.2b).

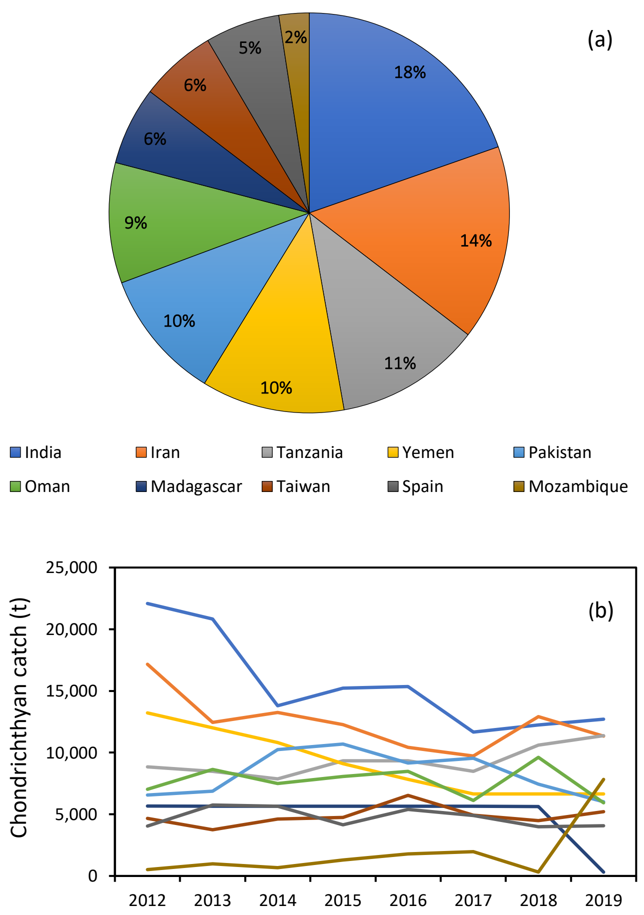


Figure 4.2: Proportions of total (a) and temporal trends in (b) reported chondrichthyan catches by the top ten chondrichthyan-catching countries in FAO Major Fishing Area 51 from 2012–2019 (FAO 2021).

Aside from South Africa, France and Seychelles, no Nairobi Convention Member States reported chondrichthyan catches outside of FAO Area 51. Seychelles reported 5,194 t of chondrichthyans in FAO Area 51 and just 75 t from outside of this Fishing Area. South Africa reported 3,822 t from FAO Area 51 and 21,742 t from other oceans (mostly from the South East Atlantic). France (including Mayotte and La Réunion) reported 310 t from FAO Area 51 and 126,934 t from outside this fishing area.

Nairobi Convention Member State chondrichthyan catches in FAO Major Fishing Area 51

Catches by most Nairobi Convention Member States in FAO Area 51 have remained relatively stable up to the year 2017, after which notable fluctuations in reported catch occurred for Mozambique and Madagascar (Figure 4.3). Chondrichthyan catches reported by Mozambique decreased from around 2,000 t in 2017, to 315 t in 2018, and then drastically increased to 7,825 t in 2019 (Figure 4.3). This may reflect increased targeting of chondrichthyans, or perhaps evidence of effort to improve chondrichthyan catch reporting. Chondrichthyan catches reported by Madagascar remained around 5,650 t from 2012 to 2018, but then reduced significantly to 310 t in 2019 (Figure 4.3); however, the complete lack of variability in the reported Madagascar catches prior to 2019 suggests estimated (and potentially highly inaccurate) catch volumes. During this period, reported catches by Tanzania and Kenya showed generally increasing trends (Figure 4.3), which reflect the overall trend in chondrichthyan catches in FAO Area 51 for all Nairobi Convention Member States combined, over this period (Figure 4.3).

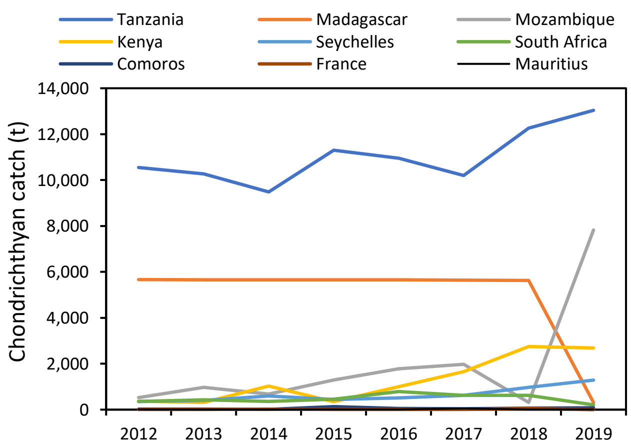


Figure 4.3: Trends in chondrichthyan catches reported by Nairobi Convention Member States from FAO Major Fishing Area 51 from 2012–2019 (FAO 2021). Note that catch statistics for France include records for Mayotte and La Réunion and statistics for Tanzania include records for Zanzibar.

Although Mauritius is a major hub in the WIO for the transhipment of tuna and tuna-like species, and thus sharks (Mamode 2011, Beeharry et al. 2013, Government of Mauritius 2015), the average annual reported chondrichthyan catch from Mauritian vessels from 2012–2019 was just 11 t (Table 4.5). Comoros and Mayotte also reported low annual average chondrichthyan catches from FAO Area 51, at 53 t and 6 t, respectively. Tanzania reported the highest chondrichthyan catch from 2012–2019 from FAO Area 51 at an annual average of 9,289 t, nearly double the next highest annual average of 4,983 t reported by Madagascar (Table 4.5). Together, Madagascar and Tanzania caught 114,176 t of chondrichthyans from FAO Area 51 from 2012–2019, representing 70% of chondrichthyans caught by Nairobi Convention Member States in this Fishing Area. Excluding France, 88% of the combined chondrichthyan catch of all Nairobi Convention Member States from 2012–2019 was reported from FAO Area 51. The remaining 12% of chondrichthyan catch over this period occurred in other oceans.

Table 4.5: Summary of reported chondrichthyan catch statistics (metric tonnes, t) from FAO Major Fishing Area 51 (FAO Area 51) and all oceans, from 2012–2019, for each Nairobi Convention Member State (NCMS). Note that catch statistics for France include Mayotte and La Réunion and statistics for Tanzania include Zanzibar.

Country	Catch from FAO Area 51 (t)	% NCMS catch from FAO Area 51	Annual average catch from FAO Area 51 (t)	Catch from all oceans	% NCMS catch from all oceans	Annual average catch all oceans (t)
Comoros	426	0.26%	53	426	0.14%	53
France	310	0.19%	39	127,244	40.78%	15,906
Kenya	10,149	6.22%	1,269	10,149	3.25%	1,269
Madagascar	39,861	24.45%	4,983	39,861	12.78%	4,983
Mauritius	91	0.06%	11	91	0.03%	11
Mozambique	15,362	9.42%	1,920	15,362	4.92%	1,920
Seychelles	5,194	3.19%	649	5,269	1.69%	659
South Africa	3,822	2.34%	478	25,565	8.19%	3,196
Tanzania	88,034	45.58%	11,004	88,034	28.22%	11,004
Total	163,249			312,001		

4.3 Trade in chondrichthyan products

4.3.1 Drivers of trade in chondrichthyan products

Domestic and international trade in chondrichthyan products, primarily shark meat and liver oil, has occurred in the WIO for centuries, as shark meat is a nutritious and relatively cheap source of protein and liver oil was widely used as a waterproofing agent for traditional vessels (Marshall and Barnett 1997). In Tanzania, the liver, internal organs and intestines of chondrichthyans are stored for months, together with products from other fish species and cetaceans, to produce a mixture called 'sifa', which is used as a protective finish on wooden boats (Braulik et al. 2020).

The export of shark fins from Madagascar to China, La Réunion and Zanzibar, and of shark meat, skin and liver oil to the Comoros, was documented in the early 1920's (Petit 1930), while Seychelles expanded its commercial fishing operations in the 1950s to meet the demand for chondrichthyan products in mainland Africa and Asia (Marshall and Barnett 1997). The nature and history of trade in chondrichthyan products in and out of the WIO both highlights the long history of chondrichthyan trade in the region and suggests that trade is both supply and demand driven.

Chondrichthyan meat caught in the WIO appears to be used mostly at a domestic or regional level in the WIO (Samoilys et al. 2015). Until recently, the high demand for shark meat in Kenya resulted in this product being imported from Somalia, Zanzibar and Yemen (Marshall 1997a, Kiszka and van der Elst 2015). However, there is some international trade in chondrichthyan meat from the WIO. Notably, shark meat is exported from South Africa to South America (mainly Uruguay and Brazil) and Europe (Italy, Spain and Portugal) (Okes and Sant 2019), and prior to that large quantities of meat were exported to Australia.

The global trade in shark meat remained stable for a period, with an overall gradual increase over the last decade (Fowler et al. 2021; and Figure 4.4). There has also been a change in terms of the dominant shark meat importing nations, with Uruguay recently emerging as a major re-exporter of frozen shark meat to supply the expanding shark meat markets in South America (Niedermüller et al. 2021).

Shark liver extracts (mostly oils and other hydrocarbons) have had a wide array of uses throughout history, in addition to their waterproofing qualities for use on traditional vessels. In the early 1940s, demand for shark liver oil increased during World War II as it was a valuable source of Vitamin A (da Silva and Bürgener 2007). Squalene and squalane (a hydrogenated version of squalene) are liver extracts used in cosmetics (Kuang 1999), as a high-grade machine oil, as a health food supplement (Vannuccini 1999) and as a component in certain vaccines (Ho et al. 2021). The highest return of squalene comes from the livers of deep-sea chondrichthyans such as gulper sharks *Centrophorus granulosus*, kitefin sharks *Dalatias licha*, Portuguese dogfish *Centroscymnus coelolepis* and chimaeras. These sharks are intensively fished, yet because of their life histories (long-lived, slow-growing and slow-reproducing animals) they are extremely vulnerable to overexploitation. These are also deepwater species, thus limiting opportunities for research, and many remain Data Deficient because of the limited biological and ecological information.

Fins of sharks and shark-like rays are also exported. Fins contributed less than 10% of the 2012–2019 reported chondrichthyan exports from the Nairobi Convention Member States, but this would have amounted to significantly greater revenue than meat exports. There is also evidence of illegal trade in fins from the WIO. Mombasa has a regulated international shark fin and meat trade, although fins sourced from purse seiners and long liners fishing off Mozambique, Zanzibar and Pemba Island, and from artisanal fishers in Somalia, are reportedly exported to Asia from Mombasa, in consignments that are not inspected (IOC-SmartFish 2016). Sharks are also landed without fins in Kenya’s artisanal fishery (WCS, unpublished data), suggestive of illicit trade, while fins (including threatened species) destined for export have been confiscated in Mozambique (Asbury et al. 2021).

Mobulid rays have traditionally been traded for their meat, cartilage and skins but in the last two decades, a market has developed for mobulid ray gill plates, which are used as a medicinal product in Asian communities (Heinrichs et al. 2011, Ward-Paige et al. 2013, Fowler et al. 2021). The market value of the global gill plate trade has been estimated at USD11 million annually and, although the largest documented mobulid fisheries occur in Indonesia, Sri Lanka and India, they are also known to occur in Kenya, Madagascar, Mozambique, Tanzania and potentially other Nairobi Convention Member States, where they are also targeted for their meat (Heinrichs et al. 2011, Stewart et al. 2018).

Chondrichthyan skin has primarily been used for leather, but the level of use in the WIO is unknown. Cartilage, which may include any part of the cartilaginous skeleton, is used as food in China and Japan. The largest market for chondrichthyan cartilage is the pharmaceutical industry, which uses the dried and milled cartilage powder to make pills and capsules, and chondrichthyan cartilage is high in chondroitin and glucosomine sulphate that are used in treating arthritis (Musick and Musick 2011).

There is also demand for live chondrichthyans from the WIO, for the aquarium trade, including threatened species (e.g., the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum*). While some of the trade follows legal processes, there is evidence of trade in live chondrichthyan species in contravention of trade and fishery regulations.

4.3.2 Official chondrichthyan trade statistics

Global chondrichthyan exports

Spain is the world’s largest exporting country of chondrichthyan products (19,000 t per year on average). No Nairobi Convention Member State featured in the top ten exporters of chondrichthyan products, and only South Africa features among the top twenty exporters (2012–2019). Trends in exports by the world’s top chondrichthyan exporting countries suggest that export volumes have been increasing up to 2017, but with a small subsequent decline (Figure 4.4). During the period 2012–2019, a global combined annual average of 105,961 t of all chondrichthyan products (meat and fins) were exported (Figure 4.4).

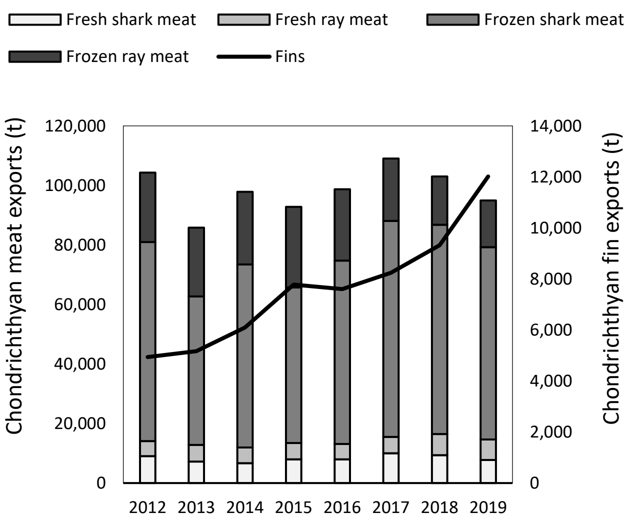


Figure 4.4: Total reported chondrichthyan meat and fin exports from all countries worldwide combined, 2012–2019 (UN Comtrade 2021).

The main chondrichthyan product exported globally by all countries is meat: frozen shark meat accounted for 58.9% of the total global chondrichthyan exports between 2012 and 2019, while frozen ray meat comprised 20.6% (although HS code 030488 comprises "frozen dogfish, other sharks, rays and skates", and so was grouped together with frozen sharks). Fresh shark meat comprised 7.8% and fresh ray meat 5.4% of total chondrichthyan exports during this period, and fins comprised 7.2%. However, while meat exports have declined slightly since 2017 (Figure 4.4), exports of chondrichthyan fins have been steadily increasing over the past eight years, from 4,938 t in 2012 to 2.5 times that in 2019 (Figure 4.4).

Exports by Nairobi Convention Member States

From 2012–2019, Nairobi Convention Member States reported a total of 10,010 t of chondrichthyan exports, at an annual average of 1,252 t (Table 4.6), contributing ~1.2% to global chondrichthyan exports. This closely matches annual average exports from the Nairobi Convention Member States, of 1,244 t over the period 2003–2011, suggesting a relatively stable trade.

Similar to global trade, the main chondrichthyan product exported from Nairobi Convention Member States for 2012–2019 was frozen shark meat (85.34% of total Nairobi Convention Member State chondrichthyan exports). Frozen ray meat comprised 4.55%, and fresh shark and fresh ray meat comprised 0.57% and 0.03% of total Nairobi Convention Member State chondrichthyan exports during this period, respectively. Overall, the export of chondrichthyan meat from Nairobi Convention Member States showed a general increase from 2012 to 2016, followed by a general decline from 2016 to 2019 (Figure 4.5). Approximately 9.5% of chondrichthyan product exported from the Nairobi Convention Member States from 2012–2019 was fins. Although the trade in chondrichthyan fins globally increased year on year from 2012–2019 (Figure 4.4), fin trade from the Nairobi Convention Member States during this period showed a near doubling from 2012 to 2014, then a decline from 2014 to 2017 to less than that reported in 2012, and subsequently increasing again in 2018 and 2019, although the fin trade in 2019 (115 t) was less than the peak in 2014 (170 t; Figure 4.5).

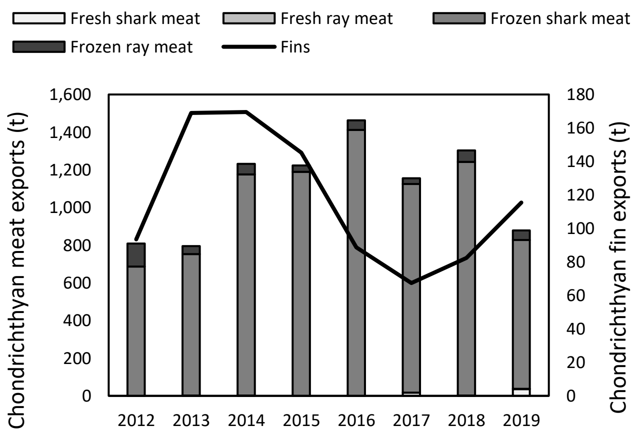


Figure 4.5: Total reported chondrichthyan meat and fin exports from all Nairobi Convention Member States (NCMS) combined, 2012–2019 (UN Comtrade 2021).

South Africa was the main exporter of chondrichthyan products of the Nairobi Convention Member States from 2012–2019, with an annual average of 1,182 t, accounting for ~95% of total exports from these countries (Table 4.6). Mauritius accounted for ~4% (average of 52 t per year) of chondrichthyan export volumes from Nairobi Convention Member States during this period, with Madagascar, Mozambique, Seychelles and Tanzania reporting exports in some years, although negligible by comparison (Table 4.6). There are no official records of any chondrichthyan exports from Comoros, Kenya, La Réunion, Mayotte or Somalia during this period.

Table 4.6: Nairobi Convention Member State (NCMS) exports of all chondrichthyan products (frozen and fresh meat, and fins; in metric tonnes), as reported by each Nairobi Convention Member State (NCMS), total import of chondrichthyan products from each NCMS as reported by the world, and relative discrepancies between these (imports by the world as a multiple of reported exports by each NCMS), from 2012–2019 (UN Comtrade 2021).

Year	Kenya	Madagascar	Mauritius	Mozambique	Seychelles	Somalia	South Africa	Tanzania	NCMS Total
2012	0	0	99.80	0	0	0	851.66	0	951.45
2013	0	0.73	179.52	0	0	0	872.99	0.04	1,053.29
2014	0	0.60	52.83	0	0	0	1,374.51	0.08	1,428.00
2015	0	5.14	60.11	0	0	0	1,333.94	0	1,399.13
2016	0	10.56	12.55	0	0	0	1,534.46	0	1,557.57
2017	0	14.83	2.43	0	24.26	0	1,180.85	0	1,222.37
2018	0	11.42	0	4.58	3.07	0	1,365.46	0	1,384.54
2019	0	15.47	5.35	21.14	26.52	0	945.66	0	1,014.13
Total export volume (reported by NCMS)	0	58.76	412.59	25.72	53.85	0	9,459.53	0.12	10,010.48
Average annual exports (reported by NCMS)	0	7.34	51.57	3.22	6.73	0	1,182.44	0.01	1,251.31
Total import volume (reported by world)	377.23	119.02	2,707.44	1,634.50	1,416.52	131.12	12,785.56	21.66	19,193.07
Variation (world import as multiple of NCMS export)	-	2.0	6.6	63.5	26.3	-	1.4	180.5	1.9
Country contribution (%) to NCMS total exports	0%	0,58%	4.12%	0.26%	0,54%	0%	94.50%	0.00%	

There are major discrepancies in reported chondrichthyan export volumes from several Nairobi Convention Member States, compared to global imports by the rest of world, for products originating in these countries. The overall discrepancy was 9,182.59 t for 2012–2019, with imports as reported by the world being nearly double the exports reported by Nairobi Convention Member States (Table 4.6). The major reporting discrepancies are highlighted below:

- South Africa showed the greatest absolute discrepancy by volume, with total reported exports of 9,459.53 t of chondrichthyan products from 2012–2019, while the rest of the world reported 12,785.56 t of chondrichthyan products imported from South Africa (with imports by the world 1.4 times higher than exports reported by South Africa (Table 4.6).
- However, Tanzania, Mozambique, Seychelles and Mauritius showed the greatest proportional discrepancies, where imports by the world were 180 times, 64 times, 26 times and 6 times, respectively, greater than exports reported by these countries, according to UN Comtrade data (UN Comtrade 2021).
- Kenya reported no chondrichthyan exports from 2012–2019, while Portugal, Spain and Singapore reported a combined total of 377.23 t of shark meat imports from Kenya, during this period (Table 4.6). Furthermore, Hong Kong and Macau reported imports of shark fins, with 87 t imported into Hong Kong from Kenya in this period (Hong Kong Census and Statistics Department 2021). This information reflects gross underreporting (failure to report at all) by Kenya.
- Somalia also reported no chondrichthyan exports from 2012–2019, yet United Arab Emirates, Oman, Hong Kong, Singapore, Malaysia and Canada reported a combined total of 131.12 t of imports of chondrichthyan products originating from Somalia during this period (Table 4.6). Furthermore, Hong Kong reported an average annual import of 17 t per year of shark fin from Somalia for the period 2017–2019. This reflects gross underreporting (failure to report at all) by Somalia.
- This information also reflects discrepancies between UN Comtrade and Hong Kong Census and Statistics Department datasets.

As Hong Kong is the largest importer of chondrichthyan fins globally (Okes and Sant 2019), an analysis of Hong Kong imports of chondrichthyan fins from the Nairobi Convention Member States is provided. An annual global average of 3,370 t of chondrichthyan fins was reported to be imported by Hong Kong during the period 2012–2019 (Figure 4.6). Eight Nairobi Convention Member States (Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania) were reported as exporting countries, with a combined annual average of 144 t per year, accounting for ~3.5% of total chondrichthyan fin imports by Hong Kong (Figure 4.6). While Hong Kong fin imports decreased over the last three years of available data (2017–2019), the relative contribution to these imports originating from Nairobi Convention Member States increased over this period.

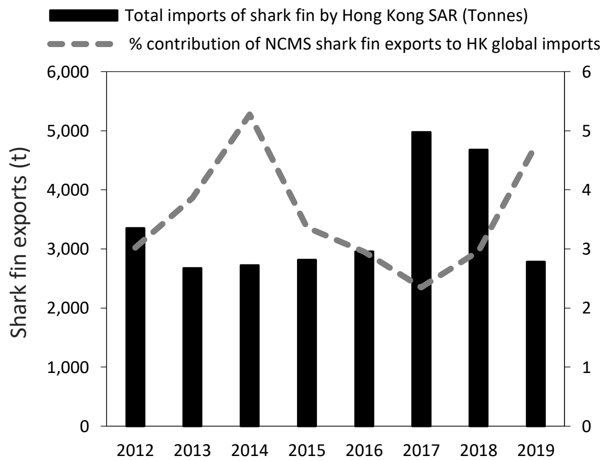


Figure 4.6: Total imports of shark fins by Hong Kong (black bars) and proportion contributed by the ten Nairobi Convention Member States (NCMS, grey line), 2012–2019 (Hong Kong Census and Statistics Department 2021).

No chondrichthyan exports were recorded for Kenya or Somalia in the UN Comtrade database from 2012–2019 (Table 4.6), but both were reported as exporting countries of chondrichthyan fins imported into Hong Kong during the same time period, as reported by the Hong Kong Census and Statistics Department (2021), which highlights the mismatch of reporting on international chondrichthyan trade. This is a serious issue which needs to be addressed, as inadequate reporting, together with weak legislation and ineffective law enforcement facilitate illegal wildlife trade (Batt et al. 2017). Furthermore, there are reports that sharks are sold and transhipped at sea, from Somalia to Yemen (Glaser et al. 2015), and it is possible that this is happening in other countries. This indicates that exports are not reported fully, or at all, from some WIO States. National-level trade statistics and discrepancies therein are discussed in greater detail in the individual country profiles in Chapter 6.

4.3.3 Trade in CITES-listed chondrichthyan species

Currently, 52 chondrichthyan species are included in the CITES Appendices, at least 26 of which are known from the WIO (see Table 3.3 in Chapter 3; Table 5.1 in Chapter 5). At least two of the five chondrichthyan species listed in CITES Appendix I (the largetooth sawfish *Pristis pristis* and green sawfish *Pristis zijsron*), and 24 of the 47 chondrichthyan species listed in Appendix II are known from the WIO. Most CITES-listed shark and batoid species are targeted for their high-quality fins. Some species, such as shortfin mako sharks *Isurus oxyrinchus* and whale sharks *Rhincodon typus* are generally targeted for their high-grade meat, although their fins also enter the fin trade as a by-product (Okes and Sant 2019).

CITES requires detailed reporting of export and import of every shipment of CITES-listed species, including *inter alia* the product, purpose of trade (e.g., scientific or commercial), date, exporting State and importing State. These annual trade data are managed in the CITES Trade Database by the UNEP World Conservation Monitoring Centre. From 2012 to 2019, there were 85 records of CITES-listed chondrichthyan products being exported from Nairobi Convention Member States, of which seven records involved CITES Appendix I species, reportedly for scientific and personal purposes (Table 4.7). All other trade was in Appendix II species (comprising at least 18 different species), for commercial, scientific and educational purposes, and several exports of fins were recorded under the category "circus" (possibly for training purposes). Only six Nairobi Convention Member States have records of trade in CITES-listed chondrichthyan species during this period – Kenya, Madagascar, Mauritius, Mozambique, Seychelles and South Africa, with South Africa having the highest levels of export (46 records) comprising 15 different CITES-listed chondrichthyan species (Table 4.7).

Although at least 16 CITES-listed chondrichthyan species were traded by Nairobi Convention Member

States for circus, educational, personal and scientific reasons from 2012–2019, trade for commercial purposes related to only five species - the oceanic whitetip shark *Carcharhinus longimanus*, great white shark *Carcharodon carcharias*, shortfin mako shark *Isurus oxyrinchus*, scalloped hammerhead shark *Sphyrna lewini* and great hammerhead shark *S. mokarran* (Table 4.7).

Interestingly, the quantities of *S. lewini* traded for commercial purposes from Nairobi Convention Member States from 2012–2019 were low (Table 4.7), and this species was not among the most commonly reported chondrichthyan species caught in FAO Area 51 from 2012–2019 (Table 4.3). However, these officially reported statistics conflict with other published studies documenting that *S. lewini* is caught in high numbers in various fisheries (predominantly artisanal) in the WIO (e.g., Schaeffer 2004, McVean et al. 2006, Robinson and Sauer 2013, Kiilu et al. 2019, Temple et al. 2019). *Sphyrna lewini* is also one of the most common species in the overall Hong Kong fin trade (Fields et al. 2018), indicating that the fins of this species are in great demand. Although the Indian Ocean as a whole contributes only ~8% of *S. lewini* fins entering Hong Kong fin markets (based on a genetic assessment of fin trimmings, Fields et al. 2020), it is reasonable to assume that the high numbers of *S. lewini* caught in Nairobi Convention Member States (but not reported to the FAO or at least not reported at species level) would lead to subsequent trade in products derived from this species. The low official catch and trade volumes reported for this species therefore suggest either that *S. lewini* is actually traded in low volumes, or that there is underreporting of the trade in this species (i.e., in breach of CITES). This was in fact confirmed through genetic analysis of shark fins confiscated in Mozambique in 2018 and 2019, which confirmed *S. lewini* and other CITES-listed species in the illegal fin trade (Asbury et al. 2021; see Table 6.5.3 in Chapter 6). This finding confirms the underreporting of export quantities of CITES-listed chondrichthyan products from the WIO and highlights the need for improved monitoring and enforcement of CITES regulations in the region.

The main CITES-listed chondrichthyan products exported by Nairobi Convention Member States were whole specimens (30 records) and fins (26 records). There was only one record of Mobulid gill plates being traded, from South Africa to Sri Lanka, for educational purposes (Table 4.7). The main reason given for trade in these CITES-listed chondrichthyan species and products was for scientific purposes (40 records), followed by educational and commercial purposes with 16 and 15 records, respectively. There were also 12 records of specimens traded under "circuses" or "travelling exhibitions", and two records of trade for personal use. The majority of these products were from wild-sourced specimens (67 records) and five records were from illegal confiscations/seizures. On average, there were 11 records of CITES-listed chondrichthyan products exported from Nairobi Convention Member States annually, from 2012 to 2019. Trade was low in 2012–2014, with an average of two records per year, but peaked in 2016 with 26 records and then remained at 14–15 records annually from 2017 to 2019 (Table 4.7). This is likely due to the new listings of chondrichthyan species on the CITES Appendices, with seven species listed in 2014 and a further nine species listed in 2017[32].

All trade in species listed in CITES Appendix II requires a positive non-detriment finding (NDF) that confirms that the trade in such species is not detrimental to their wild populations (see Chapter 5 for details); however, an extensive search revealed no completed NDFs by any Nairobi Convention Member State for chondrichthyan species, implying that all commercial trade in these CITES Appendix II-listed chondrichthyan species (Table 4.7) is in breach of this fundamental CITES requirement. If States intend to permit international commercial trade in these products in the future, NDFs would be required before any further trade takes place, to ensure adherence with binding CITES trade controls. CITES trade controls are presented in greater detail in Chapter 5.

In addition to the lack of required supporting documentation, of the 85 records in the CITES trade database listing trade in CITES-listed chondrichthyan species within or from the region, there were only five records where the reporting quantity from the exporting country matched the import quantity as reported by the importing country (Table 4.7). Inconsistencies in reporting are common, and can be

[32] https://cites.org/eng/prog/shark/history.php

attributed to various factors such as the source of the product being traded and the trade purpose being reported differently by the importing and exporting countries; different terms and units being used by importing and exporting countries; export of specimens occurring at the end of a year and the resulting import occurring in the subsequent year; or species being reported at different taxonomic levels by importing and exporting countries (CITES 2013). Although these reporting inconsistencies are common, CITES trade controls are intended to ensure that trade in CITES Appendix I-listed species occurs under exceptional circumstances only, and that any trade in Appendix II-listed species is done legally and is not detrimental to their survival in the wild (see Chapter 5 for further details). That such reporting inconsistencies are so common is a cause for concern. CITES trade controls are binding on Party States; in order for these measures to be effective, it is crucial that there is improved implementation of CITES trade regulations by all countries in the WIO region, and globally.

Table 4.7: Chondrichthyan species listed on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) exported from Nairobi Convention Member States (Exporter) and imported into various importing countries (Importer), according to the CITES Trade Database (https://trade.cites.org/en/cites_trade), for the period 2012–2019. Importer reported quantity and exporter reported quantity, terms used for exporting product, export purpose and source of the export product are given. ("App." = CITES Appendix number; "Pre-conv." = products possessed prior to listing of species in CITES Appendices). Rows highlighted in grey reflect instances where the reported export quantity (reported by exporting country) matches the reported import quantity, as reported by the importing country. Where no units are present, the quantity represents the total number of specimens traded.

Year	App.	Species name	Importer	Exporter	Importer quantity	Exporter quantity	Unit	Term	Purpose	Source
2012	I	*Anoxypristis cuspidata*	USA	South Africa	3			Unspecified	Personal	Confiscation
2012	II	*Carcharodon carcharias*	Austria	South Africa	1			Skins	Educational	Wild
2013	II	*Carcharhinus longimanus*	Hong Kong	Seychelles		100		Fins	Commercial	Wild
2013	II	*Rhincodon typus*	Australia	Seychelles		61		Specimens	Scientific	Wild
2013	II	*Sphyrna* spp.	Hong Kong	Seychelles		99		Fins	Commercial	Wild
2014	II	*Carcharodon carcharias*	USA	South Africa		86	ml	Specimens	Scientific	Wild
2015	I	*Pristis pristis*	USA	Madagascar		30		Specimens	Scientific	Wild
2015	II	*Carcharodon carcharias*	Great Britain	South Africa	4	4		Specimens	Scientific	Wild
2015	II	*Carcharodon carcharias*	Sweden	South Africa		1		Skulls	Scientific	Wild
2015	II	*Carcharodon carcharias*	Sweden	South Africa		115		Specimens	Scientific	Wild
2015	II	*Carcharodon carcharias*	USA	South Africa	161			Specimens	Scientific	Wild
2015	II	*Manta birostris*	USA	South Africa	3	3		Specimens	Scientific	Wild
2015	II	*Sphyrna lewini*	Great Britain	South Africa	8		g	Specimens	Scientific	Wild
2015	II	*Sphyrna lewini*	Great Britain	South Africa		4		Specimens	Scientific	Wild
2015	II	*Sphyrna lewini*	USA	Seychelles		151		Specimens	Scientific	Wild
2015	II	*Sphyrna mokarran*	USA	Seychelles		20		Specimens	Scientific	Wild
2016	I	*Pristis* spp.	USA	Madagascar	5			Bone pieces	Scientific	Confiscation
2016	I	*Pristis pectinata* [a]	USA	Madagascar	5			Bone pieces	Scientific	Confiscation
2016	I	*Pristis pristis*	Great Britain	Mozambique		13		Derivatives	Scientific	Wild
2016	I	*Pristis pristis*	USA	Madagascar	2			Bone pieces	Scientific	Confiscation
2016	I	*Pristis pristis*	USA	Madagascar	6			Bone pieces	Scientific	Confiscation
2016	II	*Carcharhinus longimanus*	Sri Lanka	South Africa	4	4		Fins	Educational	Wild
2016	II	*Carcharhinus longimanus*	USA	South Africa	4			Fins	Circus	Wild
2016	II	*Carcharodon carcharias*	Canada	South Africa		20		Skins	Scientific	Wild
2016	II	*Carcharodon carcharias*	Canada	South Africa		102		Specimens	Scientific	Wild
2016	II	*Carcharodon carcharias*	France	Madagascar	2			Bones	Commercial	Wild
2016	II	*Carcharodon carcharias*	Great Britain	South Africa	2	2		Bodies	Educational	Wild
2016	II	*Carcharodon carcharias*	Sweden	South Africa	116			Specimens	Scientific	Wild
2016	II	*Lamna nasus*	USA	South Africa	2			Fins	Circus	Wild
2016	II	*Manta alfredi* [b]	Australia	Seychelles	44	44		Specimens	Scientific	Wild
2016	II	*Manta alfredi* [b]	Great Britain	Seychelles		16		Specimens	Scientific	Wild
2016	II	*Manta birostris* [b]	Sri Lanka	South Africa	4			Gill plates	Educational	Wild
2016	II	*Manta birostris* [b]	Sri Lanka	South Africa		4		Specimens	Educational	Wild

Table 4.7 continued

Year	App.	Species name	Importer	Exporter	Importer quantity	Exporter quantity	Unit	Term	Purpose	Source
2016	II	*Sphyrna lewini*	Australia	Seychelles		20	kg	Specimens	Scientific	Wild
2016	II	*Sphyrna lewini*	Canada	South Africa		41		Skins	Scientific	Wild
2016	II	*Sphyrna lewini*	Canada	South Africa		147		Specimens	Scientific	Wild
2016	II	*Sphyrna lewini*	USA	South Africa	3			Fins	Circus	Wild
2016	II	*Sphyrna mokarran*	Canada	South Africa		2		Skins	Scientific	Wild
2016	II	*Sphyrna mokarran*	Canada	South Africa		4		Specimens	Scientific	Wild
2016	II	*Sphyrna mokarran*	USA	South Africa	2			Fins	Circus	Wild
2016	II	*Sphyrna zygaena*	Canada	South Africa		12		Skins	Scientific	Wild
2016	II	*Sphyrna zygaena*	Canada	South Africa		56		Specimens	Scientific	Wild
2017	II	*Carcharhinus longimanus*	Hong Kong	Seychelles	11		kg	Fins	Commercial	Wild
2017	II	*Carcharodon carcharias*	Australia	South Africa		10		Skeletons	Scientific	Pre-conv.
2017	II	*Carcharodon carcharias*	Australia	South Africa		30		Specimens	Scientific	Pre- conv.
2017	II	*Carcharodon carcharias*	Australia	South Africa		37		Specimens	Scientific	Wild
2017	II	*Carcharodon carcharias*	Italy	South Africa		4		Specimens	Scientific	Unknown
2017	II	*Carcharodon carcharias*	Italy	South Africa		28		Specimens	Scientific	Wild
2017	II	*Carcharodon carcharias*	USA	South Africa		40		Specimens	Scientific	Wild
2017	II	*Manta alfredi b*	Australia	Seychelles	170			Specimens	Scientific	Wild
2017	II	*Sphyrna lewini*	France	Kenya	2	4		Live	Commercial	Wild
2017	II	*Sphyrna lewini*	Hong Kong	Seychelles	6		kg	Fins	Commercial	Wild
2017	II	*Sphyrna lewini*	Netherlands	Kenya		3		Live	Commercial	Wild
2017	II	*Sphyrna lewini*	USA	Kenya	2			Live	Educational	Wild
2017	II	*Sphyrna lewini*	USA	Kenya		3		Live	Commercial	Wild
2017	II	*Sphyrna mokarran*	Hong Kong	Seychelles	6		kg	Fins	Commercial	Wild
2018	II	*Alopias pelagicus*	USA	South Africa	1			Fins	Circus	Pre-conv.
2018	II	*Alopias superciliosus*	USA	South Africa	1			Fins	Circus	Pre-conv.
2018	II	*Alopias vulpinus*	USA	South Africa	2			Fins	Circus	Pre-conv.
2018	II	*Carcharhinus falciformis*	USA	South Africa	3			Fins	Circus	Pre-conv.
2018	II	*Carcharhinus longimanus*	USA	South Africa	4			Fins	Circus	Pre-conv.
2018	II	*Carcharodon carcharias*	Italy	South Africa		32		Specimens	Scientific	Wild
2018	II	*Lamna nasus*	USA	South Africa	2			Fins	Circus	Pre-conv.
2018	II	*Mobula eregoodootenkee*[c]	Australia	South Africa		3		Specimens	Scientific	Wild
2018	II	*Rhincodon typus*	Australia	South Africa		17		Specimens	Scientific	Wild
2018	II	*Sphyrna lewini*	China	Kenya	10	4		Live	Commercial	Wild
2018	II	*Sphyrna lewini*	Russian Federation	Kenya		1		Live	Commercial	Wild
2018	II	*Sphyrna lewini*	Saudi Arabia	Kenya		1		Live	Commercial	Wild
2018	II	*Sphyrna lewini*	USA	South Africa	3			Fins	Circus	Pre-conv.
2018	II	*Sphyrna mokarran*	USA	South Africa	2			Fins	Circus	Pre-conv.
2019	II	*Carcharhinus falciformis*	UAE	Kenya		6		Fins	Educational	Wild
2019	II	*Carcharhinus falciformis*	UAE	Kenya	6			Fins	Educational	Wild
2019	II	*Carcharhinus longimanus*	UAE	Kenya		6		Fins	Educational	Wild
2019	II	*Carcharhinus longimanus*	UAE	Kenya	6			Fins	Educational	Wild
2019	II	*Carcharodon carcharias*	France	Madagascar	1			Skeletons	Educational	Pre-conv.
2019	II	*Carcharodon carcharias*	France	Madagascar		1		Teeth	Educational	Pre-conv.
2019	II	*Isurus oxyrinchus*	Republic of Korea	South Africa		140,407	kg	Meat	Commercial	Wild
2019	II	*Isurus oxyrinchus*	Taiwan	Seychelles		458	kg	Derivatives	Commercial	Wild
2019	II	*Rhincodon typus*	Australia	South Africa		10		Specimens	Scientific	Wild
2019	II	*Sphyrna lewini*	UAE	Kenya		3		Fins	Educational	Wild
2019	II	*Sphyrna lewini*	UAE	Kenya	3			Fins	Educational	Wild
2019	II	*Sphyrna lewini*	China	Kenya		12		Live	Commercial	Wild
2019	II	*Sphyrna mokarran*	UAE	Kenya		3		Fins	Educational	Wild
2019	II	*Sphyrna mokarran*	UAE	Kenya	3			Fins	Educational	Wild
2019	II	*Sphyrna mokarran*	Germany	Mauritius		2		Bodies	Personal	Wild

[a] *Pristis pectinata* does not occur in the Western Indian Ocean; this species is likely *P. pristis*
[b] *Manta alfredi* and *Manta birostris* have been grouped into the Genus *Mobula*, such that these species are now named *Mobula alfredi* and *Mobula birostris*
[c] *Mobula eregoodootenkee* is a junior synonym of *Mobula eregoodoo*

4.4 Catch and trade issues, gaps and priorities in the Nairobi Convention area of the Western Indian Ocean

Chondrichthyans in the Nairobi Convention area of the WIO are caught in various legal fisheries and IUU fisheries. Catch reconstructions suggest that three to four times more chondrichthyans are being caught than reported (Clarke et al. 2006, Worm et al. 2013). There are also apparent mismatches between reported export volumes of chondrichthyan products originating in Nairobi Convention Member States, and respective import volumes reported by importing countries. Such poor levels of reporting hinder effective adaptive management, which relies on accurate information and, in combination with illegal fisheries, ineffective law enforcement and poorly monitored fisheries, facilitate illegal wildlife trade (Batt et al. 2017). This is of particular concern for chondrichthyan species, as their life histories are characterized by slow growth, late age at maturity and low reproductive capacity, which render them extremely vulnerable to overexploitation.

This section identifies issues and threats relating to chondrichthyan fisheries and trade in the Nairobi Convention Member States and presents priority actions which should facilitate improved catch and trade monitoring and control, with the end goal being that management decisions are based on reliable and appropriate information.

4.4.1 Fisheries impacts and threats

- Chondrichthyan species are caught as targets and bycatch in most fisheries in Nairobi Convention Member States. There is a high demand for chondrichthyan products and reported catch data indicate significant chondrichthyan mortality.
- Threatened chondrichthyan species (Vulnerable, Endangered and Critically Endangered on the IUCN Red List), are caught in all sectors.
- Chondrichthyan species listed on the Appendices of CITES and CMS, and those for which the IOTC has implemented retention bans, constitute large proportions of chondrichthyan catches in most Nairobi Convention Member States, in artisanal, commercial and industrial fisheries.
- Large-mesh gillnets, such as those used in Kenya's artisanal fisheries and other Nairobi Convention Member States, result in high levels of shark and batoid mortality. The use of such nets should be phased out (Osuka et al. 2021).
- The use of FADs in the purse seine fishery has a devastating impact on silky sharks *Carcharhinus falciformis*, through direct fishery mortality and incidental entanglement in the FAD. Regulations on FAD use and construction must be enforced.
- The mortality of sharks in longline fisheries can be significantly reduced through the use of monofilament leaders instead of wire leaders (Harley and Pilling 2016). The regulation and enforcement of this simple design modification should be considered for longline fisheries.
- Bycatch mitigation measures need to be implemented in relevant fisheries, to reduce fishery-related mortality of threatened species.
- The majority of reported chondrichthyan catch in FAO Fishing Area 51 is taken by countries other than the Nairobi Convention Member States. The combined fishery impacts should encourage the Member States to develop regional management plans to enhance cooperative efforts to ensure sustainable fisheries.

4.4.2 Fishery monitoring and available data

- There is currently limited capacity for species-specific chondrichthyan catch monitoring in the various fisheries in the WIO, resulting in limited catch data. The extent of incidental and directed catch of chondrichthyan species in WIO fisheries is thus difficult to quantify.
- Small-scale fisheries have historically been poorly monitored in many WIO countries, and while this has improved in recent years, chondrichthyan catches are still rarely reported at species level. Spatial and temporal limitations to monitoring mean that total chondrichthyan catch values are, at best, extrapolated estimates and likely to be subject to inaccuracy.

- Incidental and directed take of chondrichthyans in WIO artisanal fisheries is difficult to quantify, although the majority of chondrichthyans caught appear to be landed and utilized.
- National chondrichthyan catch monitoring programs should be established or expanded in each Nairobi Convention Member State, particularly for small-scale, artisanal and sport fisheries, many of which are not currently being monitored. This could be supported through a regional project and training to improve monitoring capacity.
- Long-term catch monitoring programs should be adequately financed, to ensure long-term catch data are available for effective management.
- The use of mobile phone applications is showing promise for chondrichthyan catch data collection in artisanal fisheries in several Nairobi Convention Member States, and could be scaled up as an effective monitoring tool for other fisheries. Such applications allow the collection of accurate catch, effort and biological (e.g., size and sex) data, and allow collection of photographic records for accurate species identification.
- Observer programs for industrial fisheries operating in the WIO are limited, and there is evidence of underreporting of chondrichthyan catches in some observer programs (Forget et al. 2021), while the IOTC observer coverage requirement (5% of fishing days or vessels) gives a poor representation of true catches.
- Reporting of industrial catch data through vessel logbooks must be improved to meet the requirements laid out in national permit conditions, fishing partnership agreements and IOTC data reporting measures, which should in turn require species-level accuracy. Furthermore, remote electronic monitoring of bycatch is showing promise, even in small-scale fisheries (Bartholomew et al. 2018). This technology should be explored as a complementary tool to human fisheries observers.
- The paucity of knowledge on chondrichthyan stocks in the WIO must be addressed through methodical (and regularly repeated) status and/or stock assessments, particularly focusing on threatened and keystone pelagic chondrichthyan species, starting with those species most threatened, regulated under multilateral environment agreements (see Chapter 5), and most common in the fisheries. Examples of such species include Critically Endangered scalloped hammerhead sharks *Sphyrna lewini* and Vulnerable silky sharks *Carcharhinus falciformis*, which are both listed on CITES Appendix II and CMS Appendix II.

4.4.3 Fishery reporting

- Industrial fisheries are expected to report to FAO, IOTC and other global databases; however, several Nairobi Convention Member States submit incomplete data on chondrichthyan catches. Improved adherence to reporting requirements is needed, to ensure more accurate catch reporting and availability of appropriate data for management. Reporting of accurate geographic data on catches would assist with development of management measures and the enforcement of fishery and trade controls.
- Chondrichthyan catches are seldom reported at species level, with the majority (87% from 2012–2019) reported by Nairobi Convention Member States in the general categories of 'Sharks, rays, skates etc. nei[33]' and 'Rays, stingrays, mantas nei'.
- Large proportions of chondrichthyan catches, particularly in artisanal fisheries, are unrecorded, and some catches (mainly in industrial fisheries, and fisheries illegally targeting shark fins or livers) are discarded at sea. All chondrichthyan catches, whether retained or discarded, should be recorded and reported.
- Catches are often misidentified or aggregated, and accurate species-level reporting of chondrichthyan catch is impeded by limited capacity for species identification. Individuals responsible for recording chondrichthyan catches should be trained to identify chondrichthyan species. Various training and identification

[33] Nei refers to not elsewhere included, i.e., volumes of catches for species not specified at a more specific level

resources are available (e.g., Stevens 2011, Ebert 2013, 2014a, Jabado and Ebert 2015, Nevill et al. 2015). Data collectors/observers in industrial fisheries should be capable of identifying at least the 15 chondrichthyan species commonly caught by industrial fisheries in FAO Fishing Area 51.

- Some reported catch quantities are simply estimated values' e.g., Madagascar presented the identical catch quantity for seven consecutive years, which cannot possibly be accurate.

4.4.4 Trade in chondrichthyan products

- Chondrichthyan product trade from the WIO is notable on a global scale, yet national and regional chondrichthyan trade dynamics are not well understood. National chondrichthyan trade monitoring programs should be established, to monitor chondrichthyan trade and enforce trade controls.
- Major discrepancies between reported exports from Nairobi Convention Member States and imports reported by other countries (notably Hong Kong), provide evidence that export values are grossly underreported by some WIO countries, and not representative of actual export volumes. Discrepancies were highest for Kenya, Mauritius, Mozambique, Seychelles, Somalia and Tanzania. Reporting of trade volumes needs to be improved, to reduce or remove the discrepancies in reported export and import volumes.
- All trade in chondrichthyan species listed on CITES Appendix II requires a positive NDF (i.e., evidence that the trade and the source fishery have no detrimental effects on the wild populations). While such species were exported by at least six Nairobi Convention Member States (Kenya, Madagascar, Mauritius, Mozambique, Seychelles and South Africa) during 2012 to 2019, no published NDFs could be located for these species. No further trade in CITES Appendix II-listed species should be permitted until NDF assessments have been undertaken by each country, for each species for which it intends to issue CITES export permits.
- Globally, reported CITES-listed chondrichthyan trade is lower than expected, given the available information on the quantities of species caught (Pavitt et al. 2021). This same trend seems to be apparent among the Nairobi Convention Member States, suggesting an urgent need for improved implementation of CITES, including better monitoring and reporting on the trade in CITES-listed chondrichthyan species in this region.
- Distinguishing some CITES-listed chondrichthyan species from other species can be challenging, due to morphological similarities. Appropriate training of customs and border protection officials would improve capacity to detect CITES-listed chondrichthyan species. Several identification guides are available for CITES-listed chondrichthyan products[34] (e.g., Abercrombie and Jabado 2022a, 2022b, Jabado and Abercrombie 2022).
- Kenya has a regulated international shark fin and meat trade, with licensed dealers, and reports indicate the export of shark fins originating in Mozambique, Zanzibar and Somalia via Mombasa to Asia. However, no chondrichthyan exports were reported by Kenya in 2012–2019. Improved trade control and reporting are needed.
- There is trade in live chondrichthyan species from certain Nairobi Convention Member States for the aquarium trade. Some of this trade is in contravention of trade or national fisheries regulations or involves threatened species. For example, there is evidence in Kenya of live trade in Critically Endangered shorttail nurse sharks *Pseudoginglymostoma brevicaudatum* – a species prohibited under the Sixth Schedule of the Kenya Wildlife Conservation and Management Act (Government of Kenya 2013).
- Real-time data collection, use of globally accepted World Customs Organization HS codes for chondrichthyan products, and traceability systems that can track chondrichthyans from the point of capture through the supply chain to the point of consumption (e.g., SharkTrace[35]), should be explored and implemented (Okes and Sant 2019).

[34] https://www.iucnssg.org/publications-id-guide.html

[35] www.traffic.org/sharktrace/

4.4.5 Enforcement of fisheries catch and trade regulations

- Improved enforcement of existing national species protections for chondrichthyan species is necessary.
- Stronger fishery regulations are required in certain fisheries to reduce incidental and targeted mortality of threatened chondrichthyans.
- CITES trade controls are currently poorly implemented in most WIO States, including inadequate reporting and enforcement, which must be addressed.
- The illegal trade in chondrichthyan products in the WIO region must be addressed and appropriately mitigated. Genetic analysis of confiscated chondrichthyan fins in Mozambique demonstrated the utility of this method for confirming illegal trade in chondrichthyan products (Asbury et al. 2021). The use of portable, rapid DNA test kits[36] (e.g., Cardeñosa et al 2018) and mobile applications[37] that can detect CITES-listed chondrichthyan species should be explored.
- Fishers should be trained in the safe release of chondrichthyan species caught as bycatch (see Poisson et al. 2012, 2014), particularly those species that are subject to retention bans mandated by the IOTC (see Chapter 5 for details).

[36] www.vulcan.com/News/2018/New-tool-to-aid-shark-conservation.aspx

[37] https://wildlifedetection.org/fin-finder

CHAPTER 5

Chondrichthyan Management and Policy in the Western Indian Ocean

5.1 Introduction

5.1.1. Governance frameworks for chondrichthyans

Several multilateral environmental agreements (MEAs), fisheries governance frameworks, and soft-law instruments are of relevance to chondrichthyans in the WIO. Some were developed specifically for the management of fisheries associated with chondrichthyans. Certain texts are binding, thereby requiring Member States to implement the necessary legal and institutional infrastructure and capacities to fulfil those obligations, such as specific policy or legislative text, specific reporting, protection of species, or the implementation of trade regulations or gear restrictions. Other measures are voluntary and thereby offer recommendations for best practice.

Numerous chondrichthyan species in the WIO are listed on the Appendices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS[38]) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES[39]) (Table 5.1). As contracting parties, WIO States are mandated to implement the provisions of these agreements, as they apply to chondrichthyan species listed thereunder. Depending on the Appendices on which the species are listed, the required measures may include absolute protection from exploitation, improved management or regulated international trade. The Memorandum of Understanding on the Conservation of Migratory Sharks (CMS Sharks MOU[40]) is a non-binding MOU agreed under CMS, which calls for conservation and cooperative management of chondrichthyan resources among parties.

In addition to MEAs that list specific species, several relate to general management of fisheries (including chondrichthyans), elimination of fishery and maritime crime, or management of habitats that fishery species use (chondrichthyans included). The United Nations Convention on the Law of the Sea (UNCLOS) laid a landmark global governance framework for maritime activities, including fisheries. The FAO has produced several guiding documents, such as: the *International Plan of Action for the Conservation and Management of Sharks* (IPOA-Sharks, FAO 1999); *Fisheries management. 1. Conservation and management of sharks* (FAO 2000); *Code of Conduct for Responsible Fisheries* (FAO 1995); *Ecosystem Approach to Fisheries* (EAF, FAO 2003); and the Port State Measures Agreement (PSMA, FAO 2010) to eliminate illegal activities relating to fishing and other maritime activities. The Convention on Wetlands (Ramsar Convention) was established for the conservation of wetland habitats (Ramsar 1971) and thereby covers several coastal habitat types used by chondrichthyans.

In addition to the global instruments, some provide frameworks for the management of fisheries in all or part of the Indian Ocean. The Indian Ocean Tuna Commission (IOTC[41]) is a tuna Regional Fisheries Management Organization spanning the Western and Eastern Indian Ocean (FAO Statistical Areas 51 and 57). The IOTC is responsible for management of tuna and tuna-like fisheries, but has implemented several chondrichthyan-specific measures, such as retention bans for at least 12 chondrichthyan species that occur in the WIO (Table 5.1). The Southern Indian Ocean Fisheries Agreement (SIOFA) similarly covers much of FAO Statistical Areas 51 and 57, providing a management framework for deep-sea, non-migratory species, in areas beyond national jurisdiction (ABNJ).

In the WIO, the Southwest Indian Ocean Fisheries Commission (SWIOFC) is a regional fishery body (RFB) of the FAO, established to promote responsible fisheries and sustainable utilization of marine living resources in the SWIO (most of FAO Statistical Area 51). The Nairobi Convention[42] is an MEA focused within the WIO, spanning the waters of the ten East

[38] www.cms.int
[39] www.cites.org
[40] www.cms.int/sharks/en
[41] www.iotc.org

[42] *Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region,* www.nairobiconvention.org/

African States (defined in Chapter 2), where, as the name suggests, it provides a framework for the protection, management and development of marine and coastal resources of the WIO region (UNEP 1985).

The Indian Ocean Commission (IOC) is an inter-governmental organization mandated to facilitate cooperation to improve living conditions and preserve natural resources of the five WIO island States.

Table 5.1: Chondrichthyan species recorded in the Nairobi Convention area of the Western Indian Ocean that are listed under the Convention on the Conservation of Migratory Species of Wild Animals (CMS, I and II indicate relevant CMS Appendices), the CMS Sharks MOU (Annex I, giving year of inclusion), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, I and II indicate relevant CITES Appendix), and/or a prohibiting Indian Ocean Tuna Commission (IOTC) resolution, along with IUCN Red List status (IUCN, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened). Countries in which the species is confirmed (1) or reported but not confirmed (-), are also shown. (KM: Comoros, KE: Kenya, MG: Madagascar, MU: Mauritius, MZ: Mozambique, RE: La Réunion, YT: Mayotte, SC: Seychelles, SO: Somalia, ZA: South Africa, TZ: Tanzania).

Species name	Common name	CMS	CMS MOU	CITES	IOTC	IUCN	KM	KE	MG	MU	MZ	RE	YT	SC	SO	ZA	TZ
Alopiidae	Thresher sharks																
Alopias pelagicus	Pelagic thresher shark	II	2016	II	12/09	EN	1	1	1	-	1	-	1	1	1	1	1
Alopias superciliosus	Bigeye thresher shark	II	2016	II	12/09	VU	1	1	1	1	1	1	1	1	1	1	1
Alopias vulpinus	Common thresher shark	II	2016	II	12/09	VU	-	-	-	-	-	-	-	-	-	1	-
Carcharhinidae	Requiem sharks																
Carcharhinus falciformis	Silky shark	II	2016	II	-	VU	1	1	1	1	1	1	1	1	1	1	1
Carcharhinus longimanus	Oceanic whitetip shark	I	2018	II	13/06	CR	1	1	1	1	1	1	1	1	1	1	1
Carcharhinus obscurus	Dusky shark	II	2018	-	-	EN			1		1				1	1	-
Prionace glauca	Blue shark	II	-	-	-	NT	1	1	1	1	1	1	1	1	1	1	1
Cetorhinidae	Basking shark																
Cetorhinus maximus	Basking shark	I/II	2010	II	-	EN										1	
Glaucostegidae	Giant guitarfishes																
Glaucostegus halavi	Halavi guitarfish	-	-	II	-	CR		1									
Lamnidae	Mackerel sharks																
Carcharodon carcharias	Great white shark	I/II	2010	II	-	VU	1	1	1	1	1	1	1	1		1	1
Isurus oxyrinchus	Shortfin mako shark	II	2010	II	-	EN	1	1	1	1	1	1	1	1	1	1	1
Isurus paucus	Longfin mako shark	II	2010	II	-	EN	1	1	1	1	1	1	1	1	1	1	1
Lamna nasus	Porbeagle shark	II	2010	II	-	VU					-					-	
Mobulidae	Manta and devil rays																
Mobula alfredi	Reef manta ray	I/II	2016	II	19/03	VU	1		1		1		1	1		1	1
Mobula birostris	Giant manta ray	I/II	2016	II	19/03	EN	1	1	1	1	1	1	1	1	1	1	1
Mobula eregoodoo	Longhorned pygmy devil ray	I/II	2016	II	19/03	EN	-	-	-	-	-	-	-	-	1	1	1
Mobula kuhlii	Shortfin devil ray	I/II	2016	II	19/03	EN	-	1	1	-	1	-	1	1	1	1	1
Mobula mobular	Spinetail devil ray	I/II	2016	II	19/03	EN		1	1		1		1	1	1	1	1
Mobula tarapacana	Sicklefin devil ray	I/II	2016	II	19/03	EN				1	-	1				1	1
Mobula thurstoni	Bentfin devil ray	I/II	2016	II	19/03	EN			1		-					1	1
Pristidae	Sawfishes																
*Anoxypristis cuspidata***	Narrow sawfish	I/II	2016	I	-	EN									-		
Pristis pristis	Largetooth sawfish	I/II	2016	I	-	CR		1	1	-	1	-		-	1	1	1
Pristis zijsron	Green sawfish	I/II	2016	I	-	CR		1		-	1	-			1	1	-
Rhincodontidae	Whale shark																
Rhincodon typus	Whale shark	I/II	2010	II	13/05	EN	1	1	1	1	1	1	1	1	1	1	1
Rhinidae	Wedgefishes																
Rhina ancylostomus	Bowmouth guitarfish	-	-	II	-	CR		1	1	1	1	1	1	1	1	1	1
Rhynchobatus australiae	Bottlenose wedgefish	II	2018	II	-	CR		1	1		1	1		1	1		1
Rhynchobatus djiddensis	Whitespotted wedgefish	-	2018	II	-	CR		-	-	-	1	-	-	-	-	1	-
Sphyrnidae	Hammerhead sharks																
Sphyrna lewini	Scalloped hammerhead shark	II	2016	II	-	CR	1	1	1	1	1	1	1	1	1	1	1
Sphyrna mokarran	Great hammerhead shark	II	2016	II	-	CR	1	1	1	1	1	1	1	1	1	1	1
Sphyrna zygaena	Smooth hammerhead shark	II	2018	II	-	VU	1		1	1	1	1		1	1	1	-

** Presence in Nairobi Convention area of WIO uncertain; range possibly extends along Indian Ocean coastline of Somalia, but not confirmed

5.1.2. Governance frameworks in place for chondrichthyans in each Western Indian Ocean State

The Nairobi Convention Member States are eligible to ratify all of these agreements, and, indeed, most of these States are signatory to most, if not all, of these instruments (Table 5.2). Accordingly, these States are bound by the respective binding commitments imposed by virtue of being signatory to each. States are also encouraged to implement the non-binding or voluntary actions defined in these agreements. All of the WIO States are also already members of the FAO and are therefore encouraged to follow the guiding principles laid out in the many guiding documents produced by the FAO, as they relate to the management of general fisheries as well as chondrichthyans specifically. These instruments and their overarching commitments are detailed in the sections that follow. This is not an exhaustive list of governance instruments, but rather this chapter describes the key conservation and management instruments that are relevant to chondrichthyan species specifically or to fisheries species in general.

The chapter starts with global instruments that are binding, then agreements and guiding documents developed under the FAO, followed by regional instruments in place in the Indian Ocean and specifically the WIO. The chapter closes with an overview of the binding and voluntary conservation, research and management actions defined in these agreements that are imposed on signatory States, with a particular focus on chondrichthyans and the requirements as they relate to the Nairobi Convention Member States. The required actions include a description of the species for which national (and regional) regulations should be imposed.

This chapter and particularly the concluding section are thus intended to provide a useful summary of the relevant conservation and management tools and frameworks that are available to guide (and which oblige) fisheries management authorities and policy decision makers to improve the conservation and management of chondrichthyan taxa in the WIO.

Table 5.2: Membership of Nairobi Convention Member States in relevant global and regional MEAs and fisheries agreements: Convention on the Conservation of Migratory Species of Wild Animals (CMS); CMS Memorandum of Understanding for the Conservation of sharks (Sharks-MOU); Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); United Nations Convention on the Law of the Sea (UNCLOS); United Nations Fish Stocks Agreement (UNFSA); Ramsar Convention; Food and Agriculture Organization (FAO); Port State Measures Agreement (PSMA); Indian Ocean Tuna Commission (IOTC); Southern Indian Ocean Fisheries Agreement (SIOFA); South West Indian Ocean Fisheries Commission (SWIOFC); Nairobi Convention (NC); Indian Ocean Commission (IOC); the Southern African Development Community Protocol on Fisheries (SADC) and the United Nations General Assembly Resolution on Sustainable Fisheries (UNGA). (The French Departments of Mayotte and La Réunion fall under France and the European Union (EU)).

Country	CMS [a]	Sharks MOU [b]	CITES [c]	UNCLOS [d]	UNFSA [e]	Ramsar [f]	FAO [g]	PSMA [h]	IOTC [i]	SIOFA [j]	SWIOFC [k]	NC [l]	IOC [m]	SADC [n]	UNGA [o]
Comoros*	-	2014	1995	1994	-	1995	1977	-	2001	*	✓	1994	✓	-	✓
France (EU)	1990 (2003)	2019 (2011)	1978	1996 (1998)	2003 (2003)	1986	1945 (1991)	2016 (2011)	1996 (1995)	✓	✓	1989	✓	-	✓
Kenya**	1999	2010	1979	1994	2004	1990	1964	2017	2004	**	✓	1990	-	-	✓
Madagascar**	2007	2017	1975	2001	-	1999	1961	2017	1996	**	✓	1990	✓	-	✓
Mauritius	2004	-	1975	1994	1997	2001	1968	2015	1994	✓	✓	2000	✓	✓	✓
Mozambique**	2009	-	1981	1997	2008	2004	1977	2014	2012	**	✓	1999	-	✓	✓
Seychelles	2005	-	1977	1994	1998	2005	1977	2013	1995	✓	✓	1990	✓	✓	✓
Somalia	1986	2016	1986	1989	-	-	1960	2015	2014	-	✓	1996	-	-	✓
South Africa	1991	2011	1975	1997	2003	1975	1993	2015	2016	-	✓	2003	-	✓	✓
Tanzania	1999	-	1980	1985	-	2000	1962	-	2007	-	✓	1996	-	✓	✓

[a] https://www.cms.int/en/parties-range-states, [b] https://www.cms.int/sharks/en/signatories-range-states,
[c] https://cites.org/eng/disc/parties/index.php, [d] https://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm,
[e] https://www.un.org/Depts/los/convention_agreements/reviewconf/FishStocks_EN_C.pdf,
[f] https://www.ramsar.org/document/list-of-the-contracting-parties-and-date-of-entry-into-force-of-the-convention-for-each,
[g] http://www.fao.org/legal-services/membership-of-fao/en/, [h] http://www.fao.org/port-state-measures/background/parties-psma/en/,
[i] https://www.iotc.org/about-iotc/structure-commission, [j] https://www.apsoi.org/about-siofa/parties-participants, [k] http://www.fao.org/fishery/rfb/swiofc/en,
[l] https://www.nairobiconvention.org/nairobi-convention/who-we-are/contracting-parties/, [m] https://www.commissionoceanindien.org/presentation-coi/, [n] https://www.sadc.int/files/8214/7306/3295/SADC_Protocol_on_Fisheries.pdf, [o] https://documents-dds-ny.un.org/doc/UNDOC/GEN/N06/500/73/PDF/N0650073.pdf?OpenElement
* Cooperating non-Contracting Party to SIOFA, ** Signatory, but not yet ratified SIOFA.

5.2 Global instruments and governance frameworks

5.2.1 Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention) is an environmental treaty of the United Nations, which provides a global platform for the conservation and sustainable use of migratory animals and their habitats. This international agreement aims to conserve migratory species throughout their ranges, by bringing together the 'Range States' of migratory species, to lay a legal foundation for internationally coordinated conservation measures for such species.

The Convention was adopted in 1979 and came into force in 1983. As agreed by the Parties, on the basis of specific listing proposals, the Appendices of the Convention list migratory species threatened with extinction (Appendix I) and migratory species that need or would significantly benefit from international co-operation (Appendix II). As Appendix I and II are intended for different purposes, several species are listed in both Appendices.

CMS Appendix I: Endangered migratory species[43] "comprises migratory species that have been assessed as being in danger of extinction throughout all or a significant portion of their range. The Conference of the Parties has further interpreted the term "endangered" as meaning "facing a very high risk of extinction in the wild in the near future" (Res. 11.33 paragraph 1). Appendix I also requires that Parties "that are a Range State to a migratory species listed in Appendix I shall endeavour to strictly protect them by: prohibiting the taking of such species, with very restricted scope for exceptions; conserving and where appropriate restoring their habitats; preventing, removing or mitigating obstacles to their migration and controlling other factors that might endanger them". Species listed on Appendix I of CMS should therefore be strictly protected in signatory States.

CMS Appendix II: Migratory species conserved through Agreements[44] comprises "migratory species that have an unfavourable conservation status and that require international agreements for their conservation and management, as well as those that have a conservation status which would significantly benefit from the international cooperation that could be achieved by an international agreement." While CMS and its associated regulatory measures apply to CMS Parties, i.e., Signatories to the Convention, the Convention also promotes concerted action among the non-Party 'Range States', i.e., those countries through which migratory species pass, but which are not Parties to the Convention. Accordingly, the Convention encourages the Range States of species listed on Appendix II to conclude global or regional Agreements for the conservation and management of individual species or groups of related species.

CMS in the context of the Nairobi Convention area

In the WIO, 13 chondrichthyan species are listed in CMS Appendix I, of which 3 are Critically Endangered and 8 are Endangered (Table 5.1), according to the IUCN Red List of Threatened Species (IUCN 2021), highlighting their need for protection. Twenty-five species (including 12 of those listed in Appendix I) are listed in CMS Appendix II (Table 5.1). Of the 13 species listed only in Appendix II, 3 are Critically Endangered and 4 are Endangered (IUCN 2021). The narrow sawfish *Anoxypristis cuspidata*, is listed in CMS Appendices I and II, although its presence in the Nairobi Convention area of the WIO is unconfirmed.

The CMS text and Appendices are legally binding on CMS Parties. Within the WIO, the Nairobi Convention Member States of France, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania are all Party to CMS (Table 5.2) and are thereby bound by the commitments prescribed in this Convention. These States are thereby required to protect the 13 (or 14) chondrichthyan species that are listed in CMS Appendix I and which occur in the WIO (Table 5.1) and control other factors that might endanger them. However, few of these species are protected within most Nairobi Convention Member States (also see specific details in section 5.5 of this chapter). There are also few regional management measures for species listed in CMS Appendix II.

[43] https://www.cms.int/en/page/appendix-i-ii-cms

[44] https://www.cms.int/en/page/appendix-i-ii-cms

CMS Concerted Actions

The 12th CMS CoP adopted Resolution 12.28, in October 2017, on Concerted Actions (UNEP/CMS 2017a). Concerted Actions are "priority conservation measures, projects, or institutional arrangements undertaken to improve the conservation status" of selected CMS Appendix I or II species. These may involve measures to be undertaken collectively by the Parties or the actions that conclude regional agreements (as defined for CMS Appendix II species). The Resolution provides guidelines on the implementation of the Concerted Action process and lists species (or species groups) designated for Concerted Actions in the 2018–2020 triennium. These include two chondrichthyan taxa that occur within the WIO: manta and devil rays (family Mobulidae) and whale sharks *Rhincodon typus.*

The Concerted Action for the mobulid rays (Mobulidae) (UNEP/CMS 2017b) calls on Parties for the effective national protection for mobulid rays, through four key actions: 1) implementing the Global Conservation Strategy for mobulid rays (Lawson et al. 2017); 2) driving collaborative and community-based conservation and management for mobulid rays; 3) reducing mobulid ray fishery mortality; and 4) adapting conservation and management strategies for these species.

The Concerted Action for the whale shark (*Rhincodon typus*) (UNEP/CMS 2017c) calls on Parties for 1) improved research; 2) unified guidelines to reduce negative impacts of tourism; 3) increased observer coverage for improved reporting on whale shark interactions; 4) engaging with non-Party Range States, to encourage increased membership to the CMS Sharks MOU; 5) implementing national legislation for the protection and effective management of whale sharks; and 6) addressing global threats to whale sharks such as climate change, ocean acidification, and plastic pollution.

Both of these Concerted Actions align with the CMS requirements *inter alia* that Parties strictly protect the species listed in CMS Appendix I. The two documents cover whale sharks, as well seven mobulid species that occur in the WIO, and therefore relate to the nine Nairobi Convention Member States that are Party to CMS (all excluding Comoros) (Table 5.2). While the Concerted Actions were intended for the 2018–2020 period, neither was fully implemented and proposals were submitted for both Concerted Actions to be extended for the 2021–2023 period (UNEP/CMS 2019a, 2019b). In addition, new proposals for Concerted Action for the 2021–2023 triennium were submitted for largetooth sawfish *Pristis pristis* (UNEP/CMS 2019c) and bottlenose wedgefish *Rhynchobatus australiae* (both present in the WIO), as well as the guitarfish (Rhinobatidae), giant guitarfish (Glaucostegidae) and wedgefish (Rhinidae) families (UNEP/CMS 2019d), represented in the WIO by eight, one and four species, respectively.

CMS Memorandum of Understanding on the Conservation of Migratory Sharks (CMS Sharks MOU)

The CMS Convention also makes provision for the development of separate taxon-specific Memoranda of Understanding (MOUs). The *CMS Memorandum of Understanding on the Conservation of Migratory Sharks*[45] (CMS Sharks MOU; CMS 2018) is a non-binding MOU agreed under the Convention, which entered into effect in 2010. The MOU states that sharks should be managed to allow for sustainable harvest where appropriate, through conservation and management measures based on the best available scientific information. It encourages relevant bodies to set science-based targets for catch quotas, fishing effort and other restrictions to help achieve sustainable use. The MOU is based on the principles that successful shark conservation and management require the fullest possible cooperation among governments, intergovernmental organizations, non-governmental organizations, stakeholders of the fishing industry and local communities, and through engagement with the fisheries industry, FAO, RFMOs and other MEAs.

The MOU lists in its Annex I chondrichthyan species to which the MOU text and provisions relate. As an MOU of CMS, the Sharks MOU Secretariat submits to the signatories' proposals for listing new species as they are listed in the Appendices of CMS. The list has been revised and additional species have been added on several occasions, since the MOU came into effect.

[45] https://www.cms.int/sharks/en

In September 2012 (CMS 2012), the Signatories to the MOU also adopted a comprehensive conservation plan for species listed in Annex I, which is detailed in Annex 3 to the MOU[46], and provides Signatory States with a guiding conservation plan for the improved conservation and management of these species.

Annex I of the MOU currently lists 37 chondrichthyan species that have an unfavourable conservation status and which require international agreements for their conservation and management, or would significantly benefit from the international cooperation that could be achieved by an international agreement. Twenty-eight of these species are found in the WIO (Table 5.1), all of which fall within the "Threatened" categories of the IUCN Red List (i.e., Vulnerable, Endangered and Critically Endangered), and thus face a high to extremely high risk of extinction in the wild.

Due to the independent nature of the MOU, Signatories may add species to Annex I that are not contained in any of the Appendices of the Convention. Of the 28 WIO chondrichthyan species listed in Annex I of the CMS Sharks MOU, two are not listed in either of the CMS Appendices; the whitespotted wedgefish *Rhynchobatus djiddensis* and the smoothnose wedgefish *Rhynchobatus laevis*, both of which are Critically Endangered. Similarly, species included in CMS Appendices are not automatically covered by the MOU. However, just one chondrichthyan species in the WIO, the blue shark *Prionace glauca*, is listed in the CMS Appendices but not Annex I of the CMS Sharks MOU (Table 5.1).

The CMS Sharks MOU is non-binding on Signatories; however, the MOU text and particularly the detailed conservation plan provide valuable, science-based guidance for improved conservation and management of threatened migratory chondrichthyan species. As of June 2021, there are 49 Signatories (48 States and the EU), including six of the Nairobi Convention Member States; Comoros, France (through the EU), Kenya, Madagascar, Somalia and South Africa. These States are therefore all encouraged to follow the guiding principles of the MOU, implement the conservation plan (in whole or in part) and develop the appropriate management measures, to achieve and maintain a favourable conservation status for threatened migratory chondrichthyans.

[46] https://www.cms.int/sharks/en/page/sharks-mou-text

5.2.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement among governments, intended to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Through provision of a global framework for improved regulation, tracking, enforcement, management and reporting of trade, CITES has become the world's primary mechanism for regulating the international trade in plant and animal species that are threatened with extinction or that may become so without strict regulations on trade.

There are three Appendices to CITES, each requiring a different level of trade control and an associated set of regulatory requirements. Species that require international trade control are listed on one of the Appendices, through the acceptance of species listing proposals presented by CITES Parties. Species are listed on the appropriate Appendix according to the potential threat that international trade (and the associated harvesting) of that species is likely to have on one or more of its wild populations, and in turn the degree of trade regulation required. The main trade controls include regulations on which species may be traded and for what purpose, a strict system of import and export permitting for CITES-listed species, and the submission of documented evidence confirming that certain criteria have been met.

CITES Appendix I[47] includes "*species threatened with extinction*". Trade in the products of species listed in Appendix I is generally prohibited, but may be permitted in exceptional circumstances only. No commercial trade is permitted for CITES Appendix I species. Of the 52 chondrichthyan species listed on the three CITES Appendices, just five (the family Pristidae – sawfishes) are listed on Appendix I.

CITES Appendix II includes species "not necessarily now threatened with extinction but that may become so unless trade is closely controlled", i.e., species for which trade must be controlled in order to avoid utilization detrimental to their survival. All trade in Appendix II species requires evidence that the products were legally acquired (*inter alia*, not in

[47] https://www.cites.org/eng/app/appendices.php

contravention of national legislation or fishery regulations, or the regulations imposed by other MEAs or RFMOs), and that the trade (or harvesting of the species to support that trade) will have no detrimental effects on wild populations. The Legal Acquisition Finding (LAF) and Non-Detriment Finding (NDF) are binding requirements as a basis for issuing export permits for any CITES Appendix II species.

Species listing decisions for Appendix I and II are made multilaterally through adoption, by vote, of proposals to amend the Appendices for specific taxa or populations. However, CITES makes provision for a third Appendix, which allows for unilateral species listings. CITES Appendix III contains species that are protected in at least one country, which has requested the assistance of other CITES Parties in controlling the trade thereof. However, chondrichthyan species listed in CITES Appendix III include only freshwater stingrays (Family Potamotrygonidae) found only in South America, and no marine chondrichthyan species.

The Parties (CoP9) adopted a resolution (Resolution Conf. 9.17) in 1994 regarding shark conservation and management (CITES 1994); again, 'sharks' are taken to include all chondrichthyan species). Since then, there have been many decisions of the CITES parties regarding chondrichthyans and the agreement of the current Resolution Conference 12.6 (Rev. CoP17; CITES 2016). In 2013 (CoP16) and 2016 (CoP16), the Parties adopted listing proposals for a number of heavily traded, commercially valuable sharks and rays; the 2013 listings marked a major milestone for shark and ray conservation and management and catalysed new political commitments, financial investments, and collaborations aimed at ensuring that these listings prove effective for the listed species and, ideally, chondrichthyans generally. Several additional chondrichthyan species were listed in CITES Appendices in 2017. Currently, 52 of the estimated 1,280 species of chondrichthyans are listed in the Appendices of the CITES Convention and thus subject to its trade measures.

If a Party fails to comply with CITES Appendix II export requirements, in particular as regards NDFs, a Review of Significant Trade assessment may be undertaken. The outcome of the review can result in a State being prevented legally from trading any CITES species for a certain period of time.

CITES in the context of the Nairobi Convention area

Of the 52 chondrichthyan species that are currently included in CITES Appendices, 27 (or possibly 28) are known from the waters of the Nairobi Convention Member States (Table 5.1). Two of the five chondrichthyan species listed in CITES Appendix I are known from the WIO (the largetooth sawfish *Pristis pristis* and green sawfish *Pristis zijsron*), while the distribution range of a third species, the narrow sawfish *Anoxypristis cuspidata,* may extend into southern Somalia, but remains unconfirmed (D'Anastasi et al. 2013) (Table 5.1). These species and their products should therefore not be permitted for commercial international trade. However, the two *Pristis* species are now extremely rare in the WIO; their most recent confirmed records from Mozambique are from 2014 (Leeney 2017), while they are considered locally extinct within South Africa (Everett et al. 2015).

All 25 chondrichthyan species listed in CITES Appendix II, that are found in the WIO, are assessed in threatened categories of the IUCN Red List, including seven Critically Endangered, twelve Endangered and six Vulnerable species (Table 5.1); however, at least 20 of these are (or were previously) also significant components of artisanal and/or commercial fisheries in the region (see Chapter 4).

The CITES Convention is legally binding on Parties, which include all ten Nairobi Convention Member States. These States are thereby bound by the trade control commitments prescribed in this Convention, including *inter alia* to i) control (through relevant permitting) and monitor trade in the 27 (or 28) CITES-listed chondrichthyan species that occur in the WIO (Table 5.1, and see Table 3.3 in Chapter 3), ii) ensure that trade is not detrimental to wild populations of these species, iii) prevent the commercial trade in CITES Appendix I species, and iv) report on an annual basis all trade in products of CITES-listed species. However, the 2021 *Status of Legislative Progress for Implementing CITES* (CITES 2021) indicates that few Nairobi Convention Member States are implementing CITES effectively. Furthermore, while NDFs are an obligatory pre-requisite for the issuance of a CITES export permit for CITES-listed species, by August 2021 no NDF assessments had been reported (i.e., no individuals indicated knowledge of the existence of an NDF) for any CITES-listed chondrichthyan species from any WIO country. Thus, any commercial export of CITES-listed chondrichthyan products from any Nairobi Convention Member State would be in contravention of the legal requirements of the Convention. Nairobi Convention Member States should therefore put in place the necessary measures, *inter alia* including NDFs, for effective implementation of CITES and its required actions and processes.

5.2.3 United Nations Convention on the Law of the Sea (UNCLOS) and the UN Fish Stocks Agreement

The *United Nations Convention on the Law of the Sea* (UNCLOS, UN 1982) was developed to provide "a legal order for the seas and oceans which will facilitate international communication, and will promote the peaceful uses of the seas and oceans, the equitable and efficient utilization of their resources, the conservation of their living resources, and the study, protection and preservation of the marine environment" (UN 1982). This binding Convention was a turning point in the management of human activities at sea, as it set a comprehensive legal framework for the management of countless activities at sea (particularly in areas beyond national jurisdiction (ABNJ)), such as fishing and mining, as well as the delineation of areas of jurisdiction.

While UNCLOS is not heavily focused on fishery resources, it provides an overarching framework, leading to many of the features deeply rooted in their management. Among the many provisions, UNCLOS introduces the descriptions of several new maritime zones, including the Exclusive Economic Zone (EEZ) – the now well-known, 200-mile coastal zone within which a coastal State has jurisdiction over the resources (UN 1982). The EEZ concept in its own right, and thus in turn UNCLOS, was a major step towards strengthened management of coastal fishery resources, by empowering coastal States with the authority to manage fishery and other activities within their coastal zone.

The utilization of living resources is also specifically addressed in UNCLOS through several provisions. Coastal States are required to manage the harvesting of fishery resources within their EEZ, and set management measures and catch limits that are based on scientific data and intended to ensure sustainable and optimal utilization of the populations of target and dependent species. States are also required to record relevant fishery information and share such recorded information through appropriate regional and international organizations. Coastal States are empowered to set the regulations pertaining to fishing within their EEZ, including *inter alia* aspects such as catch and effort limits, restrictions on species and gears that may or may not be fished, setting of spatial or temporal protection measures, licencing of fishers and vessels, and enforcement procedures (UN 1982).

There are also specific provisions for straddling stocks (i.e., those that straddle multiple EEZs and/or one or more EEZs and ABNJ), and the requirements for the associated collaborative management thereof, as well as provisions specifically for the fishing of highly migratory species. For highly migratory species, States are required to cooperate directly or through appropriate multilateral organizations, such as RFMOs or RFBs. Annex I of the Convention lists taxa that are considered to be highly migratory and that therefore require multilateral management for their conservation and optimal utilization. This Annex lists three shark species, bluntnose sixgill shark *Hexanchus griseus*, basking shark *Cetorhinus maximus* and whale shark *Rhincodon typus*, and four shark families, Alopiidae (thresher sharks), Carcharhinidae (requiem sharks), Sphyrnidae (hammerhead sharks) and Isuridae (mackerel sharks, now named Lamnidae) as highly migratory, thus calling for international cooperation for their management. However, this Annex is the only specific mention of chondrichthyans in the Convention, as UNCLOS is largely focused on non-living resources and the management of non-fishing activities, such as shipping and the delineation of areas of different jurisdiction.

UN Fish Stocks Agreement

A significant development from UNCLOS was the *Agreement for the implementation of the provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks* (UN 1995), otherwise known as the UN Fish stocks agreement. The objective of this Agreement is to provide a legal framework to ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks through effective implementation of the relevant provisions of UNCLOS. The Agreement applies primarily to the conservation and management of such stocks in ABNJ, but also makes some provision for conservation and management in areas under national jurisdiction. The Agreement builds on the provisions of UNCLOS and introduces new provisions and rules that constitute a progressive development of those in UNCLOS, aimed at addressing new challenges relating to high seas fisheries, such as illegal, unreported and unregulated fishing, over-fishing and unsustainable fishing practices.

The Agreement reiterates some of the key UNCLOS provisions, such as optimal utilization of fishery resources; minimum requirements for and guidelines on the collection, reporting and sharing of fishery information (such as time series of catch and effort by fishing fleet, composition of the catch according to sex, size and weight, and biological information such as age and growth); and the basing of management measures on the best available scientific data.

By presenting additional detail and rules, the Agreement also expands on and strengthens many of the UNCLOS requirements on States, such as:

- application of precautionary reference points to ensure sustainable harvesting;
- preventing adverse anthropogenic impacts on the marine environment, particularly fishing;
- promotion of marine scientific research, and collection and exchange of scientific data;
- consideration of the needs of developing States and artisanal and subsistence fishers;
- minimization of bycatch, pollution, waste, discards and catch by lost or abandoned gear;
- prevention or elimination of over-fishing;
- strengthening of the obligations of States for cooperative conservation and management of straddling stocks and highly migratory fish stocks;
- strengthening of the functions of subregional or regional fisheries bodies and arrangements;
- increasing responsibilities of the flag State, such as enforcing the provisions of the Agreement and UNCLOS on vessels flying their flag.

The agreement also added new principles, not presented in UNCLOS, such as:

- the application of the precautionary approach and the principle that **management interventions should not be delayed due to insufficient scientific data**;
- defining mechanisms for conservation and management cooperation, particularly setting of compatible management measures for areas within and beyond national jurisdiction to allow for conservation of stocks in their entirety;
- sub-regional and regional cooperation in enforcement, including empowerment of flag States to enforce fisheries commitments in ABNJ and on vessels flying the flag of another State.

UN General Assembly Resolution on Sustainable Fisheries

The UN General Assembly accepted Resolution 61/105 on sustainable fisheries, in 2006 (UNGA 2007; Table 5.2). While the Resolution addresses general fisheries, it specifically recognizes the economic, social and ecological roles of chondrichthyans, their vulnerability to overexploitation and consequent poor conservation status, and their need for improved management. The Resolution also recognizes the limited data available for effective management of chondrichthyan stocks, and the equally limited chondrichthyan-specific policy in most countries. The requirements of this Resolution were reiterated in Resolution 67/79, in 2012 (UNGA 2013). The two resolutions require States and RFBs to undertake chondrichthyan-specific measures, to:

- adopt and action measures to fully implement the FAO's IPOA-Sharks (FAO 1999);
- reduce shark bycatch and bycatch mortality;
- implement strengthened conservation and management measures for chondrichthyans, based on the best available scientific information, in directed and non-directed shark fisheries;
- consider measures including *inter alia* limits on catch or fishing effort, prohibition or restriction of fisheries targeting shark fins, requiring that all sharks be landed with fins naturally attached, full use of dead sharks, and improved reporting (e.g., species-specific data, discards and landings);

- undertake comprehensive stock assessments of relevant species, including through international cooperation;
- prevent increases in fishing effort in directed chondrichthyan fisheries, until such fisheries can be managed for sustainable use, to prevent further declines in the stocks of threatened species;
- take immediate and concerted action to improve the implementation of and compliance with existing measures implemented through RFBs or other MEAs, which regulate chondrichthyan fisheries and incidental catch thereof.

UNCLOS, UN Fish Stocks Agreement and UN General Assembly Resolutions on chondrichthyans, in the context of the Nairobi Convention Area of the WIO

All ten Nairobi Convention Member States are Party to UNCLOS and six to the UN Fish Stocks Agreement. All ten States are also Members of the UN, and thereby the UN General Assembly. Considering that UNCLOS, the UN Fish Stocks Agreement and the UN General Assembly Resolutions on Sustainable Fishing are all legally binding on members, and that the majority of the threatened chondrichthyan species in the WIO are migratory and straddle multiple WIO EEZs and ABNJ (including most of those listed in the Appendices of CMS and CITES, and prohibited by resolutions of the IOTC), the binding provisions of the UN Fish Stocks Agreement and UN General Assembly Resolutions on chondrichthyans should be core to the management and conservation efforts for chondrichthyan stocks in all Nairobi Convention Member States.

5.2.4 Convention on Wetlands (Ramsar Convention)

The *Convention on Wetlands of International Importance especially as Waterfowl Habitat*, or more commonly referred to as the Ramsar Convention (adopted in Ramsar, Iran, 1971), provides the framework for international cooperation and national action for the conservation and wise use of wetlands (Ramsar 1971). The formal mission of the Convention is “the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world” (Ramsar 2016). The Contracting Parties approved the Fourth Ramsar Strategic Plan for 2016–2024 at the 12th Conference of Parties.

Under the “three pillars” of the Convention, the Contracting Parties commit to:

- Work towards the wise use of all their wetlands;
- Designate suitable wetlands for the list of Wetlands of International Importance (the Ramsar List) and ensure their effective management; and
- Cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

The Convention has no chondrichthyan-specific measures but has relevance through its mission to conserve (or use wisely) wetlands, and the broad diversity of aquatic habitats included in the scope of the Convention. The Convention considers the definition of wetlands to include “marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres” (Ramsar 1971). These habitats include several marine and estuarine habitats, such as coastal lagoons, rocky shores, seagrass beds, coral reefs, deltas, intertidal flats and mangroves (Ramsar 2016), that are used by numerous chondrichthyan species as critical nursery or other ecologically important habitats.

The Ramsar Convention entered into force in 1975. The Convention and its terms are considered binding in international law, and therefore contracting parties are obliged to adhere to the commitments defined therein, and by the measures and decisions taken by the Conference of Parties; however, the Convention is not a regulatory regime and there are no punitive sanctions for violations of such commitments (Ramsar 2016). Nairobi Convention Member States other than Somalia are Party to the Convention (Table 5.2) and are thereby bound to the associated commitments. There are numerous Ramsar sites within the Nairobi Convention area of the WIO (https://rsis.ramsar.org/), including at least 19 that cover habitat potentially important for coastal chondrichthyan species. The Ramsar Convention has established collaborations with numerous other MEAs, such as CMS, the Convention on Biological Diversity (CBD), UNESCO World Heritage Centre, and the United Nations Environment Programme (UNEP).

5.3 International instruments under the Food and Agriculture Organization

The Food and Agriculture Organization (FAO) of the United Nations has produced several policies and guiding documents intended to support improved fisheries, the improved management of fishery resources and reduced fishery-related crime. These include several guiding documents specific to chondrichthyan species and their management. While many of these texts are non-binding on Member States, they provide useful frameworks for governments to follow at national level, and encourage the development of policy documents, provide guidelines on reporting levels and propose management measures that should be considered at national level. All ten Nairobi Convention Member States are signatory to the FAO, and are therefore encouraged to follow the principles of these guiding documents. This section describes the main international instruments, starting with those developed specifically for chondrichthyans, followed by those developed for general fishery management.

5.3.1 FAO International Plan of Action for the Conservation and Management of Sharks

The FAO's *International Plan of Action for the Conservation and Management of Sharks* (IPOA-Sharks; FAO 1999) is an international guiding instrument that was adopted under the auspices of the Code of Conduct for Responsible Fisheries, to ensure the conservation and long-term sustainable use of shark resources (where the term "sharks" is taken to include all chondrichthyan species). Due to concerns that the trade in chondrichthyan products was resulting in overexploitation, in 1994 the Parties to CITES requested that the FAO establish a program of work to collate biological and trade data on sharks, in cooperation with all those using and trading shark products (CITES Resolution Conference 9.17).

The FAO Committee on Fisheries (COFI) responded by initiating an expert consultation on sharks and a series of regional and technical workshops that led, ultimately, to COFI's 1999 adoption of the IPOA-Sharks (Oliver et al. 1998), as well as the *Fisheries management. 1. Conservation and management of sharks* (FAO 2000); the technical guidelines for the implementation of the IPOA-Sharks.

The IPOA-Sharks advocates that States responsible for the mortality of sharks or in whose waters sharks are fished, should each adopt a national plan of action for the conservation and management of their shark stocks (NPOA-Sharks, or Shark-plan), based on the principle that States that contribute to fishing mortality on a species or stock should participate in its management. The development of an NPOA-Sharks is therefore advised for a State if:

i. their vessels conduct directed fisheries for sharks,
ii. their vessels regularly catch sharks in non-directed fisheries,
iii. their vessels catch sharks on the high seas, or
iv. if vessels of other States catch sharks in their waters (FAO 1999).

The IPOA-Sharks proposes a useful structure for States to follow when developing their NPOA-Sharks. It recommends that a Shark Assessment Report be prepared as the first step, as a review of shark catches, management, knowledge of species, policies, and stock status. This report should incorporate available information on the status of knowledge on chondrichthyan species, their conservation status (including stock assessments where possible), data on catches (including trends, and at species level where possible), fishing effort, management measures and policies in place to conserve chondrichthyan species, and assessment of the effectiveness of such management measures.

The Shark Assessment Report is the critical first step and should be structured to guide a decision on whether there is a need for action beyond the chondrichthyan management measures already in place, including whether an NPOA-Sharks is necessary. Where an NPOA-Sharks is deemed necessary, the Shark Assessment Report would inform a risk assessment across species and fisheries (and other threats), which would inform the NPOA-Sharks and its objectives. Suggested contents of a Shark Assessment Report are found in Appendix B of the IPOA-Sharks (FAO 1999). Suggested contents of an NPOA-Sharks are found in the IPOA-Sharks and the *Conservation and management of sharks* (FAO 2000) guidelines.

At regional and global levels, international collaboration on data collection and data sharing systems for stock assessments is particularly important in relation to migratory, transboundary and high-seas chondrichthyan stocks. The IPOA-Sharks therefore also encourages regional cooperation amongst States, involving the development of regional plans of action for sharks, cooperation through RFMOs, such as the IOTC, and other activities to ensure the effective management and conservation of stocks. Such regional plans could be based on the detailed guiding conservation plan presented in Annex 3 of the CMS Sharks-MOU (CMS 2018).

Under the IPOA-Sharks, all UN Member States that capture chondrichthyans are requested to prepare a Shark Assessment Report and NPOA-Sharks, as defined above, according to the following ten principles (FAO 1999, Lack and Sant 2009):

1. Ensure that shark catches from directed and non-directed fisheries are sustainable;
2. Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use;
3. Identify and provide special attention to threatened shark stocks;
4. Improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and education initiatives within and between States;
5. Minimize unutilized incidental catches of sharks;
6. Contribute to the protection of biodiversity and ecosystem structure and function;
7. Minimize waste and discards from shark catches;
8. Encourage full use of dead sharks;
9. Facilitate improved species-specific catch and landings data and monitoring of shark catches;
10. Facilitate the identification and reporting of species-specific biological and trade data.

States should report on the progress of the assessment, development and implementation of their *Shark-plans* as part of their biennial reporting to FAO on the Code of Conduct for Responsible Fisheries. States which implement the *Shark-plan* should regularly, at least every four years, assess its implementation for the purpose of identifying cost-effective strategies for increasing its effectiveness.

IPOA-Sharks in the Nairobi Convention area

While the IPOA-Sharks is voluntary, it was elaborated within the framework of the Code of Conduct for Responsible Fisheries[48] and all concerned States are encouraged to implement it. The IPOA-Sharks calls on all UN Member States responsible for chondrichthyan mortality to develop a Shark Assessment Report and NPOA-Sharks. Furthermore, the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) requested in 2018 that IOTC Contracting Parties without an NPOA-Sharks expedite the development and implementation thereof, and report the progress to the IOTC (IOTC 2018a). The UN General Assembly Resolution on sustainable fisheries (UNGA 2007) also obliges Member States to fully implement the IPOA-Sharks, which in turn calls on nations to develop an NPOA-Sharks.

All ten Nairobi Convention Member States are Members of the FAO and have shark-directed fisheries or fisheries that take sharks as bycatch operating within their waters or under their flag. All ten States should thus follow the IPOA-Sharks and develop a Shark Assessment Report and NPOA-Sharks. All ten States are also Party to IOTC and members of the UNGA and thereby obliged to adhere to IOTC and UNGA measures, including development of an NPOA-Sharks. The IPOA-Sharks called for States to complete their NPOA-Sharks by 2001, yet by 2021, two decades later, just five of the ten Nairobi Convention Member States had completed their NPOA-Sharks (Table 5.3).

Seychelles and South Africa have both implemented their first NPOA-Sharks (SFA 2016, DFFE 2022), and revised these after a period, for updated workplans. The French departments fall under the framework of the European Union Plan of Action for the conservation and management of sharks (EUPOA-Sharks). Mauritius and Madagascar have developed their first NPOA-Sharks, but neither is implemented.

[48] In this document, the term "State" includes Members and non-members of FAO and applies *mutatis mutandis* also to "fishing entities" other than States.

At the time of writing, Mozambique, Kenya and the United Republic of Tanzania are in the process of developing their NPOA-Sharks, Somalia has initiated a consultation process, while Comoros has not initiated their NPOA-Sharks (IOTC 2020) (Table 5.3). To improve the management and conservation framework for chondrichthyans in the WIO, and to improve the status of implementation of commitments to the FAO and the IOTC, Nairobi Convention Member States that have not yet completed a Shark Assessment Report or NPOA-Sharks should prioritize these.

A thorough Shark Assessment Report is a critical undertaking for understanding threats and informing management of chondrichthyans at national level, and should not be delayed by the slower political process to develop a formal NPOA-Sharks. States that have completed their NPOA-Sharks should continue to implement those, and should revise them periodically.

Table 5.3: Status of and progress towards the development of National Plans of Action for the Conservation and Management of Sharks (NPOA-Sharks) of the ten Nairobi Convention Member States, as called for by the FAO IPOA-Sharks (FAO 1999).

Country	NPOA-Sharks: Status/progress
Comoros	No NPOA-Sharks developed (IOTC 2021b)
Kenya	Baseline assessment completed, NPOA to be finalized 2022 (IOTC 2021b)
France (La Réunion and Mayotte)	Conservation of sharks and rays is addressed within the framework of the EU Plan of Action (EUPOA-Sharks [a]) adopted by the European Commission in February 2009 (COM 2009)
Madagascar	Finalized 2021, awaiting approval, yet to be implemented (Republic of Madagascar 2020)
Mauritius	Finalized 2015, yet to be implemented (Government of Mauritius 2015)
Mozambique	Baseline assessment completed, NPOA to be finalized 2022 (IOTC 2021b)
Seychelles	First NPOA finalised 2007; revised 2016 (SFA 2007a, 2016)
Somalia	A consultation process has begun in order to develop the NPOA-Sharks (IOTC 2020)
South Africa	First NPOA finalised 2013 (DAFF 2013); Second NPOA finalised 2022 (DFFE 2013)
Tanzania	The process to develop the NPOA-Sharks has been initiated (IOTC 2021b)

[a] The EUPOA-Sharks identifies the measures deemed necessary both at the EU level (TACs, technical measures, effort and capacity limits) and under international management regimes (measures taken in the framework of RFMOs, CITES, CMS and the Barcelona Convention; Fischer et al. 2012).

5.3.2 FAO Fisheries management. 1. Conservation and management of Sharks

Fisheries management. 1. Conservation and management of sharks (FAO 2000) is a guiding document for conservation and management authorities and other stakeholders to support the implementation of the IPOA-Sharks. The document also provides general advice and a framework for States for development of their shark NPOAs, consistent with the IPOA-Sharks, and information to assist with the preparation of Shark Assessment Reports, as defined in the previous section. While the Guidelines are not binding, they are based on the principle that "it is necessary to control directed shark fisheries and fisheries in which sharks constitute a significant bycatch" (FAO 2000).

Summary of management advice in the Conservation and Management of Sharks guidelines

Legal principles:

- **States with fisheries impacting chondrichthyans should adopt measures for their long-term conservation and sustainable use**, through appropriate policy, legal and institutional frameworks, particularly considering their life-histories and vulnerability to overexploitation.
- This includes, *inter alia*, the development of shark NPOAs and domestic implementation of measures adopted by relevant MEAs and RFBs.
- **Internationally agreed conservation and management measures should be established** for transboundary, straddling, highly migratory and high seas chondrichthyan stocks, through multilateral arrangements and RFBs.
- **WIO States should ensure compliance with the binding and voluntary commitments to the MEAs and conservation instruments** to which they are Party, including developing, where necessary, regional or multilateral species management or recovery plans.
- **States should support the development of a chondrichthyan regional plan of action (RPOA)** for the Nairobi Convention area of the WIO, with links to the IOTC, CMS, CITES and the CMS Sharks MOU conservation plan.

Management:

- **Measures should be implemented to reduce chondrichthyan mortality, bycatch, discards**, and fishery impacts, especially on threatened species.
- **Specific measures should be implemented to protect threatened species and ecosystems**, maintain healthy stocks (i.e., stock biomass at or greater than the stock size at maximum sustainable yield), and reduce fishing capacity and effort to levels commensurate with the sustainable harvesting of the resources.
- **Critical habitats for key life stages, such as nursery, pupping and mating grounds, should be protected**, to provide protection for juveniles and breeding adults (particularly pregnant females), and during aggregations.
- **Destructive fishing gears and practices should be prohibited, or phased out,** and gear regulations introduced where fishing gears are non-selective or have negative impacts on chondrichthyans (e.g., bycatch reduction devices in trawl nets, regulating net/mesh sizes or breaking strain of net filaments/longlines, prohibiting wire longline hook traces).
- **Release of live chondrichthyans** caught in fishing gears should be encouraged, wherever possible.
- **Regulations should be implemented to minimize waste and discard of dead chondrichthyans**, where incidental chondrichthyan capture cannot be avoided (e.g., banning removal of fins at sea).

Fishery monitoring: Effective stock management requires indices of abundance of a stock, changes in abundance over time, and quantitative information on the impacts of fishing (including catch and effort) on the stock. Therefore, fisheries that target or catch chondrichthyans as bycatch should be monitored, continuously or periodically, to provide information on catches. Catches should be recorded by number and by mass, to quantify the removal of individuals and biomass from the ecosystem. Catch recording should be at species level, with accurate estimates of animal size, to enable application of sex-based and length-based stock assessment models. Information on location, date, fishing gear and fishing effort should be recorded. Catch records should also include information on all discards of chondrichthyans.

Research: Effective conservation and management of chondrichthyans (setting management objectives, biological reference points, sustainability indicators, acceptable risk levels, time frames and performance criteria) must be informed by sound scientific data. Relevant research must be undertaken into all aspects of chondrichthyan species and their fisheries, such as threats, biology, ecology, socioeconomics, technology and economics. Research should focus on data gaps (see Chapter 3), data needed for effective conservation and management, and priority taxa, such as threatened and Data Deficient species. Measures should be implemented to monitor temporal trends in abundance and conduct stock assessments (where possible) of chondrichthyan species taken in fisheries, to determine whether stocks are at sustainable levels or in need of stricter regulations. States should also support regional collaboration on chondrichthyan research and fishery monitoring, to provide relevant information to inform regional management plans, particularly for migratory species or shared stocks.

Capacity: For effective conservation and management, and the collection and provision of appropriate data to support these, adequate capacity must be ensured. Training and human capacity building are crucial components for successful implementation of data collection programs, fishery monitoring, enforcement and management. This includes staffing, training, infrastructure, research capacity, analytical capacity, enforcement capacity and adequate financial support, to allow the effective monitoring, research and management. WIO States should provide resources to support the development of regional Shark Plans and participate in existing or new bilateral and multilateral agreements for the conservation and management of chondrichthyan resources at regional level.

Fisheries management. 1. Conservation and management of sharks, in the Nairobi Convention area

This technical guiding document carries no obligation but provides a comprehensive framework that Nairobi Convention Member States should follow when preparing Shark Assessment Reports, or developing, implementing and revising their NPOA-Sharks.

5.3.3 FAO Code of Conduct for Responsible Fisheries

The *FAO Code of Conduct for Responsible Fisheries* consists of a collection of principles and international standards for action, towards sustainable fishery (and aquaculture) operations (FAO 1995). The Code was developed by the FAO in response to growing global concern over rapid declines in the stocks of numerous fishery species, and increases in overfishing, pollution, destructive fishing practices and illegal, unreported and unregulated (IUU) fishing. Such irresponsible fishing actions threatened the long-term sustainability of fisheries and, thus, the economic and food security benefits that sustainable fishing should provide. The Code has 10 key objectives (see Box 5.1).

The Code of Conduct is based on the principle that those involved in fisheries should work together to manage fishery resources and their habitats, and strive to maintain or restore fish stocks to sustainable levels, allowing continued catches into the future. The Code is voluntary; however, it urges all those involved in fisheries to follow the Code's principles and goals, and to take practical measures to implement them. Governments are encouraged to commit to and incorporate the principles and goals of the Code into national fishery policies and legislation, and to work with the industries and other stakeholders to ensure implementation and compliance.

Box 5.1: Key Objectives of the FAO *Code of Conduct for Responsible Fisheries*

a. "establish principles, in accordance with the relevant rules of international law, for responsible fishing and fisheries activities, taking into account all their relevant biological, technological, economic, social, environmental and commercial aspects;
b. establish principles and criteria for the elaboration and implementation of national policies for responsible conservation of fisheries resources and fisheries management and development;
c. serve as an instrument of reference to help States to establish or to improve the legal and institutional framework required for the exercise of responsible fisheries and in the formulation and implementation of appropriate measures;
d. provide guidance which may be used where appropriate in the formulation and implementation of international agreements and other legal instruments, both binding and voluntary;
e. facilitate and promote technical, financial and other cooperation in conservation of fisheries resources and fisheries management and development;
f. promote the contribution of fisheries to food security and food quality, giving priority to the nutritional needs of local communities;
g. promote protection of living aquatic resources and their environments and coastal areas;
h. promote the trade of fish and fishery products in conformity with relevant international rules and avoid the use of measures that constitute hidden barriers to such trade;
i. promote research on fisheries as well as on associated ecosystems and relevant environmental factors; and
j. provide standards of conduct for all persons involved in the fisheries sector." (FAO 2011)

Following the ten key objectives (See Box 5.1, taken from FAO 1995), the Code of Conduct details recommended actions and practices for responsible fishing, which cover six thematic areas: fisheries management, fishing operations, aquaculture development, integration of fisheries into coastal area management, post-harvest practices and trade, and fisheries research. Some of the key principles of the Code are presented in the paragraphs that follow.

Fisheries management: A country's fishing operations and policies should be designed with a view to achieving long-term sustainable use of fish resources, as a means of assuring resource conservation, continued food supplies and alleviating poverty in fishing communities. States should implement relevant principles of the multilateral environmental agreements to which they are Party, and work collaboratively to ensure the management of straddling and highly migratory stocks, and stocks in areas beyond national jurisdiction.

When developing fisheries policies, countries should use the best scientific information available while taking into account traditional fishing practices and knowledge where it is appropriate to do so. The Code stresses the importance of implementing a precautionary approach, to protect aquatic resources, in situations where scientific data needed for management, such as stock status, stock productivity, biological reference points, levels and distribution of fishing effort and the impacts of fishing, are inadequate to inform more detailed management measures.

Fisheries should be managed to ensure that fishing and fish processing are conducted in ways that minimize negative impacts on the environment, reduce waste, and preserve the quality of fish caught, to allow maximum fiscal benefit for harvested resources. Measures should be implemented to eliminate overfishing, non-selective fishing gears, bycatch of unwanted species, bycatch of threatened species, illegal, unregulated and unreported fishing, destructive fishing gears and practices, and to avoid conflict between fishery sectors and fishing in sensitive habitats such as those that are ecologically important to aquatic resources. To this end, States should implement programs to conduct fisheries monitoring, control and surveillance and law enforcement measures.

Trade controls: Trade laws governing fish and fish products should be simple, clear, and consistent with international rules, particularly through multilateral cooperation to control the trade in threatened species. It is important that international trade does not involve fish taken from depleted stocks, and that countries cooperate in observing international agreements regulating trade in endangered species. Moreover, trade in fish and fish products should not undermine the conservation and sustainable use of fisheries, all efforts should be made to maximize the use and minimize the waste of harvested products.

Fisheries Research: Countries should recognize that responsible fisheries policy requires a sound scientific basis. Therefore, countries should make research facilities available and encourage training of young technicians. Data should be gathered on all aspects of fisheries, including *inter alia* biology, ecology, technology, environmental science, economics, social science, fishery catches and the effects of different types of fishing gear on target fish populations and on the general environment. Fishers should also be required to keep records of their fishing operations and the associated catches. Analysis of data and timeous dissemination of findings should be promoted, to ensure that derived information is available to inform effective fishery management measures. States should promote the use of research findings to inform management measures, such as the setting of management objectives and biological and fishery reference points.

The FAO Code of Conduct for Responsible Fisheries in the context of the Nairobi Convention Area

The Code of Conduct is not specific to chondrichthyans, nor is it binding on FAO Member States. However, it addresses the problems and provides proposed mechanisms and activities to overcome those issues, as they relate to fisheries in general, which include chondrichthyan fisheries. Furthermore, the Code was the basis for the development of the *FAO Fisheries management. 1. Conservation and management of sharks* (FAO 2000) guidelines, and underpins several principles therein. Therefore, as all ten Nairobi Convention Member States are signatory to FAO, the guiding principles of the FAO Code of Conduct, as they relate to fisheries management, trade controls and fisheries research, should be implemented throughout this region, both nationally within Nairobi Convention Member States, and regionally throughout the WIO, through appropriate multilateral cooperation.

5.3.4 FAO Ecosystem Approach to Fisheries

The *Ecosystem Approach to Fisheries* (EAF) is a practical strategy for the implementation of sustainable development principles in the context of fisheries management (FAO 2003). The EAF and related concepts (such as Ecosystem Based Management, EBM), have developed in response to the need to implement, practically, the principles of sustainable development (WCED 1987), the Convention on Biological Diversity (United Nations 1992) and the Code of Conduct for Responsible Fisheries (FAO 1995). The EAF is consistent with all these principles and has been adopted by the FAO Committee on Fisheries (COFI) as the appropriate approach to implementing these principles for fisheries management. The FAO's *Fisheries Management: 2. The ecosystem approach to fisheries*, was developed to guide the implementation of the EAF, following the principles of the FAO *Code of Conduct for Responsible Fisheries* (FAO 2003).

The concept of an ecosystem approach to the management of fisheries was introduced nearly half a century ago, at the 1972 World Conference on Human Environment (UNEP 1972), and has subsequently been re-stated in numerous guiding documents and conventions. The approach was developed based on the growing realization of the need to account for interactions among fishery resources and between the fisheries, the resources and their environments. The fundamental principle of the EAF is that management should be implemented in a holistic way, considering all elements of the system, including the fishery (extractive users) and non-extractive users, the ecosystem, species, and interactions among these, rather than focusing on a single user group or a single species or taxonomic group. This 'ecosystem-wide' scope means that effective implementation of the EAF will require multiple stakeholders and depend on strong coordination among environmental and fisheries management agencies, resource users, RFMOs, other stakeholders, and conservation and management instruments, such as the Code of Conduct for Responsible Fisheries and relevant MEAs.

The key principles of the EAF are that:

a. fisheries should be managed to limit their impact on the ecosystem to the extent possible;
b. ecological relationships between harvested, dependent and associated species should be maintained;
c. management measures should be compatible across the entire distribution of the resource (across jurisdictions and management plans);
d. the precautionary approach should be applied due to incomplete ecosystems knowledge; and
e. governance should ensure both human and ecosystem well-being and equity (FAO 2003).

The EAF can therefore be seen as the merging of fisheries management (often intended to maximize yield) and ecosystem management (intended for the management of the resources and their environment). In this way, the benefits may be greater as the needs of and risks to each component are considered. However, the effective implementation of this approach requires institutional support including from governments and fisheries management agencies, adequate investment in the management process (in terms of financial and human resources), adequate technical capacity, and improved knowledge.

The EAF seeks to improve all fishery management processes by adopting risk management principles that recognise complete knowledge is never available and is not essential to start the process. The EAF works through the identification and assessment of all relevant issues and the establishment of participatory processes to help address high priorities effectively and efficiently. It assists with making the best decisions with the information available by using a precautionary (to reflect the risk) and an adaptive approach (to improve knowledge and adjust decisions). Implementing the EAF helps to develop comprehensive fishery management systems that seek the sustainable and equitable use of the whole system (ecological and human) to best meet the community's needs and values, and this requires the setting of well-defined operational objectives that can lead to achieving broader policy goals (FAO 2003).

The EAF responds to the impacts of a fishing sector in a holistic way, by assessing i) the impacts that fishing activities are having on target and associated species and the broader ecosystem, ii) the impacts of fishing activities on the resources or human activities managed by other sectors, iii) the economic/social benefits and costs of fishing and related activities to the sector and society as a whole, and iv) which other activities and drivers beyond the control of fishery management are affecting the fishery's capacity to reach its management objectives.

Ecosystem Approach to Fisheries in the context of the Nairobi Convention Area

The EAF is intended to ensure that all elements of the ecosystem (human or environmental) are considered and should therefore provide a more robust and sustainable fishery-resource ecosystem. Considering that chondrichthyans, in their roles as apex and mesopredators, are ecologically critical components of marine ecosystems, that the SWIO is considered a global hotspot for chondrichthyan diversity and a priority for chondrichthyan conservation, and that numerous fisheries in the WIO either target or incidentally catch chondrichthyans, the management and conservation of chondrichthyan resources and their fisheries in the Nairobi Convention area should be conducted following an EAF. The EAF document (FAO 2003) provides guidelines on how States and management authorities can turn high-level policy goals into action.

5.3.5 Agreement of Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA)

The *Agreement of Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing,* or the Port State Measures Agreement (PSMA), is an international legally binding instrument intended to provide States with the power to prevent illegally caught fish from entering the market through ports around the world. The objective of this Agreement is "to prevent, deter and eliminate IUU fishing through the implementation of effective Port State measures, and thereby to ensure the long-term conservation and sustainable use of living marine resources and marine ecosystems" (FAO 2010). The Agreement was brokered among 92 nations by the FAO and opened for signature in 2009.

The Agreement clearly articulates the expectations and obligations of the Port State. It both empowers and expects port officials of a Port State to deny the use of a port for landing, transhipping, packaging or processing of fish products, or for vessel-related activities (such as refuelling or maintenance), if the vessel lacks the authorization of the flag State (or the State in which fishing activities stook place) to engage in fishing or fishing related activities, there is evidence that the fishery products on board were taken in contravention of national laws or regional regulations (such as those of the RFMO), or if the vessel was suspected to have been engaged in IUU fishing or providing support thereto. Port officials would turn away the vessel or subject it to immediate inspection. If there is evidence of illegal catch, port officials would prohibit the landing of the catch. They would also alert other ports and the flag State to the situation and could deny the vessel permission to refuel or receive repairs. The agreement also provides guidelines on the handling of vessels suspected of illegal fishing activities, the processes for inspecting such vessels, relevant information to be recorded during inspections of such vessels, and for training of inspectors.

The PSMA and its implementation are multilateral, and so multilateral (regional and international) cooperation and information sharing are essential to its effective implementation. States are thus expected to cooperate to the fullest extent and share information with other relevant States, the FAO, RFMOs and other relevant instruments. The Agreement is intended to intervene in the transport of illegal fishery products, thereby linking to national, regional and international regulations and management measures set by governments, MEAs (such as CITES and CMS), RFMOs (such as IOTC) or other regional organizations or arrangements. Effective implementation of the PSMA must therefore be done through such instruments, wherever necessary. The PSMA, in so doing, provides a legal mechanism with which States can enforce the regulations set by such instruments.

The PSMA is not specifically intended for the elimination of illegal fishing activities relating to chondrichthyan products, but by covering general fishing operations and legally empowering Port States to intervene where illegal activities are taking place (or suspected to be), the Agreement is a powerful tool for improving the control of fishing activities and trade. If implemented effectively, this agreement should help to block illegally caught chondrichthyans from entering the global marketplace. This is particularly important for species such as chondrichthyans, which exhibit life-histories that are highly vulnerable to exploitation and many of which are or have highly sought-after commodities, such as their valuable fins, livers, gill plates and other products, and for which there is lucrative legal and illegal trade. The PSMA therefore has great potential to contribute to a reduction in IUU chondrichthyan fishing.

PSMA in the context of the Nairobi Convention Area

As of July 2021, the PSMA has been ratified, accessioned or approved by eight of the ten Nairobi Convention Member States (Table 5.2). The PSMA is legally binding on parties. These States should therefore ensure that the regulations of the PSMA are implemented effectively, particularly in the context of the management of chondrichthyan species. Comoros and Tanzania should be encouraged to accede.

5.4 Regional instruments available for chondrichthyan resource management

5.4.1 Indian Ocean Tuna Commission (IOTC)

The Indian Ocean Tuna Commission (IOTC) is an intergovernmental RFMO, under the FAO, for the management of tuna and tuna-like species and their fisheries in the Indian Ocean[49]. The IOTC Agreement (Anon 1993) was signed in November 1993 and entered into force in March 1996. The Commission promotes cooperation among its Contracting Parties and Cooperating Non-Contracting Parties (CPCs), for effective management of these fisheries, to ensure the conservation and appropriate utilisation of fish stocks and to encourage sustainable fisheries development. The IOTC is binding on Contracting Parties.

The IOTC management mandate IOTC is tuna and tuna-like species; however, through its Working Party on Ecosystems and Bycatch (WPEB), also takes on aspects of the management of non-target bycatch species (including chondrichthyans) which are affected by IOTC fisheries.

The IOTC was established under Article XIV of the FAO constitution (Anon 1993), allowing CPCs to decide on measures concerning the management of tuna and tuna-like resources (and bycatch species) within the IOTC area of competence, to ensure the sustainability of these species. The IOTC imposes Conservation and Management Measures (CMMs) and associated requirements on its Member States (IOTC 2019c), which include several specific *Resolutions* on fishing, handling, retention, prohibition, reporting and research on species or groups, or through inclusion of new or updated national legislation to uphold these management measures. Several resolutions also call for CPCs to ensure that fishing vessels permit the collection of data and biological samples by on-board observers, to support the improvement of knowledge on species captured, and the impacts of capture and post-release mortality levels.

Several *Resolutions* and regulations relate specifically to chondrichthyan species considered to be under threat from the IOTC fisheries for tuna and tuna-like species, and which include regulations on the capture/retention of several chondrichthyan species (or families), the removal of shark fins, and specific requirements related to catch reporting and research.

These *Resolutions* include binding and voluntary (recommended) CMMs, but prohibitions on species targeting and retention are binding on all Contracting Parties. As at November 2021, these *Resolutions* covered prohibitions on retention and specific reporting requirements for at least 12 chondrichthyan species in the WIO (see Table 5.1), as well as specific reporting requirements for at least 13 species/families of chondrichthyans.

The main IOTC *Resolutions* relevant to chondrichthyans are presented in the paragraphs that follow. However, there are numerous general resolutions that States should reference, to ensure complete compliance with binding IOTC measures.

Resolution 12/09 (IOTC 2012a) On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence

This resolution specifically covers the fishing of thresher sharks, and applies to all fishing vessels on the IOTC Record of Authorized Vessels. The resolution applies to the Alopiidae family, including three species in the WIO (pelagic thresher shark *Alopias pelagicus*, bigeye thresher shark *A. superciliosus* and common thresher shark *A. vulpinus*). Specific measures include:

- It is prohibited to retain on board, tranship, land, store, sell or offer for sale carcasses or parts of any thresher shark species;
- Vessels should, to the extent practicable, release live thresher sharks when brought alongside the vessel and record all discards as dead or alive; and
- CPCs shall, where possible, implement research on thresher sharks in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider additional management measures, as appropriate.

[49] The area of competence of the Commission (hereinafter referred to as the "Area") shall be the Indian Ocean (defined for the purpose of this Agreement as being FAO statistical areas 51 and 57 as shown on the map set out in Annex A to this Agreement) and adjacent seas, north of the Antarctic Convergence, insofar as it is necessary to cover such seas for the purpose of conserving and managing stocks that migrate into or out of the Indian Ocean (FAO

Resolution 13/05 (IOTC 2013a) On the conservation of whale sharks (Rhincodon typus)

This resolution prohibits the fishing of whale sharks. Specific measures apply to all fishing vessels on the IOTC Record of Authorized Vessels, but not artisanal fisheries operating exclusively in their EEZ, including:

- All purse-seine fishing vessels are prohibited from intentionally setting a purse-seine net around a whale shark or if a whale shark has been observed in the proposed net-setting area;
- Any whale shark accidentally encircled shall require the master and crew of the vessel to make every attempt to ensure its safe release from the net; and
- All interactions (including safe releases) of IOTC-registered vessels with whale sharks, regardless of the gear type, must be reported to the IOTC and the relevant authority of the flag State.

Resolution 13/06 (IOTC 2013b) On a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries

This resolution is intended to provide a framework for setting management measures for sharks, based on scientific data, but also has specific measures for the oceanic whitetip shark *Carcharhinus longimanus* that apply to all vessels in the IOTC area of competence (except artisanal vessels engaged solely in fishing within their respective EEZ for the purpose of local consumption). Specific measures include:

- It is prohibited to retain onboard, tranship, land or store any part or whole carcass of *C. longimanus;*
- Vessels should promptly release *C. longimanus* unharmed, to the extent practicable, when brought alongside the vessel, and CPCs should encourage their fishers to release this species if recognized on the line before bringing them onboard the vessels;
- CPCs shall, where possible, implement research on oceanic whitetip sharks taken in the IOTC area of competence, to identify potential nursery areas;
- CPCs shall encourage their fishers to record incidental catches and live releases of *C. longimanus*; and
- CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

Resolution 15/01 (IOTC 2015a) On the recording of catch and effort data by fishing vessels in the IOTC area of competence

This resolution provides details on the reporting requirements in the different fisheries, including lists of chondrichthyan species in each fishery type that must be reported to species level. The resolution applies to all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. Specific measures include:

- CPCs shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system (as defined within this and other resolutions);
- The recording of several chondrichthyan species is mandatory: blue shark *Prionace glauca*, mako sharks *Isurus* spp., porbeagle sharks *Lamna nasus*, hammerhead sharks *Sphyrna* spp., silky sharks *Carcharhinus falciformis*, thresher sharks *Alopias* spp., oceanic whitetip shark *Carcharhinus longimanus*, and whale sharks *Rhincodon typus*; and
- The recording of several chondrichthyan species is optional: tiger sharks *Galeocerdo cuvier*, crocodile sharks *Pseudocarcharias kamoharai*, great white sharks *Carcharodon carcharias*, manta and devil rays *Mobula* spp., and pelagic stingrays *Pteroplatytrygon violacea*.

Resolution 16/11 (IOTC 2016) On Port State Measures to prevent, deter, and eliminate Illegal, Unreported, and Unregulated Fishing (PSMR)

This Resolution is to prevent, deter and eliminate IUU fishing through the implementation of effective Port State Measures to control the harvest of fish caught in the IOTC Area, and thereby to ensure the long-term conservation and sustainable use of these resources. The resolution, superseding resolution 10/11, follows and seeks to implement the FAO PSMA (FAO 2010), in the IOTC Area of Competence. This Resolution is not specific to chondrichthyans and closely follows the PSMA as described in a previous section, and is therefore not detailed further here.

Resolution 17/05 (IOTC 2017) on the conservation of sharks caught in association with fisheries managed by IOTC

This resolution specifically covers chondrichthyans, the treatment of shark fins and the reporting of shark catch data, and applies to all fishing vessels in the IOTC area of competence. Specific measures include:

- CPCs shall require that their fishers fully utilize their entire catches of chondrichthyans (i.e., no discard of products of value), except for prohibited species;
- CPCs shall ensure that shark fins of freshly landed sharks remain naturally attached (i.e., fins may be partially sliced through and folded against the shark carcass, but not removed from the carcass) until the first point of landing, and prohibit the removal of shark fins on board vessels;
- CPCs shall prohibit the landing, retention on-board, transhipment, carrying and sale of shark fins which are not naturally attached to the shark carcass until the first point of landing;
- For sharks landed frozen, CPCs shall require their vessels to not have on board fins that total more than 5% of the weight of sharks on board;
- CPCs shall report data for chondrichthyan catches annually, in accordance with IOTC data reporting requirements and procedures (see Resolution 15/02), including historical data, estimates and life status of discards (dead/alive) and size frequencies;
- CPCs shall undertake research to: a) identify ways to make fishing gears more selective, where appropriate, including research into the effectiveness of prohibiting wire leaders; b) improve knowledge on key biological/ecological parameters, life-history and behavioural traits, migration patterns of key shark species; c) identify key shark mating, pupping and nursery areas; and d) improve handling practices for live sharks to maximize post-release survival.
- In cases where chondrichthyans are unwanted species, CPCs shall, to the extent possible, encourage the release of live sharks, especially juveniles and pregnant sharks that are caught incidentally and not used for food/subsistence;
- CPCs shall require that fishers are aware of and use identification guides and best handling practices (the IOTC shall consider assistance to developing CPCs for the identification of shark species/groups and the collection of data on shark catches).

Resolution 18/02 (IOTC 2018b) On management measures for the conservation of blue shark caught in association with IOTC fisheries

This resolution intended to prevent overfishing of blue sharks *Prionace glauca*, and applies to all fishing vessels on the IOTC Record of Authorized Vessels, but not artisanal fisheries operating exclusively in their respective EEZ. Specific measures include:

- CPCs whose vessels catch blue shark in the IOTC Convention Area shall ensure that effective management measures are in place to support the sustainable exploitation of this stock;
- CPCs shall ensure that blue shark catches made by vessels in IOTC fisheries record their catch in accordance with the IOTC reporting requirements;
- CPCs shall implement data collection programs that ensure improved reporting of accurate blue shark catch, effort, size and discard data in accordance with IOTC reporting requirements;
- CPCs shall include in their national Annual Reports to the Scientific Committee information on actions taken domestically to monitor catches; and
- CPCs are encouraged to undertake research on blue sharks to provide information on biology, ecology, behaviour, life-history, migrations, nursery grounds, post-release survival, guidelines for safe release, and improving fishing practices.

Resolution 19/02 (IOTC 2019d) Procedures on a Fish Aggregating Devices (FADs) Management Plan

This resolution applies to purse seine vessels that fish on Drifting Fish Aggregating Devices (DFADs) equipped with instrumented buoys, and provides specific measures for improved management of this fishery, to reduce bycatch, incidental FAD-related mortality of bycatch species, and marine pollution. The resolution defines permissible DFAD designs/materials, FAD marking requirements, minimum electronic tracking technology, reporting requirements, development of FAD tracking and recovery procedures and appropriate FAD management plans, and limits on the numbers of DFADs that can be deployed per vessel. Chondrichthyan species caught in such fisheries, particularly the silky shark *Carcharhinus falciformis*, should benefit from the effective implementation of such measures, particularly the mandatory use of non-entangling and/or biodegradable FAD designs and materials, to reduce entanglement of non-target species, which causes considerable FAD-associated mortality of silky sharks (Filmalter et al. 2013b).

Resolution 19/03 (IOTC 2019e) On the conservation of mobulid rays caught in association with fisheries in the IOTC area of competence

This resolution is specifically intended to prevent the fishing of manta and devil rays (family Mobulidae), and applies to all fishing vessels on the IOTC Record of Authorized Vessels. This excludes subsistence fishers[50] which may not sell or offer for sale any part or whole carcass of mobulid rays. Specific measures include:

- CPCs shall prohibit all vessels from intentionally setting any gear for targeted fishing of mobulid rays in the IOTC Area of Competence, if the animal is sighted prior to commencement of the set;
- CPCs shall require their fishing vessels, other than subsistence fishers, to ensure to the extent practicable the safe and prompt release of live mobulid rays as soon as they are seen in the net, on the hook, or on the deck, and in a manner that will result in the least possible harm to the individuals captured (following handling practices defined in the resolution, to avoid any harm to the animals);
- Where mobulid rays are unintentionally caught and frozen as part of a purse seine vessel's operation, the vessel must surrender the whole mobulid ray to the relevant competent authority, or discard it at the point of landing. Mobulid rays surrendered in this manner may not be sold or bartered but may be donated for domestic consumption;
- Where mobulid rays are unintentionally caught by artisanal fishers[51], the vessel should report the information on the accidental catch to the relevant competent authority, at the point of landing.
- Mobulid rays unintentionally caught may only be used for purposes of local consumption (however, this exemption expired on 1 January 2022);
- CPCs shall ensure fishers use proper mitigation, identification, handling and release techniques;
- CPCs are required to develop sampling plans for the monitoring of mobulid ray catches by subsistence and artisanal fisheries, which (including their scientific and operational rationale), shall be reported in the national scientific reports to the Scientific Committee.
- CPCs are encouraged to investigate at-vessel and post-release mortality in mobulids, such as satellite tagging programs to investigate the effectiveness of live releases.

Resolution 19/06 (IOTC 2019f) On establishing a programme for transhipment by large-scale fishing vessels

This resolution covers general aspects of transhipment of fishery products, and several binding restrictions on chondrichthyans. Specific measures include:

- All transhipment operations of tuna and tuna-like species and sharks caught in IOTC fisheries (except for largescale tuna longline fishing vessels) in the IOTC area of competence must take place in port[52].
- All tuna, tuna-like and shark species landed or imported into CPCs either unprocessed or after processing on board and which are transhipped, shall be accompanied by the IOTC transhipment declaration until the first sale has taken place.

IOTC in the context of the Nairobi Convention Area

The IOTC Area of Competence covers the waters of all Nairobi Convention Member States, which are all Parties to IOTC and thereby bound by commitments detailed in IOTC resolutions, including retention bans, reporting and product handling, and are encouraged to conduct relevant research. Some Nairobi Convention Member States prohibit catches in the relevant fisheries of all 12 chondrichthyan species with IOTC retention bans; those that do not yet prohibit these species are obliged to do so (Table 5.1; see also section 5.5.2 and Appendix B).

[50] A subsistence fishery is a fishery where the fish caught are consumed directly by the families of the fishers rather than being bought by middle-(wo)men and sold at the next larger market, per the FAO Guidelines for the routine collection of capture fishery data. FAO Fisheries Technical Paper. No. 382. Rome, FAO. 1999. 113p.

[51] Artisanal fishing: fisheries other than longline or surface fisheries (i.e., purse seines, pole & line, gillnet fisheries, handline and trolling vessels), registered in the IOTC Record of Authorized Vessels (IOTC 2015, Resolution 15/02).

[52] Port includes offshore terminals and other installations for landing, transhipping, packaging, processing, refueling or resupplying (as defined by FAO Port State Measures Agreement, FAO 2010)

5.4.2 Southern Indian Ocean Fisheries Agreement (SIOFA)

The *Southern Indian Ocean Fisheries Agreement* (SIOFA[53]) is an RFB established in 2012 under the FAO, to promote regional cooperation for the management of deep-sea fish stocks on the high seas. The Agreement aims to ensure the long-term conservation and sustainable use of fishery resources other than tuna in areas beyond national jurisdiction. The Agreement is binding on Contracting and Co-operating Non-contracting Parties (CCPs).

In 2015, a resolution was adopted prohibiting the use of gillnets and committing to inspections on ships visiting ports (SIOFA 2015). In 2019, SIOFA developed CMM 2019/12, *Conservation and Management Measures for Sharks[54] (Sharks)* (SIOFA 2019), which includes provisions for deep-sea chondrichthyans:

- CCPs shall ensure that fishing vessels flying their flag do not target any deep-sea shark species listed in Annex 1 of the CMM (Table 5.4), within the Agreement Area;
- CCPs shall ensure that fishing vessels flying their flag record and submit all reporting requirements as per CMM 2019/02 (Data Standards) for all deep-sea sharks to the lowest taxonomical level possible when caught in SIOFA fisheries;
- By 2020 the Scientific Committee shall advise the Meeting of the Parties on the need to adopt any appropriate by-catch limits for relevant SIOFA deep-sea shark species and fleets, including on scientific and data needs to inform such advice;
- CCPs shall, where possible, undertake research to i) identify ways to increase fishing gear selectivity to minimize deep sea shark bycatch, and to ii) identify shark nursery areas in the Agreement Area and provide the Scientific Committee with such information.

SIOFA in the context of the Nairobi Convention Area

Of the Nairobi Convention Member States, Mauritius, France and the Seychelles are Parties to SIOFA, while Kenya, Madagascar and Mozambique are Signatories but have not yet ratified the Agreement, and Comoros is a Cooperating non-Contracting Party (Table 5.2). These States are therefore obliged to adhere to the SIOFA management measures.

Table 5.4: Chondrichthyan species listed as being "of concern" in Conservation and Management Measure 2019/12, *Conservation and Management Measures for Sharks (Sharks)* (SIOFA 2019) of the Southern Indian Ocean Fisheries Agreement (SIOFA), which are found in the Western Indian Ocean. (* indicates species considered to be "high risk" species).

Order	Family	Scientific name	English common name	IUCN Red List Status
Chimaeras				
Chimaeriformes	Chimaeridae	*Chimaera buccanigella*	Dark-mouth chimaera	Data Deficient
	Chimaeridae	*Chimaera didierae*	The Falkor chimaera	Data Deficient
	Chimaeridae	*Chimaera willwatchi*	Seafarer's ghost shark	Data Deficient
	Rhinochimaeridae	*Harriotta raleighana*	Narrownose rabbitfish	Least Concern
Sharks				
Carcharhiniformes	Pentanchidae	*Apristurus indicus*	Smallbelly catshark	Least Concern
	Pentanchidae	*Bythaelurus bachi*	Bach's catshark	Data Deficient
	Pentanchidae	*Bythaelurus tenuicephalus*	Narrowhead catshark	Least Concern
Hexanchiformes	Hexanchidae	*Hexanchus nakamurai*	Bigeyed six-gill shark	Near Threatened
Squaliformes	Centrophoridae	*Centrophorus granulosus*	Gulper shark	Endangered
	Centrophoridae	*Deania calceus* *	Birdbeak dogfish	Near Threatened
	Dalatiidae	*Dalatias licha* *	Kitefin shark	Vulnerable
	Etmopteridae	*Etmopterus alphus*	Whitecheek lanternshark	Least Concern
	Etmopteridae	*Etmopterus pusillus*	Smooth lanternshark	Least Concern
	Mitsukurinidae	*Mitsukurina owstoni*	Goblin shark	Least Concern
	Somniosidae	*Centroscymnus coelolepis*	Portuguese dogfish	Near Threatened
	Somniosidae	*Centroscymnus crepidater* *	Longnose Velvet Dogfish	Near Threatened
	Somniosidae	*Somniosus antarcticus*	Southern sleeper shark	Least Concern
	Somniosidae	*Zameus squamulosus* *	Velvet dogfish	Least Concern

[53] https://www.apsoi.org/

[54] The term "sharks" refers to Chondrichthyes for the purposes of this CMM, as defined by the Food and Agriculture Organization (FAO)

5.4.3 Southwest Indian Ocean Fisheries Commission (SWIOFC)

The SWIOFC, established in 2004, is an RFB (FAO Article VI Body) responsible for promoting regional cooperation for the sustainable utilization and management of living marine resources within the southwest Indian Ocean (SWIO), covering most of FAO Statistical Area 51 (Harris and Gove 2015). SWIOFC promotes the provisions of the FAO Code of Conduct for Responsible Fisheries (FAO 1995), the EAF (FAO 2003) and the precautionary approach. Sharks are one of its eight focus species groups (SWIOFC 2013). All ten Nairobi Convention Member States are Members of SWIOFC (Table 5.2). The Commission is intended to:

- improve governance through institutional arrangements that encourage cooperation;
- assist the development and implementation of fishery management systems that consider environmental, social and economic concerns;
- keep under review the state of fishery resources in the area and the industries based on them;
- promote, coordinate and develop research programs for living marine resources in the area;
- promote collection, exchange, dissemination and analysis of statistical, biological, environmental, socioeconomic, fishery and other information;
- provide a scientific basis to assist Members in taking fisheries management decisions;
- provide advice on management measures to member governments and fisheries organizations;
- provide advice and promote co-operation on MCS, including joint activities;
- encourage, recommend and coordinate training in the areas of interest of the Commission;
- promote and encourage the utilization of the most appropriate fishing craft, gear, fishing techniques and post-harvesting technologies (FAO 2005).

As a statutory body of the FAO, SWIOFC cannot impose obligations on its members, but promotes regional fisheries cooperation through guidance on the implementation of important fisheries projects such as the South West Indian Ocean Fisheries Project (SWIOFP), the Agulhas Somali Current Large Marine Ecosystems Project (ASCLME) and the EAF-Nansen Project (an initiative to support implementation of the EAF), and the South West Indian Ocean Fisheries Governance and Shared Growth Project (SWIOFish). SWIOFC developed the *Guidelines for minimum terms and conditions (MTC) for foreign fisheries access in the Southwest Indian Ocean Fisheries Commission (SWIOFC) Region* (SWIOFC 2019), to guide the management of foreign fishing fleets in the SWIO.

5.4.4 (Nairobi) Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region

The Nairobi Convention, adopted in 1985 as a United Nations Environment Programme (UNEP) Regional Seas Programme, is a regional framework agreement for management of marine and coastal environments in the WIO. The Convention encompasses the WIO waters of East Africa and its island States, spanning ten East African countries, and engages these countries in actions to protect their shared marine and coastal environments. All ten countries covered in this report are Nairobi Convention Member States (Table 5.2).

Through an Action Plan and associated Protocols on Protected Areas and Biodiversity, and other measures, the Nairobi Convention aims to increase the capacity of the WIO nations to protect, manage and develop the coastal and marine environment. Member States are expected to coordinate efforts to address the current and emerging issues of the WIO. To further incorporate the transboundary issues of *inter alia* climate change, integrated coastal management, and the importance of biological diversity, Member States adopted in 2010 an amended text of the Convention.

The Nairobi Convention does not specifically address threats to chondrichthyans; however, chondrichthyan species form an integral part of the marine and coastal biodiversity that the Convention was established to address. At the 7th CoP in 2012, the Nairobi Convention Member States agreed to include sharks and rays in the Convention's Program of Work for 2013–2017 (Decision CP7/1) and called for (Decision CP7/12) regional collaboration on the conservation and management of chondrichthyans, as well as the preparation, by the Secretariat, in collaboration with the Contracting Parties, of a regional report on the status of chondrichthyans in the WIO. The current document represents this regional status report.

These chondrichthyan-specific decisions showed the recognition by the Member States of the threats facing chondrichthyan species and the need to address these in the WIO. These were important steps for improved management of chondrichthyans in the region, as the Nairobi Convention is binding on Member States.

The Convention has several Protocols, which are also binding on Member States, including the *Protocol concerning protected areas and wild fauna and flora in the Eastern African Region*. This Protocol has four Annexes that list plant and animal species whose harvesting should be fully prohibited or regulated. These Annexes therefore provide an objective, centralized list of species to inform resource managers of Member States which species warrant management or legal protection at national level.

No chondrichthyan species are listed on the Annexes of the original Convention text (UNEP 1985); however, the Member States have acknowledged the need for chondrichthyan conservation actions. Furthermore, in parallel to this report, a list of chondrichthyan species proposed for protection or regulated harvesting was prepared and submitted to the Nairobi Convention Secretariat (see Chapter 2 and Appendix B), for consideration for the incorporation of such species into the relevant annexes of the *Protocol Concerning Protected Areas and Wild Fauna*. The list was developed in response to both a general lack of consideration for chondrichthyan species in legislation in most WIO countries and Decision CP8/4 made at the 8th Nairobi Convention CoP, which called for amendment of the Protocol and annexes. It is expected that relevant chondrichthyan species may be listed on the *Protocol's* annexes in the near future.

Nairobi Convention in the context of the Nairobi Convention Area

The Nairobi Convention covers the coastal and marine resources of all ten States assessed in this report, encompassing all of the East African and WIO island States, and should therefore be recognized as the primary management framework for the coastal and marine resources of the WIO region. The Convention and its measures are binding on Member States, therefore measures introduced, such as through CoP decisions and the listing of species on relevant annexes, provide a legal framework for management of resources in this region. The SWIO is recognized as a global hotspot for chondrichthyan diversity, evolutionary distinctiveness, data deficiency, and threat levels. Therefore, all Nairobi Convention Member States should work closely with the Convention to propose, support and implement relevant measures for chondrichthyans, to improve the conservation and management of these imperilled species in the WIO region.

5.4.5 Indian Ocean Commission (IOC)

The Indian Ocean Commission (IOC) is an inter-governmental organization created in 1982 in Mauritius and institutionalized in 1984 by the Victoria Agreement in the Seychelles. It is composed of five SWIO island States and territories: Comoros, La Réunion, Madagascar, Mauritius and Seychelles. The IOC's principal mission is to strengthen cooperation among these States, through sustainability projects aimed at protecting the region, improving the living conditions of the populations and preserving the natural resources on which the countries depend. The EU is IOC's main development partner. The IOC collaborates closely with SmartFish, a regional fisheries program funded by the EU and co-implemented by the FAO. It operates in twenty countries throughout the Indian Ocean Region, Southern and Eastern Africa, and focuses on fisheries governance, management, monitoring, control and surveillance (MCS), trade, and food security. The IOC and FAO SmartFish Sharks and Rays Initiative has also been working to improve the identification of pelagic chondrichthyans, through the development and dissemination of the *Onboard Guide for the Identification of Pelagic Sharks and Rays* (Ebert 2014a). Workshops were held for professionals from Mauritius and Seychelles in 2014 and from the Francophone States in 2016, aimed at helping participants to use the identification keys to identify pelagic sharks and rays, collect samples and biological data, and to have a greater awareness of CITES and IOTC requirements (Bodiguel et al. 2017). The IOC does not enforce management measures, but rather provides support to Member States, and the Commission's Biodiversity Program supported aspects of the work presented in this report.

5.4.6 Southern African Development Community (SADC) *Protocol on Fisheries*

SADC is an intergovernmental, Regional Economic Community, comprising 16 Member States, including the Nairobi Convention Member States of Mauritius, Mozambique, Seychelles, South Africa and Tanzania, and several landlocked African States. SADC objectives include *inter alia* economic growth, development, poverty alleviation and social improvement, among southern African States. The SADC treaty was adopted in August 1992. Specific and binding Protocols are developed under SADC, which commit Member States to specific procedures and actions.

In 2001, SADC signed the *Protocol on Fisheries* (Table 5.2), to promote responsible and sustainable use of living aquatic resources of interest to SADC Member States, both within and beyond the jurisdiction of Member States. The Protocol has no provisions for chondrichthyans, but there are provisions relating to improved fisheries, which thereby apply to fisheries that take chondrichthyans either directly or indirectly.

There is a strong focus on policy measures, as Member States are required to:

- take conservation and management measures to regulate the use of living aquatic resources (within and beyond national jurisdiction), to prevent overexploitation, whilst enabling sustainable utilization of the resources;
- take measures at national and international levels that introduce relevant (and harmonized) legislation, policies, plans and programs on fisheries enabling appropriate and timely responses relating to the Protocol's provisions, specifically for management of shared stocks;
- prevent and eliminate overfishing and excess fishing capacity in the SADC Region and maintain levels of fishing effort that are commensurate with the sustainable use of fishery resources;
- take measures to prevent excess fishing capacity from non-SADC-flag fishing vessels; and
- cooperate in the development of minimum terms and condition for access by non-SADC-flag fishing vessels to the fisheries resources relevant to SADC Member States.

The Protocol calls for fair access to resources, for artisanal and subsistence fishers, calling for legal, administrative and enforcement measures necessary for the protection of artisanal and subsistence fishing rights, tenure and fishing grounds, particularly for socially and economically disadvantaged fishers.

There is a strong focus on science. The Protocol requires that States i) generate and consider the best scientific information for making management decisions, ii) cooperate in joint research programs, particularly those on shared resources, and iii) promote the sharing of knowledge, through *inter alia* peer review of research, participation in research seminars, publications of regional interest, and promoting networks and professional associations.

5.5 Status of national legislation and domestic management

5.5.1 Existing and required species-level regulations

National fisheries legislation and policies for chondrichthyan species are generally limited in most Nairobi Convention Member States, but several States have recognized the need for improvements. Seychelles and South Africa have implemented their NPOA-Sharks, while Mauritius and Madagascar have developed theirs but have not yet implemented them. South Africa has also developed a specific *Shark Biodiversity Management Plan* (Republic of South Africa 2015a). Legislation has been developed in certain WIO States, specifically for national interests of protecting threatened chondrichthyan species.

In other States, legislation has been developed to adhere to requirements of regional or international agreements. Madagascar, Mayotte and La Réunion prohibit the marketing of several large shark species, due to the human risks associated with high toxicity levels in these species. South Africa, Mozambique, Kenya, Tanzania and Seychelles have legally protected several chondrichthyan species, while a few species are protected in La Réunion and Mayotte through EU legislation (Table 5.5). Comoros and Somalia are currently revising national fisheries legislation and it is expected these revised regulations will include aspects of the conservation of chondrichthyan species.

Based on the binding conservation and management instruments and agreements described in this chapter, numerous chondrichthyan species in the WIO require legal protection or retention bans in certain fisheries (Table 5.5), while some are subject to trade controls.

All Nairobi Convention Member States, except Comoros, are signatory to CMS, and should therefore protect all CMS Appendix I chondrichthyans (including all sawfishes (Family Pristidae), the basking shark *Cetorhinus maximus*, great white shark *Carcharodon carcharias*, oceanic whitetip shark *Carcharhinus longimanus*, whale shark *Rhincodon typus*, and all manta and devil rays (Family Mobulidae) (Table 5.5). Mozambique is currently the only Nairobi Convention Member State that legally protects all CMS Appendix I chondrichthyans in its waters; South Africa, La Réunion and Mayotte protect most of their CMS Appendix I chondrichthyans. The remaining Nairobi Convention Member States protect few or none (Table 5.5; Lawson and Fordham 2018), and should improve measures to ensure that all such species become protected, as required by CMS (see section 5.2.1).

As Parties to IOTC, all Nairobi Convention Member States should implement relevant IOTC retention bans, including for all thresher shark species (family Alopiidae) (IOTC Resolution 12/09) and several taxa also listed on CMS Appendix I which should therefore be fully protected (i.e., *C. longimanus* and *R. typus* and all species in the family Mobulidae, Table 5.5). Mozambique fully protects all of these species. Madagascar, Mauritius, Seychelles and Tanzania have implemented retention bans for these species through permit conditions, yet the remaining States have implemented bans for few or none (Table 5.5).

Table 5.5: Chondrichthyan species in the Nairobi Convention area of the Western Indian Ocean that are required to be protected at national level by Party States through listing in Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), through an Indian Ocean Tuna Commission (IOTC) resolution, indicating countries in which they are present (1), reported but not confirmed (?), absent (-), legally protected (green shading), prohibited only through permit conditions (blue shading) or not protected (orange shading), and IUCN Red List status (CR = Critically Endangered, EN = Endangered, VU = Vulnerable). (Alpha-2 country codes: KM: Comoros, KE: Kenya, MG: Madagascar, MU: Mauritius, MZ: Mozambique, RE: La Réunion, YT: Mayotte, SC: Seychelles, SO: Somalia, ZA: South Africa, TZ: Tanzania)

Species name	Common name	CMS	IOTC	IUCN	KM	KE	MG	MU	MZ	RE	YT	SC	SO	ZA	TZ
Alopiidae	Thresher sharks														
Alopias pelagicus	Pelagic thresher shark		12/09	EN	1	1	1	?	1	?	1	1	1	1	1
Alopias superciliosus	Bigeye thresher shark		12/09	VU	1	1	1	1	1	1	1	1	1	1	1
Alopias vulpinus	Common thresher shark		12/09	VU	?	?	?	?	?	?	?	?	?	1	?
Carcharhinidae	Requiem sharks														
Carcharhinus longimanus	Oceanic whitetip shark	I	13/06	CR	1	1	1	1	1	1	1	1	1	1	1
Cetorhinidae	Basking shark														
Cetorhinus maximus	Basking shark	I/II		EN	-	-	-	-	-	-	-	-	-	1	-
Lamnidae	Mackerel sharks														
Carcharodon carcharias	Great white shark	I/II		VU	1	1	1	1	1	1	1	1	-	1	1
Mobulidae	Manta and devil rays														
Mobula alfredi	Reef manta ray	I/II	19/03	VU	1	-	1	-	1	-	1	1	-	1	1
Mobula birostris	Giant manta ray	I/II	19/03	EN	1	1	1	1	1	1	1	1	1	1	1
Mobula eregoodoo	Longhorned pygmy devil ray	I/II	19/03	EN	?	?	?	?	?	?	?	?	1	1	1
Mobula kuhlii	Shortfin devil ray	I/II	19/03	EN	?	1	1	?	1	?	1	1	1	1	1
Mobula mobular	Spinetail devil ray	I/II	19/03	EN	-	1	1	-	1	-	1	1	1	1	1
Mobula tarapacana	Sicklefin devil ray	I/II	19/03	EN	-	-	-	1	?	1	-	-	-	1	1
Mobula thurstoni	Bentfin devil ray	I/II	19/03	EN	-	-	1	-	?	-	-	-	-	1	1
Pristidae	Sawfishes														
*Anoxypristis cuspidata***	Narrow sawfish	I/II		EN	-	-	-	-	-	-	-	-	?	-	-
Pristis pristis	Largetooth sawfish	I/II		CR	-	1	1	?	1	?	-	?	1	1	1
Pristis zijsron	Green sawfish	I/II		CR	-	1	-	?	1	?	-	-	1	1	?
Rhincodontidae	Whale shark														
Rhincodon typus	Whale shark	I/II	13/05	EN	1	1	1	1	1	1	1	1	1	1	1

** Presence in Nairobi Convention area of WIO uncertain; range possibly extends along Indian Ocean coastline of Somalia, but not confirmed

Retention bans alone may not necessarily reduce mortality; therefore, States should ensure that the other IOTC management measures are effectively implemented, including gear restrictions, reporting requirements, observer coverage and minimum port inspection requirements, and actively investigating and adopting measures that will effectively reduce fishing mortality of these and other threatened, vulnerable, and depleted species.

No commercial international trade in CITES Appendix II chondrichthyan species should be permitted, unless a formal NDF confirms that such trade and the associated fishing for that species are sustainable. This applies to the 14 CITES Appendix II chondrichthyan species (Table 5.6) that are legally harvestable without contravening CMS Appendix I, IOTC measures or national regulations (Table 5.5). It should be noted that species of the family Alopiidae (thresher sharks) have a retention ban imposed under the IOTC (Table 5.5), prohibiting retention in the tuna-associated fisheries only, and may therefore legally be caught in other (non-IOTC) fisheries and traded.

All Endangered species (i.e., Critically Endangered or Endangered on the IUCN Red List) should be considered for protection in all States, following recommendations in the text of the Nairobi Convention and FAO *Code of Conduct for Responsible Fisheries* that Endangered species should not be fished.

Species that may in the future be listed in Annex II of the Nairobi Convention *Protocol Concerning Protected Areas and Wild Fauna* should also be fully protected in all Nairobi Convention Member States.

However, capacity for implementation and enforcement is generally low in several Nairobi Convention Member States. Improvements to national legislation and better awareness amongst government fisheries agencies are required to further encourage domestic efforts for the protection of chondrichthyans in the WIO. Chondrichthyan policy and management are described in detail for each Nairobi Convention Member State in the relevant sections of Chapter 6.

Table 5.6: Chondrichthyan species in the Nairobi Convention area of the Western Indian Ocean that are listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) that may (unless prohibited nationally) be legally harvested (i.e., not listed in Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)) and are subject to CITES trade measures (* denotes species with retention ban for all fishing vessels on the Indian Ocean Tuna Commission (IOTC) Record of Authorized Vessels, but which may be harvested in non-IOTC fisheries). IUCN Red List (RL) status for each species is also presented (CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Whether species have been confirmed (1) or reported but not confirmed (-) is also presented. I and II denote Appendix.

Species name	Common name	CMS	CITES	IOTC	IUCN	KM	KE	MG	MU	MZ	RE	YT	SC	SO	ZA	TZ
Alopiidae	Thresher sharks															
Alopias pelagicus *	Pelagic thresher shark	II	II	12/09	EN	1	1	1	-	1	-	1	1	1	1	1
Alopias superciliosus *	Bigeye thresher shark	II	II	12/09	VU	1	1	1	1	1	1	1	1	1	1	1
Alopias vulpinus *	Common thresher shark	II	II	12/09	VU	-	-	-	-	-	-	-	-	-	1	-
Carcharhinidae	Requiem sharks															
Carcharhinus falciformis	Silky shark	II	II	-	VU	1	1	1	1	1	1	1	1	1	1	1
Glaucostegidae	Giant guitarfishes															
Glaucostegus halavi	Halavi guitarfish	-	II	-	CR		1									
Lamnidae	Mackerel sharks															
Isurus oxyrinchus	Shortfin mako shark	II	II	-	EN	1	1	1	1	1	1	1	1	1	1	1
Isurus paucus	Longfin mako shark	II	II	-	EN	1	1	1	1	1	1	1	1	1	1	1
Lamna nasus	Porbeagle shark	II	II	-	VU					-					-	
Rhinidae	Wedgefishes															
Rhina ancylostomus	Bowmouth guitarfish	-	II	-	CR		1	1	1	1	1	1	1	1	1	1
Rhynchobatus australiae	Bottlenose wedgefish	II	II	-	CR		1	1		1	1		1	1		1
Rhynchobatus djiddensis	Whitespotted wedgefish	-	II	-	CR		-	-	-	1	-	-	-	-	1	-
Sphyrnidae	Hammerhead sharks															
Sphyrna lewini	Scalloped hammerhead shark	II	II	-	CR	1	1	1	1	1	1	1	1	1	1	1
Sphyrna mokarran	Great hammerhead shark	II	II	-	CR	1	1	1	1	1	1	1	1	1	1	1
Sphyrna zygaena	Smooth hammerhead shark	II	II	-	VU	1		1	1	1	1		1	1	1	-

5.6 Recommended regulatory actions for chondrichthyan management in the Nairobi Convention area of the Western Indian Ocean

5.6.1 Chondrichthyan management - status quo

The WIO is characterized by a rich chondrichthyan fauna, but owing to several regional and global threats the stocks of many of these species have suffered major declines, with 38% of the chondrichthyan species present in the WIO now considered threatened on the IUCN Red List of Threatened Species (IUCN 2021, see Chapter 3). Current management of chondrichthyans in the WIO is a fragmented combination of measures at the domestic, regional and international levels (Table 5.2), with varying degrees of effectiveness. The lack of capacity in most WIO countries for MCS is a major problem that needs to be addressed. Despite being signatory to the many global and regional MEAs and members of the IOTC and FAO, domestic compliance with and the implementation of the binding and voluntary requirements of international and regional instruments remains poor in most WIO States. While some States have implemented national protections for certain chondrichthyan species, there is generally limited national legislation for chondrichthyan conservation and management, across the WIO.

There is thus a need for i) improved legislation for and management of chondrichthyans at national and WIO regional levels, to reduce the impacts of fishing on these threatened species and to improve adherence to the agreements to which Nairobi Convention Member States are Party, and for ii) implementation of protective measures for those species whose populations within the WIO require stricter management or warrant full protection (see Appendix B). Mechanisms for such protection include listing under the annexes of the Nairobi Convention *Protocol concerning Protected Areas and Wild Fauna and Flora,* listing on the national prohibited species lists of the WIO States, and support for future proposals for listing of relevant species on the annexes of other global MEAs. Furthermore, conservation and management needs of those species requiring regional collaboration or regional management plans, as called for by the Nairobi Convention, IOTC, CMS Appendix II, CITES and other agreements, need to be addressed, to ensure effective management of such species or stocks, throughout their WIO ranges.

The IUCN Red List categories carry no legal requirement for action; however, such assessments are conducted by teams of global and regional experts, and undergo strict scrutiny to ensure objective categorizations. These categorizations provide a useful tool for decision makers as to which species require improved regulations. Species listed in the Endangered and Critically Endangered categories are those which face a very high to extremely high risk of extinction in the wild (IUCN 2021), and thereby warrant strict protections, to ensure that the species or certain stocks thereof are not driven to extinction. Specifically, article 4 of the Nairobi Convention *Protocol Concerning Protected Areas and Wild Fauna*, '*Species of Wild Fauna Requiring Special Protection',* stipulates that "The Contracting Parties shall take all appropriate measures to ensure the strictest protection of the endangered wild fauna species listed in annex II", thereby supporting the notion that Endangered species (taken to include Critically Endangered species) should be protected.

Furthermore, while the IUCN Red List categories do not obligate States to conservation actions, the measures for species that have been adopted by CITES, CMS and IOTC, as well as the Nairobi Convention, are legally binding on Member States. Therefore, the Nairobi convention Member States, all of which are Party to all of these (except Comoros which is not Party to CMS), are required by binding commitments to adhere to these regulatory requirements. However, many Nairobi Convention Member States currently fail to meet these commitments, and so fall short in their implementation of these agreements (Table 5.5).

The inclusion of sharks in the Nairobi Convention's Program of Work and the call for regional collaboration on the conservation and management of sharks (in both cases referring to all chondrichthyans) including with CITES, CMS, RFBs and other partners, in recognition of the mounting threats to and declining status of WIO chondrichthyan species, therefore constitute a first step at the regional level to improve the conservation status of these imperilled species.

5.6.2 Priority management needs in summary

The urgent message is that chondrichthyan populations in the WIO have declined dramatically as a direct result of overfishing. Immediate action is essential to implement management measures that can reduce mortality of chondrichthyan species. Action should not be delayed because of imperfect information and limited capacity. The following key actions should be taken to reduce threats to chondrichthyan populations in the WIO, to improve their conservation status:

1. **States should implement specific management measures at national level that will lead to effective conservation and management of chondrichthyan species in their waters**, particularly threatened species, such as:
   a. implementing appropriate species-specific, gear-specific and fishery-specific regulatory measures for chondrichthyan species or fisheries that catch chondrichthyan species, to reduce chondrichthyan mortality and ensure sustainable catch levels;
   b. developing national legislation and policy pertaining to the management of, and fisheries for, chondrichthyan species, including legal prohibition where relevant;
   c. incorporating chondrichthyan conservation into MPA planning and area management;
   d. ensuring effective enforcement of all measures;
   e. implementing and supporting appropriate chondrichthyan fishery monitoring, research and surveillance programs;
   f. developing a Shark Assessment Report and implementing (and revising at regular intervals) their NPOA-Sharks;
   g. raising awareness of the threats faced by chondrichthyans and current regulations for their management, among government institutions, fishers and other stakeholders.

2. **Parties to MEAs must implement their binding commitments in terms of species protections and trade controls** at national level, as imposed by the agreements to which they are Party (Tables 5.1, 5.2, 5.5), and non-Party Range States should be encouraged to do the same. Specific actions include *inter alia*:
   a. full protection of all chondrichthyan species listed in CMS Appendix I;
   b. retention bans for chondrichthyan species prohibited under IOTC Resolutions; and
   c. trade controls for all chondrichthyan species listed in the CITES Appendices.

3. **States should develop and implement regional management measures for straddling stocks of chondrichthyan species** that are migratory or whose ranges cover multiple States, through multilateral collaboration, to ensure effective management, as required or guided by:
   a. CMS Appendix II;
   b. FAO IPOA-Sharks (FAO 1999)
   c. CMS Sharks MOU conservation plan (CMS 2018); and
   d. FAO *Fisheries management. 1. Conservation and management of sharks* (FAO 2000).

4. **States should voluntarily implement species protections and catch and trade restrictions** for threatened species not already covered under existing MEAs, through:
   a. following the guiding text of the Nairobi Convention, in terms of strictly protecting endangered wild fauna species, and fully protecting and managing relevant species listed in Nairobi Convention Annexes;
   b. fully protecting species listed under CITES Appendix I, for which commercial trade bans should already be in place;
   c. protecting all IUCN Critically Endangered and Endangered species; and
   d. developing management measures for IUCN Vulnerable and Near Threatened species.

5. **Nairobi Convention Member States should implement the relevant measures nationally and regionally**, including listing chondrichthyan species on the Convention Protocol Annexes, as proposed in Appendix B to this report: *Recommendations for Shark and Ray Listings in the Annexes of the Nairobi Convention Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region*.

5.6.3 Required and recommended actions for improved chondrichthyan conservation and management

Policy and management

- Measures must be implemented to ensure that overfishing is mitigated, catch levels become sustainable, threatened species and ecosystems are protected, and fishing capacity is not excessive (FAO *Code of Conduct for Responsible Fisheries*; Nairobi Convention; FAO Guidelines);
- Measures should be implemented to reduce chondrichthyan bycatch, e.g., 'bycatch reduction devices' in trawl nets, prohibiting destructive fishing gears, regulating construction of certain gears, regulating net mesh-size, regulating breaking strain of net filaments and longline snoods, and prohibiting wire traces for longline hooks (FAO Guidelines);
- Measures should be incorporated into national legislation to ensure adherence to commitments adopted under all MEAs and RFBs, *inter alia* CMS, CITES, Nairobi Convention and IOTC (IPOA-Sharks, FAO Guidelines; FAO *Code of Conduct for Responsible Fisheries*);
- National regulations should prohibit removal of shark fins at sea (i.e., fins naturally attached; IOTC Resolution 17/05), and prohibit transhipment operations at sea (IOTC Resolution 19/06);
- Total protection or fishery retention bans should be implemented for chondrichthyan species in alignment with relevant agreements, particularly CMS Appendix I, IOTC Resolutions and Nairobi Convention Annexes (Table 5.5) (FAO Guidelines);
- States should complete their Shark Assessment Reports and develop their NPOA-Sharks, including objectives and measures for implementation, following guidelines of the IPOA-Sharks (CMS; FAO IPOA-Sharks; IOTC; FAO Guidelines);
- Chondrichthyan fisheries management and conservation needs should be incorporated into MPA planning and management (Rigby et al. 2019);
- Chondrichthyan fisheries management and conservation needs should be incorporated into community-level management;
- Chondrichthyan-specific legislation should be implemented, where necessary (FAO Guidelines);
- Regional management plans for chondrichthyan species should be developed where relevant, with multilateral collaboration (CMS Appendix II);
- Measures should be taken to conserve and, where necessary, restore critical habitats of threatened species (CMS calls on Parties to ensure safe migration and prevent activities or obstacles that seriously impede the migration of such species);
- Fishers should be required to release captured chondrichthyans alive (especially juveniles and pregnant females), unless part of sustainable targeted fisheries; if chondrichthyans are retained, fishers should be required to utilize the entire animal (i.e., no discards) (IOTC Resolution 17/05);

Reporting

- States should report on catch and mortality levels of chondrichthyans at species level, in all fisheries;
- States should ensure recording of fishing capacity (numbers of vessels/fishers, gear characteristics, spatial distribution of fishing; FAO Guidelines).
- Species caught and traded should be identified to species level and field guides should be prepared to enable species identification (whole animals, carcasses, fins, heads, other etc.; FAO Guidelines);
- Systems should be in place to record information relating to all exports and imports of CITES-listed species (CITES; Nairobi Convention);
- A reporting system should be implemented to adhere to all reporting requirements at national level and of all relevant instruments to which States are Party, e.g., IOTC, CITES and FAO, and data records should be checked to ensure accurate and full reporting that meets reporting requirements (IOTC Resolution 13/06 and 15/01);
- All interactions (catches/releases, dead/alive) by IOTC-registered vessels with prohibited species must be reported, including thresher sharks (family Alopiidae), whale sharks *Rhincodon typus*, oceanic whitetip sharks *Carcharhinus longimanus*, and manta and devil rays (family Mobulidae) (IOTC Resolutions 12/09, 13/05, 13/06 and 19/03.

Permits and Trade

- All international trade (commercial and non-commercial) in CITES-listed chondrichthyans requires export and import permits, and no trade should be permitted without the relevant permits;
- All commercial international trade in wild-caught chondrichthyans listed on CITES Appendix I must be prohibited (i.e., two or possibly three sawfish species (family Pristidae) in the WIO, Table 5.1);
- Non-detriment findings (NDF) must be conducted for all CITES-listed chondrichthyan species to determine whether international trade can be sustainable (positive NDF), or should be prohibited (negative NDF). All provisions listed as prerequisite in positive NDFs must be enforced, and trade bans must be implemented for species with negative NDFs. Currently, there are 25 CITES Appendix II chondrichthyan species in the WIO (Table 5.1);
- Actions must be taken to ensure legal acquisition findings are produced and certified for every shipment containing CITES Appendix II species bound for export, to ensure that the products were obtained without contravention of national or international regulations (CITES II);
- International trade should be prohibited for any species protected under national regulations or an MEA, such as the 12 species of chondrichthyans currently listed in CMS Appendix I that occur in the WIO and should be protected (Tables 5.1, 5.5);
- Export volumes of CITES-listed species should be closely monitored, and issuing of export permits must cease if trade becomes unsustainable (CITES).

Research

States should conduct, encourage and provide support for applied chondrichthyan scientific research studies, particularly on migratory species and those with poor conservation status, towards sustainable use and conservation of resources (CMS I; FAO Guidelines), and covering a range of aspects, *inter alia*:

- Monitoring of catches and mortality levels (including discards) of chondrichthyans at species level, with size/weight data, in all fisheries;
- Stock assessments, where possible, to assess whether stocks are at sustainable levels, and identify those that require harvesting restrictions or prohibition (CMS MOU; FAO Guidelines);
- Biology, ecology, life-history, behaviour, migration patterns, genetic stock structure and key mating, pupping and nursery areas of threatened and fished chondrichthyan species (IOTC Resolution 17/05, FAO Guidelines);
- Ecology, movement and post-release survival of thresher sharks (family Alopiidae), oceanic whitetip sharks *Carcharhinus longimanus*, blue sharks *Prionace glauca* and manta and devil rays (family Mobulidae) (IOTC Resolutions 12/09, 13/06, 18/02, 19/03);
- Effects of different fishing gears on target species and habitats, and ways to reduce gear non-selectivity, e.g., testing effectiveness of prohibiting wire leaders in longlines (FAO Code of Conduct for Responsible Fisheries, IOTC Resolution 17/05);
- Improved handling practices for chondrichthyans to maximize post-release survival and minimize capture-related mortality (IOTC Resolution 17/05);

5.7 Conclusion

This chapter provides a detailed overview of the conservation and management instruments relevant to chondrichthyan resource management and conservation in the WIO, and summarizes the actions that should be taken (sections 5.6.2, 5.6.3). States should act immediately, to implement measures that prevent further stock declines and local extirpations. However, full details of the many measures imposed were beyond the scope of this report. This chapter is not an exhaustive list of binding and voluntary measures, and rather each of these instruments and their associated texts, policies, measures, protocols and annexes, should be assessed by each State, to ensure appropriate implementation at national level.

CHAPTER 6

Country Profiles

This chapter presents a series of country profiles, detailing key aspects as they relate to chondrichthyans in each Nairobi Convention Member State. Geographic delineations of the Exclusive Economic Zones (EEZs) of each country, for the purposes of these country profiles, follow those defined in Chapter 2. For most countries, the coverage includes the full EEZ. For South Africa, this section covers fisheries, governance and catch and trade statistics, in a general manner, while the species checklist considers only the EEZ east of East London (part of the Eastern Cape Province and the Kwazulu-Natal Province only), due to a sharp transition from sub-tropical to temperate waters and a boundary for the ranges of several chondrichthyan species (Ebert et al. 2021c). Somalia is discussed with respect to the Federal Republic of Somalia and the Federal States, with a focus on the EEZ and coastline of the Indian Ocean, south of Ràs Hafun, and excluding Somaliland as an independent State of Somalia in the Gulf of Aden. Owing to their geographic proximity, Iris, Zélée and Geyser banks are included in the species list of Mayotte, which, in turn, is presented with La Réunion as French Indian Ocean Territories. The Zanzibar Archipelago is included in the United Republic of Tanzania profile.

Biodiversity, species checklists and the current status of knowledge on each species were assessed and developed following the methods described in Chapter 3 for the WIO region. While there is naturally some overlap in terms of species presence and thus the specific research priorities of a given species, from one country to another within the species' range, such information is presented for each country, so as to provide a comprehensive assessment of research priorities for chondrichthyans in each country.

The conservation status of chondrichthyan species in each country was determined through the development of national chondrichthyan species lists, and reference to the IUCN (International Union for the Conservation of Nature) Red List of Threatened Species (IUCN 2021), as for the assessment of conservation status of chondrichthyans at the WIO regional level, in Chapter 3.

Catch and trade information were prepared as described for the WIO region, in Chapter 4, using the same global datasets cited therein. This information was supplemented where possible in the country profiles, using national catch and trade statistics (and anecdotal data) where available. The country profiles present basic overviews of the main marine fisheries in each country, with emphasis on those known or considered to impact chondrichthyan species.

The governance sections were developed for each country through review and analysis of available legal texts and policy documents, to identify the most relevant legislation governing fisheries in each country. Each country's commitments to Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs) were identified through the instruments to which the country is signatory, and listing of the key measures imposed (binding and voluntary) by each (see Chapter 5), as they relate to chondrichthyan fisheries or species in that country.

Information presented in each country profile relating to marine protected areas (MPAs) is adopted partly from the WIO MPA Outlook (UNEP-Nairobi Convention and WIOMSA 2021a, b). Subsequent to the publication thereof, detailed MPA sections for each country profile were deemed unnecessary in the current report. We present here basic overviews of MPAs (shapefiles courtesy of UNEP-Nairobi Convention and WIOMSA 2021b), and their coverage within each Nairobi Convention Member State and discuss in detail those MPAs through which protection for WIO chondrichthyan species is provided or intended.

The key threats to chondrichthyans in each country, and recommended and required actions for management and conservation thereof, including management measures implemented by MEAs and RFBs, are detailed. The key threats and actions identified in these country profiles are subsequently assimilated for an overview of threats and required and recommended actions for improved chondrichthyan management and conservation at the WIO level, as detailed in Chapter 7.

6.1 Union of the Comoros

6.1.1 Introduction

The Union of the Comoros (hereinafter Comoros) is an archipelagic island State in the northern Mozambique Channel comprising three major islands: Ngazidja (Grande Comore), Ndzouani (Anjouan) and Mwali (Mohéli) (Figure 6.1.1). The EEZ of Comoros is not defined due to a lack of clarification between the boundaries of Comoros and Madagascar (Houssoyni 2021), but covers an area in the order of 160,000 km^2 (Breuil and Grima 2014a, UNEP-WCMC and IUCN 2021a). In contrast to all other Nairobi Convention Member States, no part of the Comoros EEZ shares a boundary with areas beyond national jurisdiction (ABNJ).

Geographically, the Comoros archipelago also includes Maoré (Mayotte), and although the the Comorian Government assesses that Mayotte is part of its territory as per resolutions by the United Nations and the African Union, it is also claimed as an insular department and region of France and remains under French administration (Union of Comoros 2014, Houssoyni 2021), and for the purposes of this report is discussed in the La Réunion and Mayotte section (section 6.6). The Comoros Archipelago lies at the northern entrance to the Mozambique Channel and falls within the Northern Mozambique Channel marine ecoregion (Obura 2012), which it shares with Northern Mozambique 280 km to the east and Northwest Madagascar 390 km to the southeast.

The islands are volcanic and surrounded by patch and fringing coral reefs that extend a short distance from the coast, mangroves, seagrass beds and submarine banks, and a handful of smaller uninhabited islands (Granek and Brown 2005). The islands are generally characterized by deep water close to shore, with the exception of Mohéli which has an extensive continental shelf. The coastal waters have diverse habitats and a high level of endemism and biodiversity, and the WWF Global 200 conservation priority list identifies it as within one of 43 priority marine ecoregions (Olson and Dinerstein 1998).

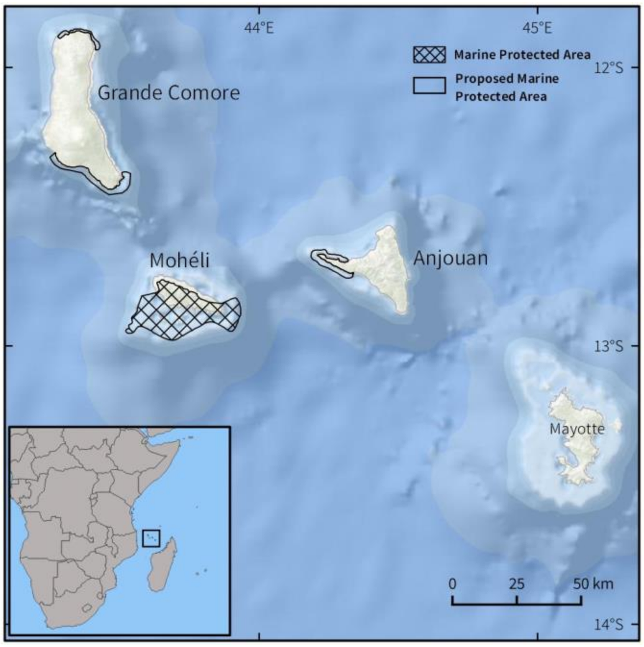


Figure 6.1.1. Map of the Union of Comoros, showing its position in the Western Indian Ocean and place names mentioned in text.

Comoros is considered a low-income country (World Bank 2018), with a relatively small human population size of 850,886[55]. The economy of Comoros is extremely dependent on the ocean, with fisheries being the main food and income generator for the majority of the coastal population and contributing approximately 8% to annual GDP (Breuil and Grima 2014a). Fish consumption in the archipelago constitutes over 20% of total animal protein (Kimani et al. 2019).

Fisheries in the Comoros are largely artisanal, with women fishing from shore and men primarily fishing from small boats in various habitats (Kiszka 2012, Doherty et al. 2015a). Domestic fishery production is approximately 20,000 t per year[1]. Owing to the bathymetry and limited shelf area, the fisheries are mainly reef and pelagic fisheries, with the dominant species being reef-associated species and tuna and tuna-like species (Breuil and Grima 2014a), although sharks seem to be intentionally targeted in Anjouan, while they are generally caught as bycatch on Grande Comore (Maoulida et al. 2009).

[55] www.nairobiconvention.org/comoros-country-profile

6.1.2 Chondrichthyan biodiversity and status of knowledge, Comoros

Biodiversity

Comoros has the lowest chondrichthyan species richness in the WIO, with 38 chondrichthyan species documented to date, comprising 31 shark and 7 batoid species (Table 3.1), representing 13 and 4 families, respectively, and an additional 4 batoid and 1 shark species which possibly occur there, but have not been confirmed (Table 3.3). No chimaera species have been recorded from Comoros. The requiem sharks (Carcharhinidae) represent the most common shark family, with 11 species recorded from Comoros. All other shark families in Comoros comprise three or less species. The most common batoid families are Dasyatidae (whiptail stingrays), Mobulidae (manta and devil rays) and Torpedinidae (torpedo rays) with two species in each family in Comoros. The only other batoid family, Aetobatidae (pelagic eagle rays), comprises one species.

There are no chondrichthyan species endemic to Comoros, although the Comoro catshark *Scyliorhinus comoroensis* is known only from Comoros and a single specimen from northwest Madagascar (Ebert et al. 2013, Fricke et al. 2018). One chondrichthyan species that occurs in Comoros is regionally endemic, the balloon shark *Cephaloscyllium sufflans* (Table 3.3). None of the 26 chondrichthyan species described from the WIO since 2011 occur in Comoros (Table 3.3).

Status of biological and ecological knowledge

There has been limited fishery and marine research in Comoros, resulting in limited information for stock assessments and management (other than for specific species managed under the IOTC) (Breuil and Grima 2014a). Consequently, very little is known about chondrichthyan communities in the waters of Comoros. Fourmanoir (1954) reported at least seven shark and three batoid species from the archipelago. In an investigation of deep demersal (100–400 m) fish fauna, eight species of chondrichthyans (Squalidae, Scyliorhinidae, Odontaspididae, Rajidae, Torpedinidae and Narkidae) were recorded (Heemstra et al. 2006). No information is available on the existence of major aggregations, but divers have reported the presence of aggregating reef sharks and rays, primarily grey reef sharks *Carcharhinus amblyrhynchos* and reef manta rays *Mobula* sp. cf. *alfredi*, off Mohéli (Kiszka and van der Elst 2015). Whale sharks *Rhincodon typus* tagged in northwest Madagascar travelled in close proximity to Comoros (Diamant et al. 2018), however there are no records of any aggregation sites for this species around the archipelago. Similarly, tiger sharks *Galeocerdo cuvier* tagged in Kenya were recorded moving among the EEZs of eight countries within a year, including the EEZ of Comoros (Barkley et al. 2019). These movement studies demonstrate the importance of regional collaboration between shared chondrichthyan stocks, and the need for regional management measures. There do not appear to be any ongoing research or conservation projects in Comoros focused on chondrichthyans.

Knowledge gaps and research priorities

Considering the limited research focused on chondrichthyans in Comoros, there are many knowledge gaps for the majority of chondrichthyan species within the archipelago. As such, research relating to chondrichthyans should be a priority in Comoros, particularly for threatened species.

Of the 42 data-poor[56], threatened chondrichthyan species identified in Chapter 3, only one is present in Comoros, the tawny nurse shark *Nebrius ferrugineus*. Aspects relating to movement and reproduction of this Vulnerable species remain poorly known, in addition to the age and growth categories of age at maturity and maximum age (Table 3.7); therefore, these aspects should be the focus of future research efforts for this species.

Although not data-poor, there are three Critically Endangered shark species that occur in Comoros, the oceanic whitetip shark *Carcharhinus longimanus*, scalloped hammerhead shark *Sphyrna lewini* and great hammerhead shark *S. mokarran*. Therefore, future

[56] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

research should prioritize these species, particularly areas important for their reproduction (Table 3.7).

There are also four Data Deficient (as defined by IUCN) chondrichthyan species in Comoros, comprising two shark and two batoid species (Table 3.3, Chapter 3). The two shark species, the roughskin spurdog *Cirrhigaleus asper* (family Squalidae, dogfish sharks) and the Comoro catshark *Scyliorhinus comoroensis* (family Scyliorhinidae, catsharks), are deepwater species and therefore infrequently encountered, as evidenced through the few records of *S. comoroensis* (Ebert et al. 2013, Fricke et al. 2018), limiting available information. The two Data Deficient batoids, the blackspotted electric ray *Torpedo fuscomaculata* and marbled electric ray *T. sinuspersici* (family Torpedinidae, torpedo rays) are coastal species and exposed to coastal fisheries and warrant further research to determine their conservation status.

6.1.3 Chondrichthyan fisheries, catch and trade

Fisheries

Sharks have been targeted in Comoros since at least the 1950s (Fourmanoir 1954). Shark meat, oil and skin were being imported into Comoros from Madagascar as far back as the 1920s (Petit 1930) and that was still occurring in the 1980s (Cooke 1997), suggesting that shark products were a valuable resource in Comoros and it seems likely that they would have also been targeted in the archipelago during this time. Although fishers do not currently target chondrichthyans (Doherty et al. 2015a), data from the IOTC indicates that sharks are still being caught by artisanal fishers, and that when they are caught, the meat is consumed locally and the fins are sold to the Asian market (Kiszka and van der Elst 2015).

Domestic fisheries in Comoros are predominantly traditional (operated from non-motorized wooden boats or dugouts) and artisanal (operated from planked or fibreglass vessels, some of which are motorized) (Breuil and Grima 2014a). There is also some shore-based subsistence fishing by women (Doherty et al. 2015a). There is also a semi-industrial domestic sector, of about 1,000 vessels, and there were plans for the introduction of industrial longline vessels (Breuil and Grima 2014a).

Artisanal and subsistence fisheries

At least 3,600 traditional fishing vessels operate within 3 nm of the coast, using handlines, surface nets and gillnets. At least 1,670 artisanal fishing boats are in operation in oceanic surface waters, over coral reefs, seagrass beds, and the general inshore area but with these fishers also traveling further offshore, targeting mainly medium to large pelagic species, using handlines and trolling lines, beach seines, fish traps, and gillnets (Poonian et al. 2008, Breuil and Grima 2014a, Everett et al. 2017). Until the 1980s, the fishing fleet was composed almost exclusively of non-motorized pirogues mostly using handlines (de San 1983). Catches by this fleet increased in the 1980s, due to the importation of fibreglass motorboats from Japan and the use of anchored Fish Aggregating Devices (a-FADs) for fishing further offshore (James 1988, Cayré 1991). Crews are small, usually 1–2 people per boat (WIOMSA 2011), and the peak in fishing occurs from November to March when tunas migrate (James 1988). There are no restrictions on the quantities of fish that may be landed, but fishers rarely catch more than they can consume or sell in one day (Hauzer et al. 2013).

Small nets and surface gillnets are the main artisanal gears impacting chondrichthyans (Poonian et al. 2008, Everett et al. 2017). Gillnets targeting sharks have been reported in the past, but the current extent of their use is unknown (Kiszka and van der Elst 2015). Approximately 80% of catches on Grand Comore observed by Fourmanoir (1954) over a one-week period were composed of sharks, whereas it has been reported that they accounted for less than 1% of annual catches on Grand Comore in 1994, and now sharks are rarely seen in catches (M. Hauzer, unpub. data in Doherty et al. 2015a). In 2009, an interview survey was conducted in Comoros to assess the artisanal exploitation of elasmobranchs in Comorian waters (Maoulida et al. 2009). Species reportedly caught included oceanic whitetip sharks *Carcharhinus longimanus,* scalloped hammerhead sharks *Sphyrna lewini,* tiger sharks *Galeocerdo cuvier* and silky sharks *Carcharhinus falciformis.* On Grande Comore, sharks were reported to be caught largely as incidental catch, while on Anjouan, 42% of local fishers confirmed intentionally targeting sharks (Maoulida et al. 2009). Local fishers also said that they valued sharks as an indicator of the presence of large schools of tuna (the most important fishery resource). WIOFish reported silvertip sharks *Carcharhinus albimarginatus* and *C. longimanus* to be retained incidental catch in hook-and-line and surface longline fisheries (Everett et al. 2017).

Industrial fisheries

There is an industrial sector comprised predominantly of foreign longline and purse-seine vessels, operating in areas about 5–15 km offshore, which have historically targeted tuna and tuna-like species and other large pelagic species (Breuil and Grima 2014a, Doherty et al. 2015a). There have been several foreign fishing partnership agreements (FPA) with States such as Seychelles (Breuil and Grima 2014a). There have also been formal agreements with the EU via the Delegation of the Commission of the European Communities in Mauritius, allowing up to 42 tuna purse seiners and 20 longliners from France, Spain, Italy and Portugal to fish for tuna in the EEZ of Comoros (EU 2013a). This specific agreement has various conditions governing elements such as catch[57], catch reporting, observers, control and inspections. However, in 2018, due to ineffective MCS implementation and continued failure by Comoros to fulfil binding obligations in terms of prevention of IUU fishing, the EU denounced the then-active FPA between the EU and Comoros (EU Commission 2018).

Industrial fishing fleets that fish in Comorian waters have a substantial impact on oceanic elasmobranchs and produce shark fins for international trade, but information is lacking on catch levels (Compagno et al. 2005). Sharks once accounted for a large proportion of catches, but now that tuna are the main target species for offshore pelagic fisheries, these proportions are thought to be lower (Doherty et al. 2015a).

Monitoring and reporting

Until 1969, much of the Comorian marine catch was recorded as unidentified marine fish (Doherty et al. 2015a). The latest and only comprehensive survey of small-scale catch was conducted by the National Directorate of Fisheries Resources (DNRH) in 1994 (Doherty et al. 2015a), and shore-based fishing is not monitored at all (Hauzer et al. 2013). Reconstructed total catches from 1950 to 2010, using estimates of missing catches, were found to be 1.3 times that reported to the FAO for the Indian Ocean (Doherty et al. 2015a). Comoros has been included in the WIOFish database since 2011, which should help to provide a scientific base for fisheries monitoring in the future (WIOFish 2021). According to WIOFish, no monitoring of catch, effort or biological parameters takes place in Comoros; the available information on catch composition and catch rate is low to none, and information on the level of incidental catch is lacking (Everett et al. 2017). Everett et al. (2017) also reported that 91% of fisheries had no research conducted on them in the previous five years and that the remaining 9% had low levels of investigation.

The '*Onboard Guide for the Identification of Pelagic Sharks and Rays (Western Indian Ocean)*', developed by the SmartFish Sharks and Rays Initiative in 2014 (Ebert 2014b), has since been translated into French for dissemination and training in Francophone countries. In 2016, a workshop was held to train professionals in these countries on how to use the guide and what to look for when identifying and recording pelagic sharks and rays (Bodiguel et al. 2017). At the end of this course, participants were expected to be able to use the identification keys to identify pelagic sharks and rays, collect samples and biological data, and to have a greater awareness of CITES and IOTC requirements.

Reported chondrichthyan catches

Chondrichthyan catches in Comoros, as expected from predominantly pelagic fisheries, comprise mainly pelagic shark species, including blue sharks *Prionace glauca* (major component; Soilihi 2014), oceanic whitetip sharks *Carcharhinus longimanus*, silky sharks *C. falciformis*, grey reef sharks *C. amblyrhynchos* and hammerhead sharks (Sphyrnidae) (Maoulida et al. 2009, Temple et al. 2018). However, chondrichthyan catches in Comoros are not reported to the FAO at species or family level, but aggregated as 'Sharks, rays, skates, etc. nei' (FAO 2021).

[57]Agreement prohibits the targeted capture of thresher sharks (Alopiidae) and hammerhead sharks (Sphyrnidae), and the capture of whale sharks *Rhincodon typus*, great white sharks *Carcharodon carcharias*, basking sharks *Cetorhinus maximus*, silky sharks *Carcharhinus falciformis* and oceanic whitetip sharks *C. longimanus*.

Chondrichthyan landings, as caught by Comoros in FAO Major Fishing Area 51, showed a major decline from 230 t reported to the FAO in 1994, to just 11 t by 2014 (Temple et al. 2018), but landings then increased dramatically to 131 t reported for 2015 and thereafter landings ranged from 42 t to 80 t (Figure 6.1.2). Comoros landed the third smallest chondrichthyan catch of all the Nairobi Convention Member States between 2012 and 2019, accounting for 0.14% of the total Nairobi Convention Member State catch in all oceans and 0.26% in FAO Major Fishing Area 51 (FAO 2021). Comoros landed an average of 53.3 t of chondrichthyans exclusively from FAO Major Fishing Area 51 during this period (Figure 6.1.2). Given the low reliability of the statistics reported to the FAO (Doherty et al. 2015a), these figures are probably very conservative.

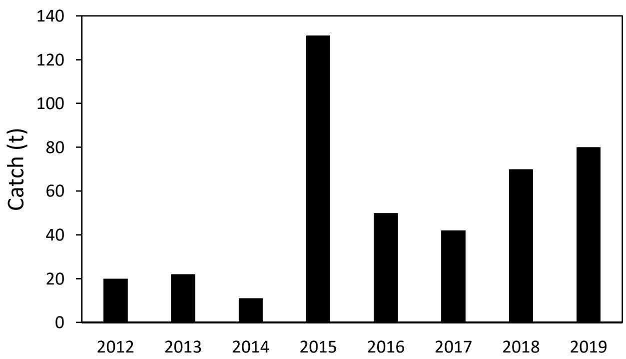


Figure 6.1.2: Total chondrichthyan catch (t) from FAO Major Fishing Area 51, by Comoros, 2012–2019 (FAO 2021).

Trade in chondrichthyan products

It is thought that dried shark meat from Comorian fisheries is exported to the African mainland (Breuil and Grima 2014a). Artisanal fishers based in Anjouan report that they collect shark fins (Maoulida et al. 2009), likely to be traded, while shark meat from Madagascar is imported into Comoros for consumption (Cooke 1997, Le Manach et al. 2011a, Cripps et al. 2015). Although shark meat was reported to be cheaper than meat of other fish such as tuna, fins and dried meat were of a disproportionately higher value (Maoulida et al. 2009).

Official chondrichthyan trade data

There are no records of chondrichthyan exports or imports reported by Comoros, and no imports into other countries from the Comoros (i.e., reported by other countries) in any of the databases searched, for the period 2012 to 2019 (Hong Kong Census and Statistics Department 2021, UN Comtrade 2021). However, there is likely to be an unreported trade in shark fins, fuelled by increasing demand from overseas (Maoulida et al. 2009).

Trade in CITES-listed chondrichthyan species

According to the CITES Trade Database[58], there are no official records of any CITES-listed elasmobranch products being exported from Comoros in the last 10 years (i.e., from 2011–2021).

6.1.4 Conservation status

As a consequence of high levels of fishing pressure, chondrichthyans in Comoros are heavily overexploited, with 26 (68%) of the 38 species confirmed in Comoros currently considered threatened with extinction (IUCN 2021). These include 14 Vulnerable, nine Endangered and three Critically Endangered species, according to the IUCN Red List of Threatened Species (IUCN 2021, see Table 3.4 in Chapter 3). The only species endemic to the region which occurs in Comoros, the Comoro catshark *Scyliorhinus comoroensis*, is classified as Data Deficient by the IUCN Red List (IUCN 2021).

Despite increases in fishing effort, chondrichthyan catch in Comoros has decreased drastically from 230 t in 1994 to an average of 53.3 t from 2012–2019 (Soilihi 2014, FAO 2021), which may reflect stock collapses (Temple et al. 2018). Considering that nearly two-thirds of chondrichthyans in Comoros are considered to be at a high to extremely high risk of extinction in the wild (IUCN 2021), there is strong evidence indicating that fisheries, as well as the shark fin trade, have negatively impacted chondrichthyan species in Comoros, and that improved conservation and management are needed.

[58] https://trade.cites.org

6.1.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

Fisheries administration in Comoros is the mandate of the General Directorate of Fishery Resources (DGRH – Direction Générale des Ressources Halieutiques) (Table 6.1.1), under the Vice-President in charge of Production, Environment, Energy and Handicrafts (Breuil and Grima 2014a). Under the DGRH, the Department of Planning is responsible for planning, regulations, fishing agreements and monitoring, while the Department for Fisheries Promotion is responsible for licensing and statistics. However, financial and human capacity of the DGRH is inadequate. There is a regional directorate in charge of fisheries on each of the three islands; however, the efficiency of these directorates is impeded by limited capacity and a lack of clarity on roles and responsibilities at national and island (regional) levels. Some responsibility is devolved to fisher level, with numerous fisher's cooperatives on each the Comorian islands, under the oversight of the National Syndicate for Fisheries Development in Comoros (SNDPC – Syndicat National pour le Développement des Pêches aux Comores) since 2009.

The Ministry of Agriculture, Fisheries and Environment (MAPEEIA) is the CITES Management Authority for Comoros, including responsibilities for enforcement, while its subsidiary, the National Research Institute for Agriculture, Fisheries and the Environment (INRAPE), is the CITES Scientific Authority (Table 6.1.1).

Comoros has limited capacity for MCS, and there is some evidence of illegal Comorian fishing operations (Kiszka and van der Elst 2015). Although EU regulations stipulate that 5-10% of purse seine fishing trips by EU vessels – including those fishing in Comorian waters – should be monitored, such information is not made directly available to the Comorian authorities. Furthermore, since Comoros does not have offloading facilities, it is not possible to verify the catches or validate the access fees paid (Kiszka and van der Elst 2015). The IOC SmartFish Programme has provided some support to the Comoros for MCS (AU-IBAR 2016). The National Centre for Fisheries Control and Surveillance (CNCSP – Centre National de Contrôle et de Surveillance des Pêches), created in 2007, reports to the Permanent Secretary of DGRH and is responsible for the operationalization of all MCS related activities including VMS (Table 6.1.1). However, the CNCSP is based in Moroni and there are no island stations (Breuil and Grima 2014a). MCS operations in Comoros are supported by the Coast Guard (for at-sea operations) and the National Gendarmerie for onshore operations (Breuil and Grima 2014a) (Table 6.1.1).

Marine Protected Area management in Comoros is the mandate of the Ministry in charge of the Environment, through the Directorate General of Environment and Forestry, although there is a plan to create and implement the Comoros National Parks Agency, which will be mandated to manage existing and proposed MPAs in Comoros (Houssoyni 2021) (Table 6.1.1).

Table 6.1.1: Designated national authorities for chondrichthyan management in Comoros.

Area of management	Designated national authorities
Fisheries management and research	General Directorate of Fisheries Resources (DGRH); National Research Institute for Agriculture, Fisheries and the Environment (INRAPE); Fisher cooperatives, under the National Syndicate for Fisheries Development in Comoros (SNDPC)
Export and import trade controls; permitting	The Ministry of Agriculture, Fisheries and the Environment (MAPEEIA), as the CITES Management Authority; INRAPE, as the CITES Scientific Authority;
Permitting of fisheries	Directorate of Marine Affairs of the Ministry of Transport (but handled by a third-party agency based in the United Arab Emirates
Enforcement of fisheries legislation	National Centre for Fisheries Control and Surveillance (CNCSP); Coast Guard; National Gendarmerie
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	MAPEEIA, as the CITES Management Authority; INRAPE, as the CITES Scientific Authority; Ministère de la Production et de l'Environnement
Species conservation; environmental protection	Direction Nationale de l'Environnement (DNE)
Coastal zone management	Direction Nationale de l'Environnement (DNE)
MPA management and enforcement	Directorate General of Environment and Forestry; Moheli Marine Park Agency, RNAP; newly formed Comoros National Parks Agency

National legislation and regulations

Fisheries in Comoros are governed through the Fisheries and Aquaculture Act (Loi n° 07-011/AU portant Code des pêches et de l'aquaculture), enacted initially in 2007 by Decree n° 07-011/PR, and revised in 2019 as Act n° 19-05/AU under Decree n° 20-051/PR (Union of Comoros 2020). The 2007 Act was enabled through assistance from the FAO for the implementation of a Technical Cooperation Program, TCP 2902 (2003–2004) (Talla et al. 2004, Breuil and Grima 2014a). The 2019 Act covers all fishing activities and sectors, and promotes *inter alia* improved fisheries capacity and infrastructure, fishing licences, fisheries that are optimally exploited, implementation of the ecosystems approach to fisheries, a participatory co-management approach, prevention of IUU fishing, and numerous aspects relating to aquaculture (Union of Comoros 2020). The law defines activities and fishing gears that are prohibited, presents penalties for infractions, and prohibits the capture of marine mammals, marine turtles and species that are protected (Union of Comoros 2020), but does not indicate what species are considered protected.

The Directorate for Marine Affairs is responsible for vessel registration in domestic fisheries (including industrial and artisanal fishing craft). Under the Fisheries and Aquaculture Act, artisanal fishers require fishing licences. Under Act No. 82-015 (Union of Comoros 1982), foreign vessels must be licenced and fishing by foreign vessels is prohibited within territorial waters, or within three nautical miles of any FAD (Breuil and Grima 2014a). Each licence has attached fishing conditions to which the vessel must adhere, and may include requirements for reporting of statistical information to competent authorities, including information on catch, effort and vessel position.

There is minimal legislation relating directly to chondrichthyan fisheries, other than a prohibition on the capture of thresher sharks (Family Alopiidae) (Décret 15-050/PR, Article 37), while a regulation to prohibit the capture of oceanic whitetip sharks *Carcharhinus longimanus* is being developed (IOTC Secretariat 2020a, 2021a). Shark finning is also banned, since 2015, under Articles 35 and 36 of Decree No 15_050/PR (HSI 2019). The 2020 IOTC report on the implementation of NPOAs for seabirds and sharks notes that shark fishing is prohibited in Comoros but that measures are difficult to enforce due to the artisanal nature of the fisheries (IOTC Secretariat 2020a). However, there are conflicting reports, as the Humane Society International's 2019 shark protection report (HSI 2019) does not list Comoros as one of the countries with a shark fishing ban. However, a new law, specific to threatened species, is currently in preparation, and this will likely include protection measures for some chondrichthyan species, but this has not yet been finalized (pers. comm., Soule Hamidou, CITES focal point for Comoros, September 2021).

The DGRH, with support from the Nairobi Convention's SAPPHIRE project, is in the process of developing a new framework document, to improve on existing legislative and regulatory texts, for the management of fisheries, and as they relate to IUU fishing. The initiative is intended to create a new sector policy and operational implementation plan aimed at strengthening the capacity of local fishing stakeholders to combat IUU fishing (Nairobi Convention 2021).

Status of NPOA-sharks

No NPOA-Sharks or Shark Assessment Report has been developed for Comoros (IOTC Secretariat 2020a). A representative of Comoros attended a workshop on the development of a WIO regional roadmap for shark and ray conservation, held in Mauritius in 2017 (see section 2.1.2), and a subsequent workshop on the development of Shark NPOAs for WIO States, held in Mauritius in 2019, as a knowledge-sharing exercise on developing an NPOA-Sharks, and Comoros is encouraged to develop an NPOA for the conservation and management of chondrichthyans in Comorian waters.

Marine protected areas

Comoros currently has a single MPA (UNEP-WCMC and IUCN 2021a). The Mohéli National Park (PNM), off the island of Mohéli, was initially gazetted as the Marine Park of Mohéli in April 2001 (Decree No. 01-053/CE), but a terrestrial component was added in 2015. This was the first National Park in Comoros and was established for the protection of biodiversity (e.g., green turtles, dugongs, coelacanths and humpback whales) and to improve local and regional fisheries (Granek and Brown 2005). The MPA covers ~367 km^2, of which 5.5% falls within Marine Reserves that are fully protected from fishing, and encompasses a diversity of habitats, including seagrass, coral reef, mangroves, sandy beaches and soft sediments, within close proximity to deep water (Houssoyni 2021).

Moheli Marine Park operates under a system of co-management, and while fishing regulations are largely absent elsewhere in Comoros, Moheli has no-take zones that are periodically cycled with open zones within the park. On average, 350 t of fish are caught annually within the Park, feeding a large proportion of the local population (Union of Comoros 2014). With the diversity of habitats that are suitable for chondrichthyan species, which have been recorded in the MPA, if the no-take Marine Reserves are enforced, this MPA could provide at least some protection for coastal, reef-associated chondrichthyan species. Chondrichthyan species record in the area include bull sharks *Carcharhinus leucas*, tiger sharks *Galeocerdo cuvier*, hammerhead sharks (Sphyrnidae) and reef sharks[59], as well as reef manta rays *Mobula alfredi*[60]. The Park was initially considered a co-management success (Granek and Brown 2005), but management capacity has reduced (Hauzer et al. 2008) and there is some evidence that the no-take zones are an attraction to illegal fishing operations from as far away as Anjouan (Kiszka and van der Elst 2015).

In 2014, 0.3% of Comorian territorial waters were reported to be MPAs (World Bank 2021), and this remains the same in 2021, with just the one MPA. However, at the 2014 IUCN World Parks Congress, Comoros committed to protecting 7% of its marine and coastal ecosystems by 2024 (IUCN 2017). The State is currently in the process of developing a National Protected Areas System (Système National des Aires Protégées, SNAP), including three proposed new MPAs, to be co-managed with (and for the benefit of) the local communities. The proposed Parc National Coelacanthe (Coelacanth National Park) and Parc National Mitsamiouli-Ndroudé (Mitsamiouli-Ndroudé National Park), will be situated along the northern and southern coastlines of Grande Comore, respectively, with sharks listed as species of interest in the area of the proposed Coelacanth National Park (Houssoyni 2021). The proposed Parc National Shisiwani (Shisiwani National Park) will be situated at the western peninsula of Anjouan Island, encompassing vast areas of coastal coral reef habitat and also has sharks listed as species of interest (Houssoyni 2021). All three proposed MPAs could provide refuge for coastal chondrichthyan species, if appropriate regulations are implemented and enforced.

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Comoros is signatory to several MEAs and RFBs (see Table 5.2). Comoros is the only Nairobi Convention Member State that is not Party to the Convention on the Conservation of Migratory Species of Wild Animals (CMS). Comoros is, however, Party to the CMS Sharks MOU and a Range State to 14 CMS-listed chondrichthyan species (including five species in CMS Appendix I and nine species listed only on Appendix II); therefore, the State should consider joining CMS, and should implement the measures called for by CMS and the Sharks MOU, including protection for at least the five CMS Appendix I species, and regional management plans, where relevant, for the Appendix II species (Table 5.1, and see section 5.2.1).

Comoros has been Party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1995 and is thus required to implement means to ensure appropriate regulation of the international trade in chondrichthyan species listed on CITES Appendices (see section 5.2.2). Thirteen chondrichthyan species that are listed on CITES Appendix II are known from Comoros (Table 3.3, Chapter 3). However, apparently no NDFs have been conducted for the export of these species from Comoros, Comorian legislation is considered to generally not meet any of the four legal requirements defined by CITES[61] for effective CITES implementation, and the State has been identified as needing the attention of the CITES Standing Committee (CITES 2021). The improved implementation of CITES in Comoros, including the development of a relevant legal framework, should thus be seen as a priority.

[59] https://divingaway.com/en/destination-scuba-diving-88/comoros/moheli,-comores

[60] https://www.facebook.com/missionblue/posts/6284325741608381/

[61] https://cites.org/eng/res/08/08-04R15.php

In terms of RFBs, Comoros is a member of the Southwest Indian Ocean Fisheries Commission (SWIOFC) and a Cooperating non-Contracting Party to the Southern Indian Ocean Fisheries Agreement (SIOFA) (Table 5.2). The State should therefore work with SWIOFC, and is bound by the commitments under SIOFA, which include *inter alia* a ban on the use of gillnets and several measures specific to deep-sea chondrichthyan species, such as research on and setting of bycatch limits for these species, and prevention of targeting of deep-sea chondrichthyans listed in Annex I of SIOFA's Sharks CMM (SIOFA 2019; see section 5.4.2). Comoros is also Party to the Indian Ocean Tuna Commission (IOTC) since 2001 (Table 5.2). Under the IOTC, shark, tuna and swordfish fisheries in Comoros must report their catches and follow IOTC regulations concerning chondrichthyan species, retention bans, finning and reporting (see section 5.4.1). These measures include the requirement of retention bans in IOTC-managed fisheries for at least six species of chondrichthyans that occur in Comorian waters (Table 3.3), including at least two thresher shark species (Family Alopiidae) which are protected in Comoros, and the oceanic whitetip shark *Carcharhinus longimanus*, for which a draft decree on prohibition is being developed (IOTC Secretariat 2020a, 2021a). Shark finning and large-scale drift nets are also banned in Comoros (IOTC Secretariat 2021a). The 2021 IOTC compliance report identified Comoros as being compliant with the requirements to report nominal catch, as well as catch and effort for sharks, but only partially compliant for reporting of size frequency data on sharks (IOTC Secretariat 2021a). This is a significant improvement from the 2015 compliance report that reflected repeated compliance issues, including non-compliance with requirements to report nominal shark catch, shark catch and effort, shark size frequency, purse seine catch and effort, and coastal fisheries catch data; and non-compliance with the implementation of an observer scheme for artisanal sampling (IOTC Secretariat 2015a).

Comoros is also a Member of the Nairobi Convention, and while this Convention does not currently list chondrichthyan species for protection or for species-specific measures, there is potential for chondrichthyan species to be included under this Convention at some point in the future. Comoros has not signed the Port State Measures Agreement (PSMA), as there are no ports available for foreign vessels (IOTC Secretariat 2020a). Comoros is also one of five Member States of the Indian Ocean Commission (IOC), although this body does not impose management commitments on Members, but promotes regional cooperation among WIO island States. Comoros is also Party to the Ramsar Convention, which commits the State to appropriate management of wetlands; three sites are designated as Wetlands of International Importance in Comoros, but none is likely to be contributing to chondrichthyan conservation.

Comoros is also Party to the United Nations Convention on the Law of the Sea (UNCLOS) and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2, see section 5.2.3). The State is thus bound by commitments under UNCLOS to effectively manage fishery resources within its EEZ, as well as the commitments defined within the UN General Assembly Resolution on sustainable fisheries, both of which carry specific measures for chondrichthyan species. Both instruments impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks for sustainable fisheries, such as reduced chondrichthyan mortality and strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999; see section 5.2.3). As a Member of the FAO since 1977, Comoros is also encouraged to follow and implement the measures presented in the many guiding documents published by the Food and Agriculture Organization (FAO), many of which present specific chondrichthyan measures (see section 5.2).

6.1.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Comoros

- Owing to overexploitation in general in the WIO, Comoros has a remarkably high proportion of threatened chondrichthyan species, with over two thirds of the species known from Comorian waters now threatened.
- Comoros depends on agriculture, but with limited agricultural land available on the small land masses (Breuil and Grima 2014a), fisheries are likely to become an increasingly important source of both

protein and income, and so fishing pressure on coastal fish populations is likely to increase. Already fisheries are the main food and income generator for coastal populations, therefore these resources are under significant threat.

- The existing legal framework and institutional capacity for regulation of chondrichthyan fisheries and trade are inadequate, and there is a lack of policy (such as a shark NPOA) to guide the management of these taxa.
- MPAs in Comoros are of limited coverage and are not likely to provide protection for chondrichthyan species, unless considerably expanded.
- Comoros is signatory to multiple MEAs and RFBs, but has not adhered to all their commitments, such as species prohibitions and reporting.
- There is evidence of IUU fishing, and of Comoros failing to adequately prevent IUU fishing through inadequate capacity for MCS (EU Commission 2018), thereby placing Comorian fishery resources at risk of unregulated harvesting.
- Comoros has also been identified as a flag of convenience State for high seas fishing (Gianni and Simpson 2005, ITF 2021). Doherty et al. (2015) reported that the FAO fishing vessel finder database listed six foreign vessels that have been registered with the flag of Comoros between 2004 and 2012 but suspected them to fish in the Atlantic.
- There is poor knowledge and a paucity of data on chondrichthyan biodiversity and exploitation in Comoros, although chondrichthyans are known to be targeted, and there are reports of targeting of sharks for their fins, for the Asian fin trade, despite no records of shark product exports from Comoros.
- There are limited data on fish stocks (including chondrichthyans) in Comoros, and thus limited information to support effective management of such species. Reports to the IOTC suggested that the stocks of pelagic fishery species (mainly tuna and tuna-like species) were not yet fully exploited, but that demersal stocks in shallow areas are overexploited (Breuil and Grima 2014a) and this is likely to be the case with at least the coastal chondrichthyan species.
- There is insufficient local capacity for research and there have been very few research projects in Comoros that cover aspects relating to chondrichthyans.

Required and recommendations actions

Governance, policy, legislation, enforcement and capacity needs

- Improved species-level protections are required, particularly those of threatened chondrichthyan species and species prohibited through retention bans under IOTC.
- Comoros is not a signatory to CMS, but is to the CMS Sharks-MOU, and Comoros is a Range State to many of the chondrichthyan species listed in CMS Appendices I and II; therefore, the State should consider acceding to CMS, protecting the relevant species on CMS I and working with other WIO States to develop multilateral management plans for relevant chondrichthyan species.
- Improvements in the existing governance framework are needed, including modernization of laws (and chondrichthyan-specific legislation where necessary), and the decentralization and co-management of fishery resources.
- Maritime security is needed, including MCS of foreign and domestic fleets, to mitigate IUU fishing, particularly of threatened species of chondrichthyans.
- Institutional development is needed, in the form of capacity and information systems for evaluating resources and developing and analyzing fisheries statistics, which would allow for species stock assessments and conducting of NDFs for CITES-listed species.
- Human capacity building and training are required for fisheries managers, and awareness raising for fishers.

Data collection and research priorities

Very little information is available for chondrichthyan species in Comoros. With such a high proportion of threatened species, chondrichthyan research should be a major priority in Comoros. Specific aspects that require further investigation in Comoros are defined in section 6.1.2.

6.1.7 Priority chondrichthyan species for protection

There are nine species of chondrichthyans either confirmed or reported from Comoros waters that are prohibited in certain fisheries through several IOTC resolutions (Table 6.1.2). These include three thresher shark species (family Alopiidae), which are already prohibited, at least in fisheries targeting tuna and tuna-like species (Décret 15-050/PR, Article 37). The remaining six IOTC-prohibited species, plus a seventh (non-IOTC prohibited) species, are listed on CMS Appendix I (Table 6.1.2), and thereby require national level protection in CMS Party States. As a signatory State to IOTC, Comoros is bound by the IOTC measures and should prohibit these species in the relevant fisheries defined by the IOTC resolutions. While Comoros is not signatory to CMS, it is a Range State for these CMS Appendix I species and should therefore voluntarily protect these seven species.

In addition, there are two Critically Endangered and six Endangered chondrichthyan species in Comoros, which should be considered for protection (at least from commercial harvesting and trade) by virtue of their poor conservation status. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1995); therefore, as a Member State of both Organizations, Comoros should implement the precautionary principle and prohibit the take of Endangered and Critically Endangered species (Table 6.1.2).

Table 6.1.2. Chondrichthyan species confirmed or reported (*not confirmed) from the waters of Comoros, for which certain fishery prohibitions are binding on the State through a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), or that are recommended for protection by virtue of listing on Appendix I (CMS I) of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) and Comoros being a Range State for these species. Species prohibited through permit conditions in IOTC-related fisheries are shaded in blue (see governance section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Critically Endangered and Endangered species for which prohibition is recommended are also presented.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN RL	Rationale
Species for which prohibition in certain fisheries is binding (IOTC), and for which full protection is recommended (CMS Appendix I)							
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	IOTC (CMS I)
Mobulidae	*Mobula birostris*	Giant manta ray	I, II	Yes	II	EN	IOTC (CMS I)
Mobulidae	*Mobula eregoodoo* *	Longhorned pygmy devil ray	I, II	Yes	II	EN	IOTC (CMS I)
Mobulidae	*Mobula kuhlii* *	Shortfin devil ray	I, II	Yes	II	EN	IOTC (CMS I)
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	IOTC (CMS I)
Mobulidae	*Mobula alfredi*	Reef manta ray	I, II	Yes	II	VU	IOTC (CMS I)
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	(CMS I)
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
Alopiidae	*Alopias superciliosus*	Bigeye thresher shark	II	Yes	II	VU	IOTC
Alopiidae	*Alopias vulpinus* *	Common thresher shark	II	Yes	II	VU	IOTC
Critically Endangered and Endangered species, for which prohibition is recommended							
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
Sphyrnidae	*Sphyrna mokarran*	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN
Carcharhinidae	*Carcharhinus plumbeus*	Sandbar shark				EN	EN
Carcharhinidae	*Negaprion acutidens*	Sicklefin lemon shark				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
Lamnidae	*Isurus paucus*	Longfin mako shark	II		II	EN	EN
Centrophoridae	*Centrophorus granulosus*	Gulper shark				EN	EN

6.2 Republic of Kenya

6.2.1 Introduction

The Republic of Kenya (hereinafter Kenya) is situated on the East African mainland, between Somalia to the north and Tanzania to the south (Figure 6.2.1). It has a coastline of approximately 536 km and an EEZ covering roughly 142,000 km^2 (Tuda and Thoya 2021). The continental shelf is narrow, extending approximately 5 km from shore south of Malindi and increasing to 60 km from shore in the north of the country (Spalding et al. 2007). There are a number of nearshore islands, including the barrier islands around Kiunga in the north, the Lamu Archipelago and Sii and Wasini islands in the south.

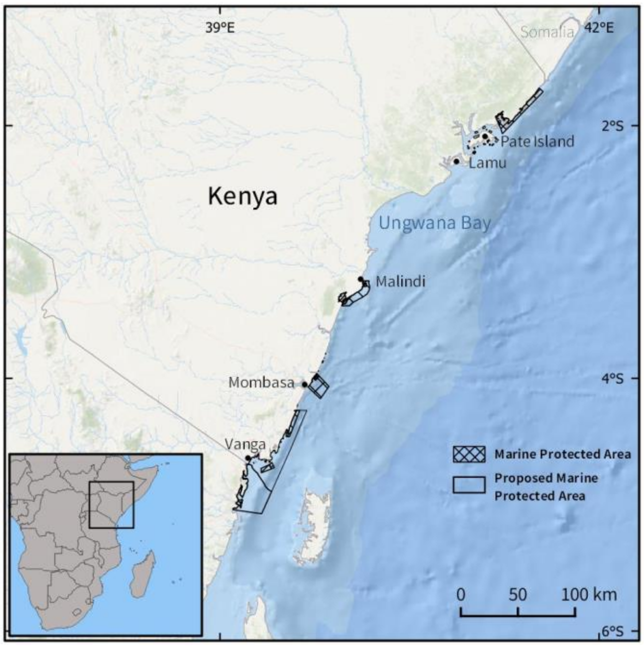


Figure 6.2.1: Map of Kenya, showing its position in the Western Indian Ocean and place names mentioned in text.

The coastal region of Kenya is characterized by mangroves, seagrass beds and coral reefs, with large areas of sandy and soft sediment substrates and several embayments and estuaries, including from Kenya's two largest rivers which permanently flow into the Indian Ocean, the Athi and Tana Rivers (Obura 2001, Spalding et al. 2007, Tuda and Thoya 2021). Biodiversity appears to be highest where reefs are prevalent, generally in the south of the country (Spalding et al. 2001).

Kenya shares its marine diversity with northern Tanzania to the south, as both fall within the East African Coral Coast marine ecoregion, as defined by Spalding et al. (2007) or the Northern Tanzania/Kenya Monsoon Coast as defined by Obura (2012). The biology of coastal Kenya is largely driven by the various currents which flow along its shores, namely the East African Coastal Current, Somali Current, Southern Equatorial Current and the Equatorial Counter Current (Spalding 2001). The weather in Kenya is characterized by two distinct seasons, the Southeast Monsoon (April–October) and the Northeast Monsoon (December–March).

The 2019 human population estimate for Kenya was 47.6 million people (IMF 2021), with coastal areas being densely populated, particularly Mombasa (Kenya National Bureau of Statistics 2019). Kenya is considered to have a lower to middle income (World Bank 2018). The main economic activities in coastal areas include tourism, ports and shipping, agriculture, fisheries, forestry and mining, with small-scale fisheries employing approximately 12,000 people and supplying 95% of Kenya's total marine catch[62].

The narrow continental shelf in Kenya (about 8,437 km^2; Claus et al. 2014) limits marine fishing to very inshore areas, but marine fisheries are critical to the food security and livelihoods of the coastal communities, contributing over 80% of the income to many of these households (Oddenyo et al. 2018). There is an offshore fishery in Kenya comprised of two local longline vessels and a distant water fleet mainly comprising purse seiners and longliners, but fisheries in Kenya are dominated by small-scale and artisanal sectors, with several semi-industrial longline vessels operated by small-scale fishers and approximately 6,500 artisanal fishermen accounting for 80% of Kenya's marine catches (WildAid 2007, Le Manach et al. 2015a, Oddenyo et al. 2018). Evidence of overexploitation in recent decades has led to improvements in Kenyan fisheries management; however, Kenya's coral reef fish populations continue to show severe impacts from fisheries, particularly when assessed at species level (Samoilys et al. 2016).

[62] www.nairobiconvention.org/kenya-country-profile/ocean-economy-kenya-country-profile

6.2.2 Chondrichthyan biodiversity and status of knowledge, Kenya

Biodiversity

At least 79 chondrichthyan species have been recorded in Kenya, comprising 45 shark (representing 17 families), 33 batoid (13 families) and 1 chimaera species (Table 3.1; Table 3.3), and an additional three batoid and seven shark species which possibly occur there, but which require confirmation. Requiem sharks (Carcharhinidae) represent the most common shark family, with 18 species recorded in Kenya. All other shark families in Kenya comprise four or fewer species. The most common batoid family is Dasyatidae (whiptail stingrays), with 12 species in Kenya, while all other batoid families comprise five or fewer species. The only chimaera species in Kenya is from the family Chimaeridae (short-nosed chimaeras).

Only one chondrichthyan species is endemic to Kenya, Elaine's skate *Leucoraja elaineae* (Table 3.3), which was described from a single specimen caught in 1980 during a research trawl off Malindi, Kenya (Ebert and Leslie 2019). Eight chondrichthyan species which occur in Kenya are regionally endemic, including the batoid species prownose skate *Dipturus stenorhynchus*, Mozambique electric ray *Narcine rierai,* East African skate *Okamejei heemstrai* and slender guitarfish *Rhinobatos holcorhynchus*, and shark species African ribbontail catshark *Eridacnis sinuans*, grinning spotted izak *Holohalaelurus grennian*, crying izak catshark *H. melanostigma* and shorttail nurse shark *Pseudoginglymostoma brevicaudatum* (Table 3.3).

Of the 26 chondrichthyan species described from the WIO since 2011, five of them have distributions which occur in Kenya, including *Leucoraja elaineae*, Baraka's whipray *Maculabatis ambigua*, the bluespotted maskray *Neotrygon caeruleopunctata*, Human's whaler shark *Carcharhinus humani* and the African dwarf sawshark *Pristiophorus nancyae* (Table 3.3). It is therefore possible that there are more chondrichthyan species present in Kenya, that have not yet been recorded. In addition, although previously only thought to occur in the Northern Indian Ocean, Persian Gulf and Arabian and Red Seas (Last et al. 2016c), the Critically Endangered Halavi guitarfish *Glaucostegus halavi* was documented in Kenya in 2018 (Kyne and Jabado 2019), but has not been observed in any other WIO countries to date.

Status of biological and ecological knowledge

Chondrichthyans in Kenya have been poorly studied in comparison to other countries in East and Southern Africa, with published research focusing primarily on shark fisheries and trade (see Cliff et al. 2000, Kiszka 2012, Kiilu and Ndegwa 2013, Temple et al. 2018, 2019, Kiilu et al. 2019), and catch records dating back to the 1980s (Marshall 1997a).

No population assessments or stock assessments have been conducted on chondrichthyans in Kenya, and very little information is available on their abundance or distribution (Kiszka and van der Elst 2015). The Kenya Coastal Development Project (KCDP) developed a comprehensive catch assessment survey for small-scale fisheries, in which scalloped hammerhead sharks *Sphyrna lewini* were a priority species for sampling (KCDP 2013). The BYCAM (BY-Catch Assessment and Mitigation) project, funded by the Western Indian Ocean Marine Science Association (WIOMSA) with collaboration from the Kenya Marine and Fisheries Research Institute (KMFRI), conducted a regional bycatch assessment of coastal gillnets and longlines, which improved data availability for chondrichthyan fisheries in Kenya, recording at least 20 shark and 15 batoid species in fisher catches (Temple et al. 2019). The trophic ecology of several shark species was studied in northern Kenya (Oddenyo 2017), while the growth parameters of *S. lewini* were assessed, which can be used to model population dynamics (Kaunda-Arara 2016).

In 1994, the IUCN and Kenya Wildlife Service (KWS) conducted an aerial survey along the coast to determine the occurrence and distribution of turtles, dugongs and cetaceans (Wamukoya et al. 1996). A total of 37 whale sharks *Rhincodon typus*, 15 unidentified sharks and 63 unidentified batoids were sighted, with noticeable concentrations in Ungwana Bay and around the islands of Pate and Manda. *Rhincodon typus* are more common from July to May with observed aggregations off Kikambala-Malindi (Wamukoya et al. 1996, Rowat 2007). Anecdotal evidence suggests that *R. typus* increased in abundance in Kenyan coastal waters and have been targeted as a result (Bassen 2007), although no other reports have been found to corroborate this. Large adult great white sharks *Carcharodon carcharias* have also been recorded in Kenya (Cliff et al. 2000).

The FAO has published a field identification guide (Anam and Mostarda 2012) to the living marine resources of Kenya, which documents some of Kenya's chondrichthyan species, although many new chondrichthyan species distributions in Kenya have been determined since then.

In 2014, the University of Windsor (Canada), the Zoological Society of London and CORDIO began research on tiger sharks *Galeocerdo cuvier*, tagging five individuals off Watamu – including two pregnant females – using satellite tags that give real-time location data (Barkley et al. 2019). The results from this study showed that one of the tiger sharks moved among the EEZs of eight countries within a year, demonstrating the importance of regional collaboration for shared chondrichthyan stocks. In a separate movement study carried out in the Chagos Archipelago, a satellite-tagged silky shark *Carcharhinus falciformis* swam over 3,500 km from the Chagos Archipelago to Kenya over a period of approximately eight months (Curnick et al. 2020). In Watamu Marine National Park, the NGO A Rocha Kenya is trying to focus the attention of the local community on the conservation of elasmobranchs, such that populations are protected and managed well (Anon 2017a). The aim is to determine which species are using this national park and in what ways and then to educate the whole community on this, before working with KWS to develop specific actions that need to be taken to safeguard the elasmobranch population in this area of Kenya. Through KWS's current project of data sharing along the coast this could be utilized in other marine parks as well. To date, using underwater visual census (UVC) and baited remote underwater video (BRUV) surveys, the project has identified 13 different elasmobranch species, representing 8 families (Musembi et al. 2017). In a global study, in 2017, BRUVs were deployed by CORDIO in collaboration with the Global FinPrint Project to survey reef sharks in two main areas in Kenya – Kisite and Watamu (MacNeil et al. 2020). Although the sample size was small, this study recorded no sharks and ranked Kenya in the top 10 countries in the world with the lowest reef shark abundance, rated as functionally extinct (MacNeil et al. 2020). In a more comprehensive BRUV study conducted by WCS in 2018, a total of 165 BRUV deployments spanning much of the Kenya coastline from Shimoni in the south to Watamu in the north yielded a total of 18 batoids from six different species, but again not a single shark was recorded during this survey (WCS, unpublished data) providing strong support to the global study.

There is very little information available regarding areas of importance for chondrichthyan reproduction in Kenya. In 2016, growth parameters were estimated for blacktip reef sharks *Carcharhinus melanopterus*, grey reef sharks *C. amblyrhynchos* and *S. lewini* (Kiilu 2016). Size frequencies showed that sharks are taken primarily as juveniles throughout the length of Kenya's coastline (Kiilu 2016), which suggests that fisheries are overlapping with nursery grounds. This finding was supported by a 2014 study, which focused on *S. lewini* and identified Ziwayu Island's lagoon to be a nursery habitat in need of protection (Kaunda-Arara 2016). In addition, data collected from artisanal fishers and shallow-water prawn trawl bycatch from Malindi-Ungwana Bay indicate a high proportion of juvenile shark species in the catch, including *C. amblyrhynchos*, *S. lewini* and smooth hammerhead sharks *S. zygaena*, indicating that this is likely an important nursery area for these species (Kiilu and Ndegwa 2013, Kiilu et al. 2019). BRUV and UVC surveys in Watamu Marine National Park in 2017 determined that juvenile *N. caeruleopunctata*, bluespotted ribbon-tailed stingrays *Taeniura lymma* and *C. melanopterus* were present within the no-take section of the MPA and, as such, that this area could function as a nursery for these species (Musembi et al. 2017).

Knowledge gaps and research priorities

Chondrichthyan research in Kenya is limited, resulting in many knowledge gaps for the majority of chondrichthyan species within Kenya's EEZ. Therefore, there should be a focus on prioritizing research relating to chondrichthyans in Kenya, particularly for threatened species. Of the 42 data-poor[63] threatened

[63] The term data-poor is used to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by IUCN. The 17 information categories: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

chondrichthyan species identified in Chapter 3 (i.e., those species for which information is available in less than 50% of the categories of information needed to inform their conservation and management), 18 are present in Kenya, comprising 16 batoid species (representing eight families) and two shark species (representing two families).

There are seven data-poor, threatened species in the family Dasyatidae that occur in Kenya, comprising the Endangered honeycomb stingray *Himantura uarnak*, and the Vulnerable leopard whipray *H. leoparda*, broad cowtail ray *Pastinachus ater*, Jenkins whipray *Pateobatis jenkinsii*, blotched stingray *Taeniurops meyeni*, porcupine ray *Urogymnus asperrimus* and mangrove whipray *U. granulatus*. Research priorities for this family and these species are primarily from the movement and reproduction categories, and the specific age and growth categories of age at maturity and maximum age for all species, size at birth for *U. asperrimus*, female size at maturity for all species other than *U. asperrimus,* and male size at maturity for *P. ater*, as outlined in Table 3.7 in Chapter 3.

In the family Myliobatidae, there are two data-poor, threatened species which occur in Kenya, the Critically Endangered common eagle ray *Myliobatis aquila* and the Endangered ornate eagle ray *Aetomylaeus vespertilio.* Although migratory status and litter size are known for both species, and gestation period is known for *M. aquila*, there is no information relating to any other categories of movement or reproduction for either species. In addition, age at maturity and maximum age are unknown for both species, and female size at maturity and size at birth are unknown for *A. vespertilio*. Therefore, future research should focus on these aspects for these two species, as outlined in Table 3.7, Chapter 3.

There are two data-poor, Critically Endangered species belonging to the family Rhinidae which occur in Kenya, the bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*. Other than litter size, all other aspects relating to movement and reproduction for these two species should be prioritized in Kenya, in addition to age at maturity and maximum age (see Table 3.7).

The families Glaucostegidae (giant guitarfishes), Gymnuridae (butterfly rays), Mobulidae (manta and devil rays), Pristidae (sawfish) and Rhinopteridae (cownose rays) are each comprised of one data-poor, threatened species that occurs in Kenya; the Critically Endangered *Glaucostegus halavi*, the Vulnerable longtail butterfly ray *Gymnura poecilura,* the Endangered shortfin devil ray *Mobula kuhlii,* the Critically Endangered green sawfish *Pristis zijsron*, and the Endangered cownose ray *Rhinoptera jayakari*, respectively. Other than gestation period, information in the majority of reproduction categories is available for *G. poecilura*, however reproductive information is generally lacking for the other four species, and information is lacking for most categories of movement for all five species. In the age and growth categories, maximum age is unknown for all five species and age at maturity is unknown for all species except *P. zijsron*, although male size at maturity is unknown for *P. zijsron*, and female size at maturity and size at birth are unknown for *R. jayakari* (Table 3.7). In addition, while the largetooth sawfish *Pristis pristis* is not classified as data-poor (Figure 3.6; Table 3.7), it is classified as Critically Endangered. It is unknown whether both sawfish species persist in Kenya (Pierce 2014), therefore identification of areas still used by these species remains a priority.

There are numerous taxonomic uncertainties in terms of species present and their associated distributions within Kenya, therefore further taxonomic research is required, particularly among the batoids. Species of the *Himantura* and *Rhynchobatus* genera*,* as well as the so called “brown rays” (several genera within the family Dasyatidae) are common in Kenya, and require taxonomic clarifications, as outlined in Chapter 3.

The two data-poor, threatened shark species in Kenya comprise the Vulnerable speckled catshark *Halaelurus boesemani*, one of the few shallow-water species in the family Pentanchidae (deepwater catsharks), in addition to the Vulnerable tawny nurse shark *Nebrius ferrugineus*. Other than breeding season and migratory status, which are known for *N. ferrugineus*, all categories of movement and reproduction should be prioritized for future research for these two species. In addition, age at maturity and maximum age are unknown for both species, and generation length is unknown for *H. boesemani* (Table 3.7). *Halaelurus boesemani* is also only currently known from four locations in the WIO, all of which are in Somalia, and one unconfirmed report from Kenya (Compagno 1988), therefore the current presence of this shark in

Kenya is uncertain, and species-specific catch monitoring is necessary to either confirm or refute its presence in Kenya.

Although not data-poor, there are also four shark species in Kenya that are Critically Endangered; the oceanic whitetip shark *Carcharhinus longimanus*, shorttail nurse shark *Pseudoginglymostoma brevicaudatum*, scalloped hammerhead shark *Sphyrna lewini* and great hammerhead shark *S. mokarran*. Fishery catch data across Kenya include a large proportion of juvenile *S. lewini* (Kiilu and Ndegwa 2013, Oddenyo et al. 2018, Kiilu et al. 2019), suggesting the presence of nearby nursery and parturition areas, such as the Malindi-Ungwana Bay area. Future research efforts should thus aim to determine important reproductive areas in Kenya for these four species, to ensure they are effectively managed and conserved in future. In addition, as the only Critically Endangered (and therefore most threatened) shark species endemic to the WIO, *P. brevicaudatum* is a key research and conservation priority for Kenya, as this forms the northernmost part of this species' range.

There are also nine Data Deficient (as defined by IUCN) chondrichthyan species in Kenya, comprising six batoid and three shark species (Table 3.3, Chapter 3). At least six of these are deepwater species from the families Heterodontidae (bullhead sharks), Narcinidae (numbfishes), Pentanchidae, Rajidae (skates) and Rhinobatidae (guitarfishes), and are therefore infrequently encountered, limiting available information, while the remaining three species representing the families Carcharhinidae, Dasyatidae and Torpedinidae (torpedo rays) have coastal distributions and are exposed to coastal fisheries.

In addition, of these nine Data Deficient species, one is endemic to Kenya – Elaine's skate *Leucoraja elaineae* – while four species, the prownose skate *Dipturus stenorhynchus,* grinning spotted izak *Holohalaelurus grennian*, Mozambique electric ray *Narcine rierai* and slender guitarfish *Rhinobatos holcorhynchus* are regionally endemic. Data Deficient species should also be prioritized for research.

6.2.3 Chondrichthyan fisheries, catch and trade

Fisheries

Kenyan fisheries are comprised of a diversity of fishery sectors and gear types. There are artisanal, semi-industrial, industrial and recreational fisheries. Many of these fisheries target tuna and tuna-like species (Ndegwa et al. 2020), or operate close inshore where smaller sharks and batoids are more common, which results in the bycatch of chondrichthyan species.

Kenyan fisheries are largely small-scale (subsistence and artisanal), producing over 90% of the country's marine fish landings annually (Kiszka and van der Elst 2015). Kenya's small-scale fisheries are confined to shallow coastal waters, and they are widespread, have been operating for hundreds of years, utilize a diversity of fishing gears and target a wide range of species (Samoilys et al. 2016). These fisheries are considered to be in excess of what is sustainable, with fishing effort increasing, and significant fishing pressure placed on several species (Le Manach et al. 2015a, Samoilys et al. 2017, Kiilu et al. 2019). Specific targeting of sharks is known from areas around Lamu, where sharks have been targeted for centuries because of the value of their dried meat (Samoilys et al. 2008). These fisheries have been extensively studied (Samoilys et al. 2016), yet monitoring of catches at species level remains limited for certain taxa, and reported catch data are often underestimates (Le Manach et al. 2015a). This is particularly so for chondrichthyan species, which have historically been overlooked globally as a group.

Kenya has a small semi-industrial shrimp trawl fleet (between four and 20 trawlers licensed at any one time since 1970s) operating in Ungwana Bay. After experiencing high turtle mortalities, it was closed for several years and now requires the use of TEDs, which should reduce incidental catch of chondrichthyans (Wamukoya et al. 1996). Yet, observer reports suggest low compliance with this requirement (pers. comm., Boaz Kaunda-Arara, UoE, May 2017).

Kenya's offshore fisheries are comprised of domestic longline and semi-industrial longline vessels, as well as foreign-flagged purse-seine vessels, which predominantly target tuna and tuna-like species (Oddenyo et al. 2018). While coastal fisheries dominate Kenya's fishing operations, the offshore subsector is becoming more important as reef fish decline and, in addition to tuna and tuna-like species, these fishers target sharks, which are valued locally for their cheap meat and in Asia for their fins (Le Manach et al. 2015a). The artisanal sector alone is comprised of approximately 3,500 small craft, which undertake day fishing trips, of which over 400 are engaged in tuna and tuna-like fisheries (Ndegwa et al. 2020). It remains unclear whether specific chondrichthyan species are targeted, and the scale of incidental capture is not well known.

Chondrichthyan species have been caught in Kenya's coastal fisheries for many decades (Marshall 1997a), including as bycatch and through some dedicated fisheries for chondrichthyans (Ndegwa et al. 2020), with at least 25 species having been recorded in Kenya's coastal fisheries (Kiilu and Ndegwa 2013). Chondrichthyans are taken as bycatch by small-scale fishers operating on Kenya North Bank using handlines, and those operating in the Malindi-Ungwana Bay area using seine nets, monofilament nets and handlines (Oddenyo et al. 2016, Oddenyo 2017). There is also a significant bycatch and discard of chondrichthyans in the semi-industrial prawn trawl fishery in Ungwana Bay, with at least 12 chondrichthyan species confirmed in this fishery, with the most common species including scalloped hammerhead sharks *Sphyrna lewini*, smooth hammerhead sharks *S. zygaena* and grey reef sharks *Carcharhinus amblyrhynchos* (Kiilu and Ndegwa 2013), all of which are threatened. It appears that the Ungwana area contributes the vast majority of chondrichthyan bycatch in Kenya's waters (Kiilu and Ndegwa 2013). In contrast, several shark taxa are targeted in the semi-commercial longline fishery that operates off Mombasa, including thresher sharks *Alopias* spp. and mako sharks *Isurus* spp. (Kiilu and Ndegwa 2013, Ndegwa et al. 2020).

An assessment of the overall bycatch in the artisanal and prawn trawl fisheries at selected sites along the Kenyan coastline revealed numerous chondrichthyan species, including *Sphyrna lewini* (53.7% of total bycatch), blacktip reef sharks *Carcharhinus melanopterus* (33.7%), *C. amblyrhynchos*, silky sharks *C. falciformis*, oceanic whitetip sharks *C. longimanus*, spinner sharks *C. brevipinna*, smooth hammerhead sharks *Sphyrna zygaena* and zebra sharks *Stegostoma tigrinum* sharks (Kiilu and Ndegwa 2013). Almost all of these individuals were well below the respective species-specific sizes at attainment of sexual maturity, including some neonates still bearing umbilical scars (Kiilu and Ndegwa 2013), suggesting fishing within or in close proximity to nursey areas. The gears responsible for these catches were largely gillnets (>90%) and longlines, predominantly targeting tuna species (Kiilu and Ndegwa 2013).

Kenya's offshore waters are heavily exploited by foreign longliners and purse seiners targeting tuna (Le Manach et al. 2015a). National reports of numbers of licensed vessels in 2008 ranged from 19 to 116, indicating that some vessels may not be licensed (Sigana et al. 2008, Sigana 2009). Only 20% of tuna vessels are though to be licensed, and the lack of MCS capacity in Kenya incentivizes illegal fishing by industrial vessels (Le Manach et al. 2015a). From 1950 to 2010, catches reported by industrial longliners have consistently included individuals from the Carcharhinidae, Alopiidae and Sphyrnidae families, as well as shortfin mako sharks *Isurus oxyrinchus*, crocodile sharks *Pseudocarcharias kamoharai* and large numbers of blue sharks *Prionace glauca* (Wekesa 2013, Le Manach et al. 2015a).

Fisheries monitoring and reporting

Fisheries monitoring and reporting are poor in Kenya. According to WIOFish, most Kenyan fisheries have poor data recorded and have been subject to limited research (Everett et al. 2017). A reconstruction of Kenya's domestic marine fisheries (1950–2010) estimated total catches to be 2.8 times that reported to the FAO (Le Manach et al. 2015a). In 2013, the State Department of Fisheries, Aquaculture and Blue Economy (SDF&BE) and KMFRI began a more comprehensive catch assessment survey as part of the Kenya Coastal Development Project (KCDP), aimed at facilitating and assisting in the generation of important fisheries indicators useful for developing and evaluating policies and fishery management plans for the small-scale fisheries (KCDP 2013). This survey involved recording all landings, including chondrichthyan species, at 22 landing sites along the coastline for 10 days in each month. The surveys were intended to estimate total landings (by family) and the economic value of each taxon (SDF&BE 2016). However, chondrichthyans are generally not identified to species or family level in most cases (SDF&BE 2015).

To address this, a project funded by the US Fish and Wildlife Service provided species identification training to government fisheries officers and BMU staff in Kenya (Kaunda-Arara 2016). Recent projects implemented by CORDIO East Africa and the Wildlife Conservation Society (WCS), funded by the Indian Ocean Commission and the Shark Conservation Fund, have built on this project by providing additional species identification training and documenting species-level chondrichthyan landings by artisanal fishers (Table 6.2.1).

Reported chondrichthyan catches

Chondrichthyans contribute significantly to catch volumes with catch reconstructions indicating contributions exceeding 5% of the total marine fishery catch in Kenya from 1950 to 2010 (Le Manach et al. 2015a). However, the latter part of that period showed a sharp decline in chondrichthyan catches (Kiilu and Ndegwa 2013). Over the four decades from the 1960s to the early 21st century, a decline of 85% in shark catches was noted, and attributed to the use of gillnets (Samoilys et al. 2008).

Table 6.2.1. Chondrichthyan species recorded in Kenyan artisanal fisheries catch at Lamu, Mombasa and Vanga landing sites (2018–2019, WCS unpublished data). IUCN Red List Categories are presented as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC).

Family	Species name	Common name	IUCN Red List	Lamu	Mombasa	Vanga
Batoids						
Aetobatidae	*Aetobatus ocellatus*	Indian eagle ray	VU		x	x
Dasyatidae	*Himantura leoparda*	Leopard whipray	VU			x
	Himantura uarnak	Honeycomb stingray	EN	x		x
	Maculabatis ambigua	Baraka's whipray	NT	x	x	x
	Neotrygon caeruleopunctata	Bluespotted maskray	LC	x		
	Pateobatis jenkinsii	Jenkins whipray	VU		x	
	Taeniura lymma	Bluespotted ribbon-tailed stingray	LC	x		
	Urogymnus granulatus	Mangrove whipray	VU	x		
Mobulidae	*Mobula kuhlii*	Shortfin devil ray	EN			x
Glaucostegidae	*Glaucostegus halavi*	Halavi guitarfish	CR	x		
Rhinidae	*Rhynchobatus australiae*	Bottlenose wedgefish	CR	x		x
Rhinobatidae	*Acroteriobatus leucospilus*	Greyspot guitarfish	EN	x		
	Acroteriobatus zanzibarensis	Zanzibar guitarfish	NT	x		x
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray	EN			x
Sharks						
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	EN		x	
	Alopias superciliosus	Bigeye thresher shark	VU		x	
	Alopias vulpinus	Common thresher shark	VU		x	
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark	EN		x	
	Carcharhinus falciformis	Silky shark	VU	x	x	
	Carcharhinus leucas	Bull shark	VU	x		
	Carcharhinus limbatus	Blacktip shark	VU	x		
	Carcharhinus macloti	Hardnose shark	NT	x		
	Carcharhinus melanopterus	Blacktip reef shark	VU	x	x	
	Carcharhinus plumbeus	Sandbar shark	EN	x		
	Carcharhinus sorrah	Spottail shark	NT	x	x	
	Galeocerdo cuvier	Tiger shark	NT			x
	Prionace glauca	Blue shark	NT		x	
	Rhizoprionodon acutus	Milk shark	VU	x		
	Triaenodon obesus	Whitetip reef shark	VU		x	
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	EN		x	
	Isurus paucus	Longfin mako shark	EN		x	
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	CR	x		
Triakidae	*Mustelus mosis*	Arabian smoothhound	NT	x		

Data records held by the Kenya Fisheries Service (KeFS) provide some idea of the impact of Kenya's fisheries on chondrichthyans, although the majority of catches are not to species level (aside for selected taxa). These records indicate a general decline in annual reported shark landings in the semi-industrial prawn trawl fishery in Kenya, from ~275 t in the 1980s, to ~115 t in 2000, but a rapid resurgence in catches (perhaps indicative of targeting) since 2010, reaching 373 t in 2012 (Oddenyo et al. 2018).

The combined total chondrichthyan catch in Kenya, for the years 2014–2016, amounts to ~1,800 t, comprised largely of requiem sharks (Carcharhinidae), stingrays (Dasyatidae), manta and devil rays (Mobulidae), hammerhead sharks (Sphyrnidae) and guitarfishes (Rhinobatidae) (Oddenyo et al. 2018).

A recent survey (2018–2019) of the artisanal fishery at selected sites along the Kenyan coastline revealed the capture of at least 19 species of sharks from five families and 14 species of batoids from seven families, of which 24 species (73% of the catch by number) are threatened, according to the IUCN Red List (Table 6.2.1; WCS, unpublished data).

Kenya reported the seventh largest chondrichthyan catch of all Nairobi Convention Member States, to the FAO, from 2012 to 2019, accounting for 3.3% of the total Nairobi Convention Member State catch in all oceans and 6.2% in FAO Major Fishing Area 51 during this period (FAO 2021). Kenya landed an annual average of 1,268.6 t of chondrichthyans exclusively from FAO Major Fishing Area 51 during this period, although there was a strong increasing trend from less than 500 t in 2012 to more than five times that in 2018 and 2019 (Figure 6.2.2; Table 6.2.2).

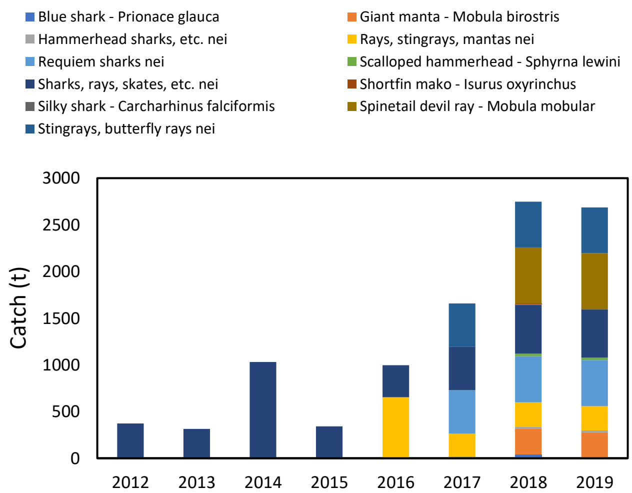


Figure 6.2.2. Kenya chondrichthyan catches from FAO Major Fishing Area 51, by species/group (2012–2019; FAO 2021).

Table 6.2.2: Total nominal chondrichthyan catch in metric tonnes (t) reported by Kenya in FAO Major Fishing Area 51; exports and imports of chondrichthyan products (all product codes) from and to Kenya (as reported by Kenya); imports and exports of chondrichthyan products reported by other countries (all product codes) from and to Kenya, and imports reported by Hong Kong alone (shark fins only) that originated in Kenya, for the years 2012 to 2019.

Year	Total Catch [a]	Imports into Kenya - all codes [b]	Exports to Kenya - as reported by the world, all codes [b]	Exports from Kenya - all codes [b]	Imports from Kenya - as reported by the world, all codes [b]	Shark fin imports by Hong Kong [c]
2012	373	0	0	0	14.30	14.10
2013	314	0	0	0	14.83	12.05
2014	1,032	0	15.19	0	38.94	7.50
2015	343	0	22.07	0	12.67	7.23
2016	996	0	28.71	0	47.92	10.89
2017	1,658	0	0	0	20.22	13.34
2018	2,747	0	0.04	0	31.86	14.58
2019	2,686	0	0.75	0	196.49	7.69
Total	**10,149**	0	66.76	0	**377.23**	**87.38**
Average	**1,269**	0	**8.35**	0	**47.15**	**10.92**

a) FishStatJ (FAO 2021)
b) UN Comtrade (2021)
c) Hong Kong Bureau of Statistics (2021)

Prior to 2016 chondrichthyans were reported by Kenya to the FAO together in a broad group named 'Sharks, rays, skates, etc. nei' (FAO 2021). In recent years (i.e., since 2018) the reporting categories used by Kenya have been extended and include species-level records for six chondrichthyan species, including blue sharks *Prionace glauca*, scalloped hammerhead sharks *Sphyrna lewini*, shortfin mako sharks *Isurus oxyrinchus*, silky sharks *Carcharhinus falciformis*, the giant manta ray *Mobula birostris* and spinetail devil ray *M. mobular*, and family-level records for the families Sphyrnidae (hammerhead sharks) and Carcharhinidae (requiem sharks, other than blue and silky sharks) (Figure 6.2.2; FAO 2021). During the two years (2018–2019) for which these species were recorded to species level, the dominant species reported to the FAO were the Endangered spinetail devil ray *Mobula mobular* (22% of total chondrichthyan catch) and Endangered giant manta ray *Mobula birostris* (10% of catch) (Figure 6.2.2; FAO 2021). While the species-level data represents improved reporting, both mobulid rays are listed on CMS Appendix I and should therefore be prohibited from capture; however, here they are shown to dominate catches, which is a major cause for concern.

The artisanal sector alone is reported to have landed 546 t of sharks (Carcharhinidae) and 233 t of rays (Dasyatidae) in 2019, while Kenya's domestic longline fishery landed at least 115 t of sharks in 2019, exponentially more than the three years prior, with this volume dominated by *P. glauca*, Vulnerable *C. falciformis* and Endangered *I. oxyrinchus* (Ndegwa et al. 2020). However, it should be noted from previous studies on catch records, that chondrichthyan catches in Kenya are probably substantially underreported (Le Manach et al. 2015a).

Trade in chondrichthyan products

Sharks caught by artisanal fishers are sold in the local markets directly to consumers, to traders and middlemen, and to retailers. The sharks are either sold fresh, deep-fried or salted and sun-dried (Oddenyo et al. 2016). Until recently, Kenya has had high domestic demand for shark meat, leading to imports from Somalia, Zanzibar and Yemen (Marshall 1997a, Kiszka and van der Elst 2015). Some twenty years ago, shark liver oil was domestically traded within Kenya for use in the maintenance of traditional fishing vessels (Marshall 1997a), but it is unknown whether this still occurs.

Mombasa has a regulated international shark fin and meat trade, with various dealers licensed to import and export shark fin (IOC-SmartFish 2016). Shark fins from Tanzania and Somalia are traded through the port of Mombasa (pers. comm., Boaz Kaunda-Arara, University of Eldoret, May 2017). Recent interviews and market assessments by the FISH-i Africa Task Force[64] showed that very little data are available on chondrichthyan product imports, and while some data exist on exports, they do not represent the full extent of exports (IOC-SmartFish 2016). The study found that shark fins sourced from purse seiners and Asian long liners from Mozambique, Zanzibar and Pemba Island (smuggled in small quantities, potentially via trade boats) – and, to a limited extent, from artisanal fishers in Somalia – are exported to Asia from Mombasa Port via containers, and the exported consignments are not inspected.

Anecdotal evidence indicates that there is considerable demand in Kenya for the capture of live sharks for export driven by the aquarium trade, and this trade appears to be unregulated. Several threatened species are among those targeted, such as the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum* (which is included in the list of protected species presented in Kenya's 2013 Wildlife Conservation and Management Act (Act no. 47 of 2013) (Government of Kenya 2013), and Endangered zebra shark *Stegostoma tigrinum*.

Official chondrichthyan trade data

Kenyan imports of shark products

According to UN Comtrade, Kenya reported no imports of any chondrichthyan products from 2012 to 2019 (UN Comtrade 2021). However, Taiwan, South Africa and the USA have reported exports of frozen shark meat to Kenya in some years during this period, although not in large quantities (for example: USA reported exports of 22.1 t (2015) and 28.7 t (2016); South Africa and Taiwan, respectively, reported

[64] See www.fish-i-africa.org

exports of 7.3 t and 7.9 t, of frozen shark meat to Kenya in 2014; and in recent years only USA and South Africa have reported exports, in negligible quantities (40 kg in 2018 and 748 kg in 2019) (Table 6.2.2).

Kenyan exports of shark products

According to UN Comtrade, Kenya reported no exports of any chondrichthyan products from 2012 to 2019 (UN Comtrade 2021). However, numerous countries reported imports of shark products from Kenya over the same period (an average of 47 t/year – all products and all importers; Table 6.2.2; Figure 6.2.3a), although the average is biased by the large import quantities in 2019. This represents gross under-reporting by Kenya, of shark product exports.

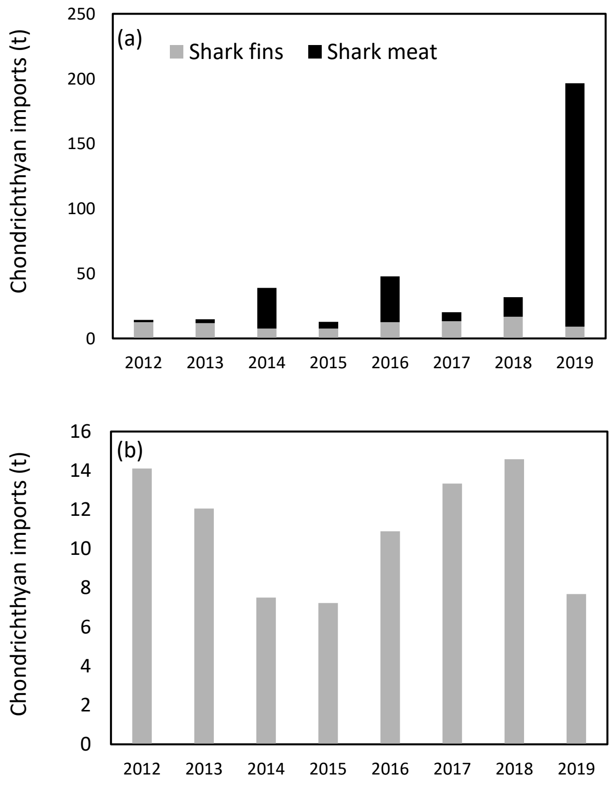


Figure 6.2.3. (a) Reported world imports of chondrichthyan products (fins and meat) from Kenya (UN Comtrade 2021); and (b) Reported imports of shark fins by Hong Kong SAR from Kenya (Hong Kong Census and Statistics Department 2021) for the period 2012–2019.

Trade data for the period 2006 to 2015 collected by the Kenya Fisheries Service contradicts the UN Comtrade (2021) export data for Kenya, indicating that shark fins were exported at an annual average of approximately 10.9 t, primarily to Hong Kong, China and Spain (Oddenyo et al. 2018). This aligns with the the Hong Kong Bureau of Statistics (2021), which indicates shark fin imports from Kenya by Hong Kong every year from 2012 to 2019 (Figure 6.2.3b), at an annual average of 10.9 t/year. This also closely agreed with the UN Comtrade (2021) import data for Hong Kong, indicating average imports of 10.5 t/year of shark fin (2012–2019) from Kenya (Figure 6.2.3a). Macau SAR and Singapore also reported imports of shark fin from Kenya during this period.

Taiwan imported an annual average of 11 t/year of shark meat from Kenya (2014–2019). Other countries reporting imports of shark meat from Kenya include Portugal (notably 109 t in 2019), Spain (72 t in 2019) and Singapore (27 t in 2016).

Trade in CITES-listed chondrichthyan species

For the period 2011 to 2020, there are records of the export of CITES Appendix II shark species from Kenya, as reflected by the CITES Trade Database[65] (Table 6.2.3), for the years 2017 to 2020. This is likely linked to the 2017 listing of several shark and ray species on CITES Appendix II. However, this contradicts data from UN Comtrade, which reflects no chondrichthyan product exports by Kenya from 2012 to 2019 (Table 6.2.2), again showing discrepancies between Kenya's reported export volumes and import volumes reported by other countries. There is clear under reporting of exports of shark products (including fins) from Kenya and imports into Kenya (Table 6.2.2). There is also evidence that the Port of Mombasa has been used for the export of unreported quantities of shark fins, destined for Hong Kong (TRAFFIC 2020). As CITES imposes binding measures on Parties, including strict reporting requirements to ensure that trade in CITES Appendix II-listed species is not detrimental to their survival in the wild (see section 6.2.5 and Chapter 5 for further details), the poor quality of reporting through these official channels is a cause for concern, and should be addressed as a matter of urgency.

[65] https://trade.cites.org/en/cites_trade

Table 6.2.3: CITES-listed elasmobranch species exported from Kenya and imported into various importer countries, as reported in the CITES Trade Database, for the period 2011–2020. Importer country, importer reported quantity and exporter (i.e., Kenya) reported quantity, units and export purpose of the export specimen are given. App. refers to the CITES Appendix of the traded species. Where no units are given, the quantity represents the total number of specimens/products traded.

Year	App.	Taxon	Importer country	Importer reported quantity	Exporter reported quantity	Term	Unit	Purpose
2017	II	*Sphyrna lewini*	France	2	4	Live	Count	Commercial
2017	II	*Sphyrna lewini*	Netherlands		3	Live		Commercial
2017	II	*Sphyrna lewini*	USA	2		Live		Educational
2017	II	*Sphyrna lewini*	USA		3	Live		Commercial
2018	II	*Sphyrna lewini*	China	10	4	Live		Commercial
2018	II	*Sphyrna lewini*	Russia		1	Live		Commercial
2018	II	*Sphyrna lewini*	South Africa		1	Live		Commercial
2019	II	*Carcharhinus falciformis*	UAE		6	Fins		Educational
2019	II	*Carcharhinus falciformis*	UAE	6		Fins		Educational
2019	II	*Carcharhinus longimanus*	UAE		6	Fins		Educational
2019	II	*Carcharhinus longimanus*	UAE	6		Fins		Educational
2019	II	*Sphyrna lewini*	UAE		3	Fins		Educational
2019	II	*Sphyrna lewini*	UAE	3		Fins		Educational
2019	II	*Sphyrna lewini*	China		12	Live		Commercial
2019	II	*Sphyrna mokarran*	UAE		3	Fins		Educational
2019	II	*Sphyrna mokarran*	UAE	3		Fins		Educational
2020	II	*Carcharhinus falciformis*	Spain	158		Fins	kg	Commercial

6.2.4 Conservation status

As a consequence of the high level of fishing pressure (which includes a component of illegal fishing), chondrichthyans in Kenya are heavily overexploited, with a reported decline of approximately 85% in shark catches in Kenya over the last 40 years, largely attributed to the increased use of gillnets (Samoilys and Kanyange 2008, Oddenyo et al. 2018, Osuka et al. 2021). There has also been intense pressure on the juvenile size classes of many chondrichthyan species, as most studies have revealed large proportions of juveniles in the catches (Osuka et al. 2021).

As a result of this heavy exploitation, 47 (59%) of the 79 confirmed chondrichthyan species in Kenya are currently considered threatened with extinction (IUCN 2021). This is considerably worse than the status at WIO regional level, in which 40% of chondrichthyan species are threatened (see Chapter 3). Threatened chondrichthyans in Kenya include 21 Vulnerable, 16 Endangered and 10 Critically Endangered species, according to the IUCN Red List of Threatened Species (IUCN 2021; see Table 3.4 in Chapter 3). Of the nine chondrichthyan species that occur in Kenya that are endemic to the WIO, the only threatened one is the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum*. The only species endemic to Kenya, *Leucoraja elaineae*, is classified as Data Deficient.

The formally abundant largetooth sawfish *Pristis pristis* has suffered major population declines globally and is now considered Critically Endangered. Historical records confirm the presence of *P. pristis* in Kenya (Okeyo 1998), and although the green sawfish *P. zijsron* may still be present (Dulvy et al. 2016), surveys are required to confirm the continued presence of both species in Kenya (Pierce 2014).

Considering the documented declines in shark catch in Kenya, that Kenya's inshore coastal waters were thought to be fully exploited already by the early 1990s (Ardill and Sanders 1991, Marshall 1997a), and that fisher perceptions indicate a decline in elasmobranch catches (Kiszka 2012), there is strong evidence indicating that fisheries, as well as the shark fin trade, have negatively impacted chondrichthyan species in Kenya. This, along with their life-history traits, has had a negative impact on the populations of numerous chondrichthyan species in Kenya, possibly even leading to the extirpation of both sawfish species. This is confirmed by the findings from the Global FinPrint Project, which identified Kenya as having one of the lowest reef shark abundances of 58 countries surveyed (MacNeil et al. 2020). This is of great concern, considering that the Kenyan coastline is characterized by almost continuous fringing reef (Ndegwa et al. 2020) and should therefore have a great abundance of reef shark species. However, there have been no stock assessments undertaken in Kenyan waters, and few in the WIO.

6.2.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

The Kenya Fisheries Service (KeFS) and the State Department of Fisheries Aquaculture and Blue Economy (SDFA&BE) under the Ministry of Agriculture, Livestock, Fisheries and Co-operatives, are responsible for fisheries management in Kenya, including aspects of permitting and enforcement (Table 6.2.4). Research is the responsibility of the Kenya Marine and Fisheries Research Institute (KMFRI), and the Kenya Wildlife Services (KWS). Marine species conservation and environmental protection are the legal responsibilities of KWS (in the Ministry of Tourism and Wildlife), KeFS, and the National Environmental Management Authority (NEMA) (Table 6.2.4).

Fisheries were previously governed under the Fisheries Act Cap. 378 (1989, Rev. 2012; Republic of Kenya 2012a), which was supported by the Fisheries (General) Regulations 1991 (Republic of Kenya 2012b) and the Fisheries (Foreign Fishing Craft) Regulations 1991 (Republic of Kenya 2012c). In 2016, the Fisheries Management and Development Act No. 35 (Republic of Kenya 2016a) was enacted to provide for the conservation, management and development of fisheries. It establishes the KeFS and Kenya Fisheries Advisory Council, Fisheries Marketing Authority, Fisheries Research and Development Fund, and Fish Levy Trust Fund. These institutions are autonomous, but receive policy direction from SDFA&BE. The Act also provides for the implementation of obligations under regional and international law concerning fisheries (with strong links to the Indian Ocean Tuna Commission resolutions).

However, enforcement of regulations is generally poor. While there is reportedly adequate human training and surveillance infrastructure in Kenya, MCS activities are largely restricted to inshore areas and the Somalia-Kenya border, with limited offshore capacity for patrolling the full EEZ, and the number of trained MCS officers is inadequate (Pramod 2018). Kenya does not have regular or adequate fisheries observer schemes, Port State control, vessel or catch inspections, or aerial surveillance for foreign vessels operating in its waters, but a VMS was installed in March 2017 (Pramod 2018). There is also a lack of transparency relating to permitting of foreign vessels, as the EU and the Government of Kenya have been negotiating the signing of a Fisheries Partnership Agreement (FPA) for several years, although no FPA is yet in place (European Commission 2020); although, there are records of numerous foreign fishing licenses having been issued to Spanish- and French-flagged vessels (Le Manach et al. 2015a). However, Kenya has opened a new MCS Centre and operationalized the KeFS, with training and employment of skilled compliance inspectors (Republic of Kenya 2016b). In 2019, the Kenya Coast Guard Service (KCGS) was established, which took over the running of the MCS Unit and an offshore fisheries patrol vessel.

Enforcement related to trade is collaboratively overseen by KeFS and KWS (Table 6.2.4), but chondrichthyan trade controls are poor. The broader system of Port State controls does not effectively integrate the fisheries-related Port State Measures, and the relevant national agencies (port, fisheries, customs, etc.) do not effectively exchange information or coordinate regarding the implementation of Port State Measures and the control of the shark trade (IOC-SmartFish 2016). Inspections for valid export permits are not routine, and inspectors apparently do not look for evidence of shark fins (IOC-SmartFish 2016). However, the provisions of the new Fisheries

Act to form a mandatory Interagency MCS Unit might substantially resolve the observed management gaps (pers. comm., Benedict Kyalo Kiilu, KeFS, May 2017).

MPA management and enforcement are led by KWS, while coastal zone management is the collaborative responsibility of KeFS, KWS, KCGS and NEMA (Table 6.2.4). Following a history of centralised marine resource management, in 2007 legislation was passed to introduce Beach Management Units (BMUs) as a co-management tool for small-scale fisheries (Republic of Kenya 2007). With support from SDF&BE, KeFS and the County Governments, these BMUs can develop and enforce by-laws to govern their day-to-day fishery operations, allowing them to delineate jurisdictional boundaries and, for example, exclude non-registered fishers or boats from the area. At the time of writing there are 85 BMUs along the Kenyan coastline, spread across 75 gazetted fish landing sites and 80 non-gazetted sites (pers. comm., Benedict Kyalo Kiilu, KeFS, May 2017). Many of these BMUs exist only in name and are yet to formalise their by-laws, but some have established Locally Managed Marine Areas (LMMAs; Rocliffe et al. 2014).

Table 6.2.4: Designated national authorities for chondrichthyan management in Kenya.

Area of management	Designated national authorities
Fisheries management	Ministry of Agriculture, Livestock, Fisheries and Co-operatives: State Department of Fisheries Aquaculture and Blue Economy (SDFA&BE); Kenya Fisheries Service (KeFS); Beach Management Units (BMUs) – local governance through KeFs
Fisheries research	Kenya Marine and Fisheries Research Institute (KMFRI); Ministry of Tourism and Wildlife: Wildlife Research and Training Institute (WRTI), Kenya Wildlife Services (KWS)
Export and import trade controls (including permitting)	KeFS; KWS as CITES Management and Scientific Authority
Permitting of fisheries	KeFS
Enforcement of fisheries legislation	KeFS; Kenya Coast Guard Service (KCGS), and KWS within marine protected areas
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	KeFS; KCGS; KWS as CITES Management and Scientific Authority; National Museums of Kenya (NMK) as a CITES Scientific Authority
Species conservation and environmental protection	KWS; National Environmental Management Authority (NEMA); KeFS; KCGS
Coastal zone management	NEMA; KCGS; KeFS; KWS (as well as Kenya Forest Service, Kenya Maritime Authority, Coast Development Authority)
MPA management and enforcement	KWS; KeFS; KCGS

National legislation and regulations

The 2013 Kenya Wildlife Conservation and Management Act (Act no. 47 of 2013; Government of Kenya 2013) is the overarching legislation for the management and protection of Kenya's wildlife resources. The Sixth Schedule of the Act lists species that are classified as "critically endangered", "vulnerable", "nearly threatened" or "protected", and article 48 states that "A person shall not carry out any activity involving a specimen of a listed species without a permit from the [Kenya Wildlife] Service". The Sixth Schedule lists several chondrichthyan species as vulnerable, including ragged-tooth sharks (or grey nurse as presented in the Act text) *Carcharias taurus*, whale sharks *Rhincodon typus*, oceanic whitetip sharks *Carcharhinus longimanus*, great white sharks *Carcharodon carcharias* and shorttail nurse sharks *Pseudoginglymostoma brevicaudatum*, as well as bowmouth guitarfish *Rhina ancylostomus,* giant guitarfish *Rhynchobatus djiddensis* (although this species may not be present in Kenya; therefore this could refer to bottlenose wedgefish *Rhynchobatus australiae*)*,* blotched stingrays *Taeniurops meyeni* and porcupine rays *Urogymnus asperrimus*. However, whether all species in this schedule are subject to the same level of restriction, whether the required permits are available to any applicant, and whether the law actually provides full protection are open to interpretation, and this will need clarification. A revision of this Act is underway.

The Fisheries Management and Development Act (revised in 2016, No. 35 of 2016, Republic of Kenya 2016a) establishes a requirement for the recognition of any international conservation and management measures to which Kenya is Party; it empowers the Director-General to impose measures for the conservation and management of any fishery, including limitations on the fish that may be caught, landed or traded, and to impose measures for the data that should be collected and reported; and it establishes a process for the designation of fishing ports. Accordingly, through Gazette Notice Vol. CXXII-No. 83 (Republic of Kenya 2020), the Act domesticates the IOTC Resolutions 12/09 and 19/03 that prohibit commercial exploitation of thresher sharks (family Alopiidae) and mobulid rays (family Mobulidae), respectively, in tuna fisheries under the management of the IOTC, Resolution 12/12 that prohibits the use of large-scale drift nets, and Resolution 17/05 that prohibits the removal of shark fins at sea (IOTC 2012b, 2012a, 2017, 2019e; see section 5.4.1 in Chapter 5).

Kenya's new Fisheries Management and Development Act (Republic of Kenya 2016a) allows implementation of a system for Port State Measures, largely in line with IOTC Resolution 10/11, but the new regulations under development need to further operationalize these provisions (pers. comm., Benedict Kyalo Kiilu, KeFS, May 2017). The new Act also has provisions for the import, export, trade, and marketing of fish and fish products, which should have an impact for chondrichthyan products.

Status of NPOA-sharks

Kenya has initiated the development of an NPOA-Sharks, following in detail the guidelines of the FAO *International Plan of Action for the Conservation and Management of Sharks* (IPOA-Sharks, FAO 1999). Preliminary meetings to discuss the Kenya NPOA-Sharks were held in 2017 facilitated by WCS. After a series of meetings led by KeFS, a baseline assessment report was drafted in 2018 (Oddenyo et al. 2018) and presented to a broad group of stakeholders from all coastal counties in Kenya, in a validation workshop. Recommendations from this workshop were then incorporated into the baseline assessment report during a meeting held in January 2019. In 2019, a Risk Assessment was drafted for the NPOA, and representatives of the KeFS and Kenya Marine and Fisheries Research Institute (KMFRI) attended a WIO regional workshop on the development of Shark NPOAs for WIO States, held in Mauritius in 2019, as a knowledge-sharing exercise on developing an NPOA-Sharks (see section 5.3.1 in Chapter 5). The Kenyan baseline assessment report was subsequently revised in 2020 and 2022, highlighting the need for a formal NPOA-Sharks, and the KeFS is intending to finalise the drafting of the NPOA in 2022/2023. The NPOA development is guided by the policy-level objectives presented in the Fisheries Management Development Act (Republic of Kenya 2016a):

- to protect, manage, use and develop the aquatic resources in a manner which is consistent with ecologically sustainable development;
- to uplift the living standards of fishing communities, to introduce fishing to traditionally non-fishing communities and to enhance food security; and
- to meet commitments that have been made under international agreements (pers. comm., Elizebeth Mueni, KeFS, 2019).

Marine protected areas

A series of Marine Protected Areas (MPAs) was developed along the Kenyan coast, with the first implemented as early as 1968 (Tuda and Thoya 2021). While none of these was specifically developed for the protection of chondrichthyan species, increased exploitation of fisheries and observed declines in abundance of chondrichthyan species, as well as turtle and reef fish species, are cited as the rationale for these MPAs (McClanahan et al. 2005). MPAs have largely been established under the Wildlife Conservation and Management Act of 1976 (Government of Kenya 2013), which had no MPA-centric provisions; however, since 2016, MPAs can be established under the Fisheries Management and Development Act (Republic of Kenya 2016a). Kenya's government-established MPAs are viewed as a conservation success, which is unusual in the WIO region (Samoilys and Obura 2011). The protection of Kenya's coral reef MPAs has been described by regional experts as 55% effective (Rocliffe et al. 2014).

Just 0.7% of Kenya's EEZ falls within six MPAs (UNEP-WCMC and IUCN 2021b). Four of these MPAs are comprised of small no-take Marine National Parks (IUCN category II), in which only non-extractive activities (e.g., snorkelling) are allowed, surrounded by Marine Reserves (IUCN category IV) that act as buffer zones and which are zoned for multiple uses, such as traditional and subsistence fishing activities, while two comprise Marine Reserve areas only (SDF&BE 2015, Tuda and Thoya 2021). Watamu National Park is the oldest MPA, within which there have been sightings of at least 13 elasmobranch species, including several threatened species and juveniles of some species (Musembi et al. 2017). However, Kenya's MPAs, and particularly the no-take Marine National Park zones, are small, and therefore likely offer little protection to chondrichthyan species, other than perhaps some of the smaller, resident coastal species. Furthermore, overfishing and destructive fishing practices remain a threat in these MPAs and Kenya's coastal zone (Samoilys and Obura 2011, Tuda and Thoya 2021). However, plans are being developed to increase Kenya's MPA coverage, including expansion of several existing MPAs. A large transboundary conservation area (TBCA) is being established that will be shared with northern Tanzania and encompass extensive habitat known to be used by chondrichthyan species, particularly batoids of the Dasyatidae (stingray) family. Planning for expansion of the Malindi/Watamu MPA to encompass a considerably greater offshore area is also underway (Tuda and Thoya 2021), and this may provide refuge for pelagic or demersal chondrichthyan species.

Kaunda-Arara (2016) identified the lagoon off Ziwayu Island to be a potential pupping ground for sharks and proposed that a Community Conservation Area should be established, combined with short-term incentives that promote alternative livelihoods to shark fishing. There are other community-managed areas already established in Kenya, including at least 24 LMMAs (with no-take zones, seasonal closures, gear restrictions), and a further 18 not yet operational (McClanahan et al. 2016). However, their effective management has been and remains limited by a lack of capacity, funding and land ownership (Rocliffe et al. 2014, Tuda and Thoya 2021).

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Kenya is signatory to several MEAs and RFBs (see Table 5.2). Kenya ratified CMS in 1999, and is thereby bound by CMS commitments, and subsequently signed the CMS Sharks MOU, for which KWS is the designated competent authority. There are nine chondrichthyan species listed on Appendix I (Table 6.2.5) and 16 listed on Appendix II of CMS (eight of these are listed on Appendices I and II), which are known to occur in the Kenya EEZ (see also Table 3.3, Chapter 3). Kenya is thus obliged to protect these nine species listed on Appendix I, and to implement the CMS concerted actions for whale sharks *Rhincodon typus* and mobula rays (see section 5.2.1). The 2014 CMS National Report on implementation stated that monitoring of sharks has been initiated, but that technical support is required (UNEP/CMS 2014). The 2019 CMS National Report on implementation suggested that all CMS Appendix I species are prohibited in Kenya by national legislation under the Wildlife Conservation and Management Act, 2013 (UNEP/CMS 2019e); however, scrutiny of this Act suggests that *R. typus*, oceanic whitetip sharks *Carcharhinus longimanus* and great white sharks *Carcharodon carcharias* are the only CMS Appendix I chondrichthyan species that are protected under this Act. As a Party to CMS, Kenya is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. Kenya should also develop regional management plans for the species listed in CMS Appendix II, as many of these species are shared with other Nairobi Convention Member States (see Table 5.1, Chapter 5).

Kenya ratified CITES in 1978 and is thereby required to implement means by which to ensure that international trade in chondrichthyan species listed on Appendices I and II is regulated appropriately (See section 5.2.2). Two chondrichthyan species known from Kenya are listed on CITES Appendix I and 18 on CITES Appendix II (Table 3.3, Chapter 3). The two Appendix I species are both Critically Endangered sawfishes (Pristidae); therefore, Kenya must enforce the CITES requirement to prohibit any international trade in these species, even though their persistence in Kenya remains unconfirmed. The integration of CITES requirements into national law has been judged by the CITES National Legislation Project not to meet all the requirements for implementation of CITES (CITES 2016, 2021) although amendments are underway. The Wildlife Conservation and Management Act (Government of Kenya 2013) domesticates requirements to meet the CITES provisions, but there is little implementation in practice (pers. comm., Boaz Kaunda-Arara, UoE, May 2017). Current national legislation does not cover the implementation of CITES Appendix II shark listings. Policy is in place regarding international trade in CITES-listed sharks and rays, as well as systems to implement CITES trade controls for these species and to record and report on CITES shipments. However, no NDFs have been concluded or stock assessments undertaken by Kenya to ensure that export is not detrimental to the survival of the species in the wild, for any CITES-listed chondrichthyan species.

Kenya is a member of two RFBs relevant to chondrichthyans in the WIO, SWIOFC and IOTC, and is a signatory to SIOFA but has not yet ratified this Agreement (Table 5.2). Kenya is legally bound by the IOTC resolutions (see Section 5.4.1), but the current regulations of 1991 do not have many provisions for implementation of these resolutions (IOC-SmartFish 2016). The chondrichthyan-specific measures include a prohibition on the removal of fins, as well as prohibitions among IOTC registered vessels on the capture of seven chondrichthyan species that occur in Kenyan waters (Tables 3.3, 6.2.5). The Fisheries Management and Development Act (No. 35 of 2016; Republic of Kenya 2016a) domesticates the IOTC Resolutions 12/09 and 19/03 that protect thresher sharks (Alopiidae), and mobulid rays (Mobulidae), respectively, from commercial exploitation, Resolution 12/12 that prohibits the use of large-scale drift nets, and Resolution 17/05 that prohibits the removal of shark fins at sea, at least in tuna fisheries. The Act makes no provision for the prohibition of capture of *C. longimanus* or setting of nets around *R. typus* (IOTC Secretariat 2021b), although listing on the Sixth Schedule of the Wildlife Act (Government of Kenya 2013) suggests they are prohibited. Furthermore, while species protections and prohibition of finning are reflected in the legislation, Kenya's latest IOTC compliance report indicates only partial compliance with the requirement to report nominal shark catch, catch and effort data and size frequency data for sharks (IOTC Secretariat 2021b).

Kenya is also a Member of the Nairobi Convention, and ratified the PSMA in 2017 (Table 5.2). While neither instrument specifies management measures or commitments for chondrichthyan species, the Nairobi Convention presents species-specific measures for listed species and there is potential for chondrichthyan species to be included under this Convention at some point in the future. The PSMA empowers port officials to prohibit foreign vessels that are suspected of illegal activity from receiving port services and access, and should help to prevent illegally caught fish from entering the market. Both of these instruments are binding on Member States, and Kenya is thus obliged to implement the required measures. Both instruments have the potential to facilitate improved chondrichthyan management and decreased IUU fishing of chondrichthyans in Kenya. The Ramsar Convention entered into force in Kenya in 1990, and there are currently six sites designated as Wetlands of International Importance (UNEP-WCMC and IUCN 2021b). While these are mostly inland and unlikely to contribute to chondrichthyan conservation, the Tana River Delta Ramsar Site comprises a variety of habitats, including estuarine and coastal habitats, extensive mangrove systems, marine brackish and freshwater intertidal areas, and shallow coastal marine areas (Anon 2021a), which could provide critical habitat to numerous chondrichthyan species.

Kenya is also Party to UNCLOS, the UN Fish Stocks Agreement and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments to these and the UN General Assembly Resolution on sustainable fisheries. While the UN Fish Stocks Agreement presents no chondrichthyan-specific measures, UNCLOS and the UN General Assembly Resolution on sustainable fisheries do, such as reduced chondrichthyan mortality, strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). All three instruments impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks, for sustainable fisheries. Furthermore, as a Member of the FAO since 1964, Kenya is encouraged to implement the measures presented in the guiding documents the FAO has published, many of which present specific measures for chondrichthyans (see section 5.3).

6.2.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Kenya

Fisheries

- Kenya's coastal areas are heavily populated, and coastal communities depend heavily on fishing. Fishery resources are therefore under a high level of fishing pressure. The narrow continental shelf also restricts much of the fishing effort into the nearshore zone, particularly on coral reefs.
- Shark fishing has taken place in Kenya for centuries, with shark meat being valued locally as a source of protein and the fins being sold to Asia (Marshall 1997a). The appearance of industrial longliners and shrimp trawlers in recent decades has led local fishers to believe that these fisheries are the cause of drastic declines in shark catches seen in recent years (WildAid 2007).
- Longlines, gillnets and prawn trawl nets have considerable impacts on chondrichthyan species, with high levels of bycatch (and discards in some fisheries). The Ungwana area appears to be of great concern for chondrichthyan mortality, including impacts on perceived nurseries. Mortality of juvenile threatened chondrichthyans in fisheries in this area makes these fisheries unsustainable, regardless of the status of their target species.
- The majority of chondrichthyan species recorded in Kenya's artisanal and commercial fisheries are threatened, including Critically Endangered oceanic whitetip sharks *Carcharhinus longimanus* and scalloped hammerhead sharks *Sphyrna lewini*, and Endangered shortfin mako sharks *Isurus oxyrinchus* (Ndegwa et al. 2020), which is of major concern for the sustainability of these populations.
- Further, catches include manta and devil rays (Mobulidae) (some Mobulid species dominate reported catches for some years), and thresher sharks (Alopiidae) which are listed under both IOTC resolutions and Gazette Notice Vol. CXXII-No. 83 (Republic of Kenya 2020), prohibiting their capture in tuna-related fisheries. Furthermore, mobulid rays and oceanic whitetip sharks are listed in CMS Appendix I and should be fully prohibited in Kenya as a signatory State to CMS.
- There is a large proportion of juveniles within the chondrichthyan catches, which could lead to recruitment overfishing (Oddenyo et al. 2018).
- There are numerous sharks and shark-like rays landed without fins (contravening the no-finning ban) or heads, which makes species-level identification difficult. However, other diagnostic features suggest that many of these animals are threatened species (including thresher sharks (Alopiidae), hammerhead sharks (Sphyrnidae), mako sharks (*Isurus* spp.), wedgefishes (Rhinidae)) and prohibited species (Alopiidae) (WCS, unpublished data). Further monitoring is required and the impacts on these threatened and prohibited species need to be addressed.
- There is evidence of IUU fishing, including in coastal fisheries; meaning that unknown proportions of chondrichthyan catches are not reported, complicating attempts at assessing baseline values or trends in stock status.

Trade

- There appears to be gross underreporting of catch and trade volumes, with large discrepancies between import and export volumes, including for CITES-listed species, and it is probable that large proportions of the unreported trade volumes also comprise threatened species.
- There is poor collection of trade data, and there remains limited information on the details of chondrichthyan value chains.
- There are reports that the Port of Mombasa is a hub for non-inspected shark fin exports, from a wide area of the WIO.
- There is also a considerable aquarium trade for live animals from Kenya, including threatened species such as the shorttail nurse shark *Pseudoginglymostoma brevicaudatum* (which is protected under the Wildlife Conservation and Management Act, 2013), without quantitative assessments of the sustainability of such extraction, which requires improved regulation.

Governance, legislation and capacity

- The overall state of management of chondrichthyans in Kenya is poor, and regional and international cooperation in the management of Critically Endangered elasmobranch species are inadequate (pers. comm., Boaz Kaunda-Arara, UoE, May 2017).

- Constraints to the completion of an NPOA-Sharks and more effective management of chondrichthyan resources include a lack of knowledge of chondrichthyan fisheries and trade (the primary constraint), lack of knowledge of management actions needed, shortcomings in the legal regulatory framework, lack of trained personnel, limited manpower, inadequate political will, and insufficient funding (University of Windsor 2015).
- There is limited legal protection for threatened chondrichthyan species in Kenya and the legal protections fall short of the requirements of the MEAs to which Kenya is signatory, and there is currently no management framework for chondrichthyans in Kenya.
- There is limited enforcement and capacity (funding and skilled personnel) therefor, of fishery measures and regulations that are in place (pers. comm., Boaz Kaunda-Arara, UoE, May 2017), and trade controls are inadequate, allowing the breeching of regulations to take place largely unchecked.
- Kenya's MPAs, and particularly the Marine National Park no-take zones, are small and therefore likely offer little protection to chondrichthyan species, and there is evidence of overfishing and destructive fishing practices in Kenya's coastal zone and MPAs (Tuda and Thoya 2021).

Biological and ecological knowledge and fisheries monitoring

- Biological and ecological information are lacking for many aspects of many chondrichthyan species, such as locations of pupping and nursery areas, region-specific sizes and ages at maturity, movement patterns and genetic stock structure, which hampers effective species management.
- There has been limited recording, particularly at species level, of chondrichthyan catches in Kenya's various fisheries, although plans are being implemented to record improved species-level catch data for certain chondrichthyan species (Ndegwa et al. 2020). Catch data presented vary considerably among reports, even for the same fisheries, indicating incomplete catch recording and thus likely underestimates of actual catch volumes.
- Coastal artisanal gillnet fishers are not monitored (Ndegwa et al. 2020), and chondrichthyan catches in this fishery remain unknown, which hampers appropriate management of these species. Assessments of artisanal fisher landings at selected landing sites in Kenya (Vanga, Mombasa, Kipini) reflect significant contributions of chondrichthyan species in the catches, including threatened and prohibited species (WCS, unpublished data).
- There has been poor collection of fishery data in "shark fisheries" and poor recording of chondrichthyan catches specifically, within other multi-species fisheries.
- There is limited information on migrant fishers and a known contingent of fishers that enter and fish Kenyan waters from Tanzania and the islands of the Zanzibar Archipelago.

Recommendations/actions required

Governance, policy, legislation, enforcement and capacity needs

There is a need for improved management of and governance for chondrichthyans in Kenya. This will require improved knowledge on fisheries, an improved regulatory framework and species-specific management measures and regulations including species prohibitions where appropriate (see species section that follows). The following measures should be considered:

- Measures are needed to address the high level of IUU fishing and the use of gears that cause high levels of bycatch mortality for threatened chondrichthyans, and to mitigate bycatch.
- Regulatory improvements should consider no-take zones in pupping grounds, seasonal closures where chondrichthyans aggregate prior to and after mating or pupping, and size limits for slow-growing species with low reproductive capacity.

- Management plans for existing MPAs could be improved to benefit chondrichthyan species present; while new MPAs should consider a scientific spatial planning approach for threatened chondrichthyans and other species.
- Implementation of CITES and other international trade controls are needed and could be strengthened with more information on chondrichthyans and the threats they face in Kenyan waters (SDF&BE 2015).
- Co-management of chondrichthyan fisheries should be expanded (SDF&BE 2015).
- Enforcement must be strengthened to ensure compliance with regulations, such as existing species prohibitions and the ban on removal of fins at sea, to ensure that juveniles and threatened species are not significant components in fishery catches.
- Improved capacity for management, monitoring and enforcement are needed.
- The implementation of a WIO Regional Plan of Action (RPOA, such as the Regional Roadmap presented in Appendix A) pursuant to the FAO IPOA-Sharks would be useful, as it would support the Kenyan NPOA-Sharks and encourage harmonization between national and regional levels (SDF&BE 2015).
- Education and community-based initiatives are important for the success of these points.

Data collection and research priorities

There is a need for improved biological, ecological and fishery knowledge in Kenya, particularly on threatened chondrichthyan species. Biological and ecological research needs include aspects such as confirming the locations of pupping grounds – particularly for threatened species caught as bycatch in Kenya's fisheries, such as the perceived *S. lewini* pupping grounds in Ungwana Bay (Kiilu and Ndegwa 2013). Priority aspects and species for further research are detailed in section 6.2.2, and in Chapter 3.

There is a need for improved fishery data collection, in all fisheries, including a mechanism for verification of data, to overcome discrepancies among existing datasets. This includes the need for improved monitoring and reporting of catches to national authorities, FAO, IOTC and any other relevant bodies, and improved monitoring and reporting of trade data, particularly for CITES-listed and threatened species.

Priority needs for enhancing the state of knowledge include (SDF&BE 2015, University of Windsor 2015):

- Creation of a national fisheries monitoring program focused on chondrichthyans, including creation of species identification guides for chondrichthyans (including local names);
- Genetic samples to confirm species identification;
- Research on pelagic species to examine interactions with offshore fisheries, including assessment of bycatch data (implementing new data collection programs where necessary); and assessment of movement patterns of threatened pelagic species, such as silky sharks, blue sharks, shortfin mako sharks and oceanic whitetip sharks, relative to the spatial distribution of fishing effort;
- Data collection on fisheries landings by location, gear type and across seasons, including training of government fisheries/conservation staff to undertake continuous monitoring, with photographic data capture, biological sampling (e.g., reproductive status, vertebrae for ageing) and genetic sampling, to build a biological database for each species, which can contribute to future stock assessments;
- Plans have been set in place for improved chondrichthyan catch monitoring, particularly for species identified by the IOTC for species-level catch reporting (Ndegwa et al. 2020). There are also several ongoing surveys of artisanal fishery catches at selected landing sites and fish markets (WCS, CORDIO, TRAFFIC unpublished data), that could contribute to national statistics. Monitoring of artisanal landings could also be supported through existing co-management structures such as BMUs (pers. comm., Clay Obota, CORDIO East Africa, June 2017).

6.2.7 Priority chondrichthyan species for protection

There are eight chondrichthyan species confirmed (and one reported) from Kenyan waters that are listed on CMS Appendix I, and thereby require national level protection; and there are nine species (six of which are also listed on CMS Appendix I) prohibited in certain fisheries through IOTC resolutions (Table 6.2.5). As a signatory State to CMS and IOTC, these species should be fully protected or protected within the relevant fisheries, respectively. The harvesting of whale sharks, great white sharks and oceanic whitetip sharks appears to be restricted, by virtue of their listing on the Sixth Schedule of the Kenya Wildlife Conservation and Management Act (Government of Kenya 2013); however, ambiguity in the text of the Act leaves it open to interpretation as to whether these species, listed as “Vulnerable” in the Sixth Schedule, are actually protected. The remaining six CMS Appendix I species, including four mobulid rays (family Mobulidae) and two sawfish species (family Pristidae) are not protected. However, the capture in tuna fisheries of seven of the species with IOTC retention bans, including the three thresher shark species (family Alopiidae) and four mobulid ray species, was prohibited in 2020 (Gazette Notice no. Vol. CXXII-No. 83, Republic of Kenya 2020). Therefore, Kenya has implemented some of the binding species protections, although not all CMS Appendix I species are fully prohibited, as required by CMS Appendix I.

In addition, there are seven Critically Endangered and 12 Endangered chondrichthyan species in Kenya, other than those listed in CMS Appendix I or prohibited by IOTC resolutions, which should be considered for protection (at least from commercial harvesting and trade) by virtue of their poor conservation status. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1995); therefore, as a Member State of both Organizations, Kenya should implement the precautionary principle and prohibit the take of Endangered and Critically Endangered species (Table 6.2.5). Just two of these species, the Critically Endangered bowmouth guitarfish *Rhina ancylostomus* and shorttail nurse shark *Pseudoginglymostoma brevicaudatum*, are already included in the Sixth Schedule of the Wildlife Conservation and Management Act (Government of Kenya 2013), restricting the harvesting of these species.

Table 6.2.5. Chondrichthyan species confirmed or reported (*not confirmed) from the waters of Kenya, for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Species already (seemingly) protected at national level are shaded in green, with those prohibited from capture in the IOTC-associated fisheries shaded in blue (see National legislation section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). (Species in bold = WIO endemic). Critically Endangered and Endangered species for which prohibition is recommended are also presented.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus *	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula birostris*	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula eregoodoo *	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Pristis pristis*	Largetooth sawfish	I, II		I	CR	CMS I
Pristidae	*Pristis zijsron*	Green sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Other species that are already considered protected							
Dasyatidae	*Taeniurops meyeni* [a]	Blotched stingray				VU	
	Urogymnus asperrimus	Porcupine ray				VU	
Ginglymostomatidae	***Pseudoginglymostoma brevicaudatum***	**Shorttail nurse shark**				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
	Rhynchobatus djiddensis [b]	Whitespotted wedgefish	II		II	CR	CR
Critically Endangered and Endangered species for which prohibition is recommended							
Glaucostegidae	*Glaucostegus halavi*	Halavi guitarfish			II	CR	CR
Myliobatidae	*Myliobatis aquila*	Common eagle ray				CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN
	Carcharhinus plumbeus	Sandbar shark				EN	EN
	Negaprion acutidens	Sicklefin lemon shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Myliobatidae	*Aetomylaeus vespertilio*	Ornate eagle ray				EN	EN
Rajidae	*Raja ocellifera* *	Twineyed skate				EN	EN
	Rostroraja alba	Spearnose skate				EN	EN
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray				EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN
Triakidae	*Mustelus manazo*	Starspotted smoothhound				EN	EN

[a] Listed in the Kenya Wildlife Conservation and Management Act (Government of Kenya 2013) as *Taeniura meyeni* – Black-blotched stingray

[b] Listed in the Kenya Wildlife Conservation and Management Act (Government of Kenya 2013) as the giant guitarfish *Rhynchobatus djiddensis*, but it is likely that only the bottlenose wedgefish *Rhynchobatus australiae* occurs in Kenya

6.3 Republic of Madagascar

6.3.1 Introduction

The Republic of Madagascar (hereinafter Madagascar) is the fourth largest island in the world and the largest in the Western Indian Ocean, with a coastline of ~5,500 km (Jeffers et al. 2019) and an Exclusive Economic Zone (EEZ) of approximately 1,147,712 km^2 (de Young 2006, Claus et al. 2014, Ramahery et al. 2021). Directly east of Mozambique (Figure 6.3.1), the island is influenced by three major currents – the East Malagasy Current, South Equatorial Current and Mozambique Channel eddies. The southwest, west and northern coastlines are characterized by extensive coral reefs, with the west coast also exhibiting broad mangrove stands. These habitats are known to support a high abundance and diversity of marine taxa, and act as important nursery and feeding areas for many chondrichthyan species (Spalding et al. 2001, Le Manach et al. 2012). Along the east coast, the shelf drops off sharply, whereas along the west coast the continental shelf extends far offshore, covering ~117,000 km^2 up to the 200-m isobath (de Young 2006). Madagascar has been identified as a priority location for marine biodiversity conservation due primarily to its high species richness and high levels of endemism (Selig et al. 2014, Gardner et al. 2018).

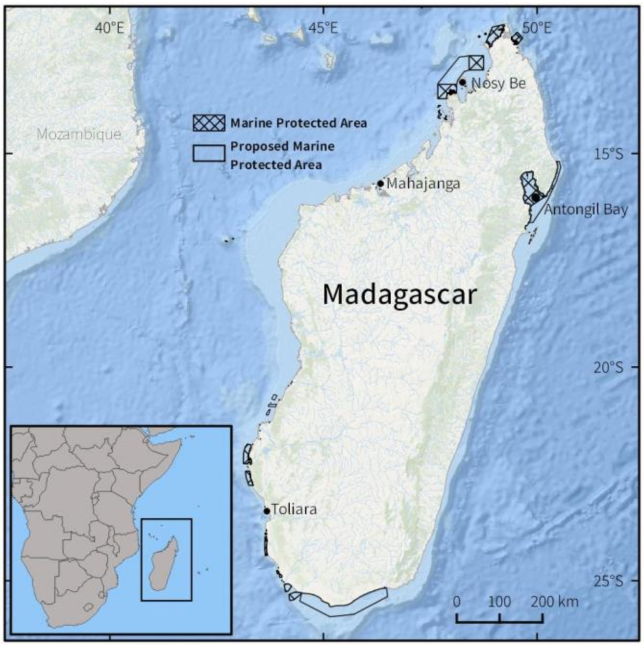


Figure 6.3.1 Map of Madagascar, showing its position in the Western Indian Ocean and place names mentioned in text.

Madagascar represents a unique area, with the country's waters spanning four marine ecoregions, based on coral reef biodiversity: east Madagascar and South Madagascar regions that are shared with no other countries or land masses, and on the west coast the Southern and Northern Mozambique Channel regions that are shared, respectively, with southern Mozambique and with northern Mozambique, the Comoros Archipelago and Mayotte (Obura 2012).

Madagascar is one of the poorest countries in the world (World Bank 2018), where traditional and artisanal fisheries play a fundamental role in food security, particularly on the west coast (Le Manach et al. 2012, Barnes-Mauthe et al. 2013). Extensive small-scale (traditional and artisanal) fisheries provide livelihoods and food security for millions of people in Madagascar (World Bank 2015). The population is estimated at 27.7 million people[66], of which more than 50% live within 100 km of the coastline (WRI 2003, Barnes-Mauthe et al. 2013) and 70% below the poverty threshold (Le Manach et al. 2012). There is a high level of dependence on marine resources, particularly along the arid west coast where there has been severe overexploitation due to low agricultural productivity (Le Manach et al. 2012, Barnes-Mauthe et al. 2013, Gardner et al. 2018). The impacts of overexploitation are worsened by a growing human population size and migration to coastal areas (Barnes-Mauthe et al. 2013). There is also extensive migration of fishers among coastal areas, driven both by declining resources at the origins of migrations, and the attraction of perceived opportunities (healthier resource stocks) elsewhere (Cripps and Gardner 2016).

These coastal migrations of fishers in Madagascar are largely to target chondrichthyans and sea cucumbers, driven by Asian markets (Cripps and Gardner 2016, Gardner et al. 2018). There are also domestic and foreign industrial fishing vessels, using a diversity of fishing gear types, as well as illegal fishing vessels, many of which target chondrichthyans or catch them incidentally (Cooke 1997, McVean et al. 2006, Cripps et al. 2015). The combined impacts therefore place considerable pressure on chondrichthyan species.

[66] https://data.worldbank.org/indicator

6.3.2 Chondrichthyan biodiversity and status of knowledge, Madagascar

Biodiversity

Madagascar has the third highest chondrichthyan species richness in the WIO, after South Africa and Mozambique, with 108 species documented to date, comprising 72 shark (representing 24 families), 35 batoid (14 families) and one chimaera species (Table 3.1), and an additional seven shark and five batoid species which possibly occur there, but which require further confirmation (Table 3.3). The requiem sharks (Carcharhinidae) represent the most common shark family in Madagascar, with 22 species recorded. All other shark families in Madagascar comprise five or fewer species. The most common batoid family in Madagascar is Dasyatidae (whiptail stingrays), with 10 species, while all other batoid families comprise fewer than five species. The single chimaera species in Madagascar is from the family Rhinochimaeridae (long-nose chimaeras). The high species richness in Madagascar is likely attributed to its vast and complex coastline which encompasses multiple habitat types (Spalding et al. 2001).

Six chondrichthyan species are endemic to Madagascar, the recently described Malagasy blue-spotted guitarfish *Acroteriobatus andysabini,* Madagascar catshark *Bythaelurus clevai*, bluespotted bambooshark *Chiloscyllium caeruleopunctatum*, Madagascar skate *Dipturus crosnieri*, Madagascar pygmy skate *Fenestraja maceachrani* and Madagascar numbfish *Narcine insolita* (Table 3.3). An additional 11 chondrichthyan species which occur in Madagascar are regionally endemic (Table 3.3), including the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum*, which is currently the single most threatened shark species that is endemic to the WIO. Of the 26 chondrichthyan species described from the WIO since 2011, 10 have distributions which occur in Madagascar, including *A. andysabini,* Human's whaler shark *Carcharhinus humani*, African gulper shark *Centrophorus lesliei*, Baraka's whipray *Maculabatis ambigua,* bluespotted maskray *Neotrygon caeruleopunctata*, western blue skate *Notoraja hesperindica,* Kaja's sixgill sawshark *Pliotrema kajae*, African Dwarf sawshark *Pristiophorus nancyae*, Austin's guitarfish *Rhinobatos austini*, and the Malagasy skinny spurdog *Squalus mahia* (Table 3.3). It is therefore highly likely that there are more chondrichthyan species present in Madagascar, that have not yet been recorded.

There are key aggregation sites in Madagascar for Endangered grey reef sharks *Carcharhinus amblyrhynchos* and whale sharks *Rhincodon typus*, and for Vulnerable bull sharks *Carcharhinus leucas* (Kiszka et al. 2009, Diamant et al. 2018, Micarelli and Venanzi 2019).

The largetooth sawfish *Pristis pristis* is the only sawfish species known from Madagascar (Harrison and Dulvy 2014). Although this species has been taken in fisheries throughout Madagascar (Cooke 1997, Le Manach et al. 2011b), few individuals have been seen in recent years. In 2001, four individuals were caught in the Betsiboka River in northeast Madagascar, three of which were neonates, suggesting this may have been a nursery area for this species (Taniuchi et al. 2003). Recent efforts to confirm the presence of sawfish in Madagascar covered the east, northwest and west coasts. Several relatively recent catches (2014–2016, i.e., 1–2 years prior to the interviews) in the northwest were reported during interviews with small-scale fishers, and efforts to encourage communities to report catches resulted in the report in 2019 of a largetooth sawfish caught by a small-scale fisher in Bombetoka Bay. The animal had been killed but photographs verified the species identification. The rostrum was 1.4 m in length, suggesting a total length of around 6 m. The flesh was eaten locally, with some salted and dried for sale; the fins and rostrum were also dried and sold. Although this confirms the persistence of sawfish in Madagascar's waters, fishers state that they encounter them far less frequently than in the past, with the population likely to be extremely depleted (Leeney and Adouhouri in prep.).

Status of biological and ecological knowledge

Research on chondrichthyans in Madagascar commenced in the early 20th century. The export of shark fins from Madagascar to China, La Réunion and Zanzibar, and of shark meat, skin and liver oil to Comoros, was documented in the early 1920's (Petit 1930). Fourmanoir (1961, 1963) described 32 shark species and 17 batoid species from the northwest of the country. Bass et al. (1973, 1975a, 1975b, 1975c, 1975d) describe at least nine species which occur in

Madagascar, while Bauchot and Bianchi (1984) include 34 shark species in their guide to commercial fisheries around Madagascar. At least 29 chondrichthyan species were identified in a report on the shark fisheries and trade in Madagascar (Cooke 1997). Smale (1998) focused on estimating shark populations around the Masoala Peninsula in northeast Madagascar, as there were concerns that human-shark conflict could negatively impact tourism development in this area. This study provided a list of at least 51 different shark species thought to occur in northeast Madagascar. Large adult great white sharks *Carcharodon carcharias* have been recorded in northern Madagascar (Cliff et al. 2000).

In the southwestern region, near Toliara, McVean et al. (2006) recorded at least 13 chondrichthyan species in coastal fisheries, while a subsequent study in the same area recorded at least 20 chondrichthyan species (Humber et al. 2017). Kiszka et al. (2009) focused on shark biodiversity, distribution and interactions with human activities in the whole of Madagascar, and provided a comprehensive list of 83 chondrichthyan species thought to occur around the island. Genetic techniques have also been used to characterize shark fisheries in Antongil Bay, northeast Madagascar, with at least 19 chondrichthyan species confirmed with this methodology (Doukakis et al. 2011). A study on the shark fishery in Antsiranana (northern Madagascar) identified 23 landed chondrichthyan species between 2001 and 2004, of which Carcharhinidae accounted for 69% and Sphyrnidae (hammerhead sharks) 24% of the catch (Robinson and Sauer 2013).

Between 2013 and 2017, Centre National de Recherches Océanographiques (CNRO, a government research institution under L'Enseignement Supérieur et de la Recherche Scientifique) identified around 20 species of sharks and six families of rays (species still being identified) in surveys in Ambaro Bay, Nosy Be, Analalava, and from Cap Saint André to Besalampy. Fricke et al. (2018) provided a checklist of all fish species known to occur in Madagascar, including 112 chondrichthyan species, which is currently the most up to date published Madagascar chondrichthyan species checklist.

No population status or stock assessments have been conducted for chondrichthyan species in Madagascar. Shark catch rates appear to be declining across the country, with fishers having to travel and fish further from shore than in previous years, but catching fewer and smaller sharks (Cooke 1997, Cooke et al. 2003, McVean et al. 2006, Cripps et al. 2015). Given the numerous legal shark fisheries that operate in Malagasy waters and potentially high levels of targeted and incidental catch in illegal fisheries in pelagic waters, the status of many chondrichthyan stocks in Madagascar is likely to be unfavourable (Robinson and Sauer 2013, Cripps et al. 2015).

There have been few movement studies on chondrichthyan species in Madagascar, other than whale sharks *Rhincodon typus* (Diamant et al. 2018). However, great white sharks *Carcharodon carcharias* tagged in the Western Cape region of South Africa have been recorded swimming to Madagascar[67], and a large, pregnant bull shark *Carcharias leucas* which was tagged in Seychelles travelled to southeast Madagascar and back over a period of approximately three months (Lea et al. 2015). Tiger sharks *Galeocerdo cuvier* tagged in southern Mozambique and northeast South Africa have been recorded swimming to southern Madagascar (Dicken et al. 2016, Daly et al. 2018). Similarly, tiger sharks tagged in Kenya were recorded moving among the EEZ's of eight countries within a year, including that of Madagascar (Barkley et al. 2019). These movement studies demonstrate the importance of regional collaboration for shared chondrichthyan stocks, and the need for regional management measures.

Genetic studies that have assessed chondrichthyan geographic population connectivity and biogeography in Madagascar, or between Madagascar and the broader WIO region, include studies focused on crocodile sharks *Pseudocarcharias kamoharai* (da Silva Ferrette et al. 2021), bull sharks (Pirog et al. 2019c), and scalloped hammerhead sharks *Sphyrna lewini* (Hadi et al. 2020).

Endangered whale sharks have a key aggregation site which is situated in northwest Madagascar, off Nosy Be (Jonahson and Harding 2007, Kiszka et al. 2009, Diamant et al. 2018). This site has been monitored since 2016, with at least 85 different individuals

[67] www.ocearch.org

making use of the area; all of which were juveniles (Diamant et al. 2018). Satellite tagging of several of these whale sharks indicated movements close to Comoros and Mayotte; however, the area around Nosy Be appears to be a core use area, with part of this activity hotspot falling within the community-managed MPAs of Ankarea and Ankivonjy (Diamant et al. 2018). However, whale sharks are likely afforded little protection from these MPAs due to their transient nature and the relatively small size of the MPAs. There is also likely a bull shark aggregation site in northeast Madagascar, near the port of Tamatave, as they have been observed in this area in high concentrations (Kiszka et al. 2009).

A global baited remote underwater video (BRUV) survey project, which surveyed seven different reefs in northwest and western Madagascar, found that Madagascar had among the lowest reef shark abundances of all the WIO countries surveyed as part of this study (MacNeil et al. 2020). Additional BRUV studies conducted in the southwest, northwest and northeast (Antongil Bay) of Madagascar confirmed low abundances of shark and batoid species (WCS/SAIAB, unpublished data). Surveys in the northeast of the country, which comprised 120 deployments in Antongil Bay, recorded the lowest chondrichthyan diversity and relative abundance, with no sharks and just a few rays observed, despite this area being the only shark sanctuary in the WIO region.

There is scant information regarding important areas for chondrichthyan reproduction in Madagascar. The area around Nosy Be is important for juvenile whale sharks, while the Betsiboka River in northwest Madagascar is thought to be a nursery area for the Critically Endangered largetooth sawfish(Taniuchi et al. 2003), with records as recent as 2019 (Leeney and Adouhouri in prep.). Certain rivers in southeast Madagascar may serve as important pupping and nursery grounds for bull sharks, as a pregnant female tagged in Seychelles was tracked to southeast Madagascar and is thought to have entered estuarine habitats, and upon returning to Seychelles was no longer pregnant (Lea et al. 2015). In Madagascar, the bignose shark *Carcharhinus altimus* gives birth in September and October, the spottail shark *C. sorrah* possibly gives birth in summer, and the sicklefin lemon shark *Negaprion acutidens* gives birth in October and November (Compagno 1984), while the tawny nurse shark *Nebrius ferrugineus* is thought to breed in July and August (Compagno 2001). Endangered *C. amblyrhynchos* are present daily off Nosy Be in northwest Madagascar, in the Mozambique Channel, with the area possibly functioning as a nursery for this species, however this requires further monitoring (Micarelli and Venanzi 2019). A study from Antongil Bay, one of the few large shallow water habitats on the eastern coast, suggests that the Bay may be a breeding area for milk sharks *Rhizoprionodon acutus*, spinner sharks *Carcharhinus brevipinna* and scalloped hammerhead sharks, with milk sharks likely breeding between December and April as this is when pregnant females and juveniles were detected (Doukakis et al. 2011).

Knowledge gaps and research priorities

Chondrichthyan research in Madagascar to date has primarily focused on trade and catch in artisanal fisheries. However, considering that Madagascar has the third highest chondrichthyan species richness of the WIO countries (Table 3.1), and the highest number of national endemic chondrichthyan species (six) in the WIO (i.e., species confined only to Madagascar's EEZ), chondrichthyan research should be prioritized for this important chondrichthyan region. All the data gaps identified for these species should thus be prioritized for future research (as shown in Table 3.7). Of the 42 data-poor[68], threatened chondrichthyan species identified in Chapter 3, 21 (11 batoid and 10 shark species) are present in Madagascar, representing seven shark and five batoid families.

There are five data-poor, threatened species in the family Dasyatidae that occur in Madagascar, comprising the Endangered honeycomb stingray *Himantura uarnak*, and Vulnerable broad cowtail ray *Pastinachus ater*, Jenkins whipray *Pateobatis jenkinsii*,

[68] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

blotched stingray *Taeniurops meyeni* and porcupine ray *Urogymnus asperrimus*. Apart from litter size, which is known for *H. uarnak*, *P. ater* and *T. meyeni*, in addition to breeding season, gestation period and migratory status which are known for *H. uarnak*, information is lacking in all other movement and reproduction categories for these five species. Age at maturity and maximum age are unknown for all five species, while female size at maturity is unknown for all species except *U. asperrimus*. Male size at maturity is unknown for *P. ater* and size at birth is unknown for *U. asperrimus*. Future research should address these information gaps (see Table 3.7).

There are two data-poor, Critically Endangered species belonging to the family Rhinidae which occur in Madagascar – the bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*. Other than litter size, which is known for both species, all other aspects relating to movement and reproduction for these two species should be prioritized in Madagascar, in addition to age at maturity and maximum age (see Table 3.7).

The families Mobulidae, Rajidae and Rhinopteridae each comprise one data-poor, threatened species in Madagascar, the Endangered shortfin devil ray *Mobula kuhlii*, Vulnerable *Dipturus crosnieri* and Endangered shorttail cownose ray *Rhinoptera jayakari*, respectively. Other than litter size, which is known for all three species, and gestation period and migratory status which are known for *M. kuhlii*, information is lacking in all other movement and reproduction categories for these three species. Age at maturity and maximum age are also unknown for all three species, while size at birth is unknown for *D. crosnieri* and *R. jayakari*, in addition to female size at maturity being unknown for *R. jayakari* (see Table 3.7).

There remain numerous taxonomic uncertainties in terms of species present and their associated distributions within Madagascar, therefore further taxonomic research is required, particularly among the batoids. Species of the *Rhynchobatus* genus are common in Madagascar, and require taxonomic clarifications, as outlined in Chapter 3. The current distribution and important breeding, parturition and nursery areas for *P. pristis* also remain poorly known in Madagascar.

Four data-poor, threatened shark species representing the family Centrophoridae occur in Madagascar, comprising the African gulper shark *Centrophorus lesliei*, smallfin gulper shark *C. moluccensis,* little gulper shark *C. uyato* and longsnout dogfish *Deania quadrispinosa*. In addition, the kitefin shark *Dalatias licha*, African spotted catshark *Holohalaelurus punctatus*, angular rough shark *Oxynotus centrina* and roughskin dogfish *Centroscymnus owstoni*, represent the sole species present in Madagascar, in each of the families Dalatiidae, Pentanchidae, Oxynotidae and Somniosidae, respectively (Table 3.7). These sharks are all deepwater species, all of which lack information in each movement category and the majority of reproduction categories. In addition, information regarding age at maturity and maximum age is lacking for all these shark species, as well as size at birth for *C. lesliei* and *H. punctatus* (Table 3.7).

There are also two coastal shark species that are data-poor and threatened, which occur in Madagascar. Other than breeding season and migratory status, which is known for *N. ferrugineus* and litter size which is known for the whitetip weasel shark *Paragaleus leucolomatus*, information is lacking for all the other movement and reproduction categories for these two species. In addition, age at maturity and maximum age are unknown for both species, and male and female sizes at maturity, and the size at birth, are also unknown for *P. leucolomatus* (Table 3.7).

Although not data-poor, there are also four additional shark species which are Critically Endangered and occur in Madagascar, the oceanic whitetip shark *Carcharhinus longimanus*, shorttail nurse shark *P. brevicaudatum*, scalloped hammerhead shark *Sphyrna lewini* and great hammerhead shark *S. mokarran*. There is limited information on parturition and nursery areas for these species within Madagascar. Artisanal fishery data from Antongil Bay in northeast Madagascar suggests the presence of a breeding area and possible parturition ground for *S. lewini*, with pregnant females also being caught in this area (Doukakis et al. 2007, 2011). In the Toliara region, southwest Madagascar, artisanal catch data includes a large proportion of juvenile *S. lewini* (Humber et al. 2017), suggesting the presence of a nearby nursery area, however this nursery area has not been confirmed or located. As such, future research should also focus on identifying specific areas and habitats that play an important role for reproductive success for these four species, to inform future protection measures. As the only Critically Endangered (and therefore most threatened) shark species endemic to the WIO, *P. brevicaudatum* is a key research and conservation priority, in Madagascar and other countries in its range.

There are also 15 Data Deficient (as defined by IUCN) chondrichthyan species in Madagascar, including eight shark, six batoid and one chimaera species (Table 3.3). Four are endemic to Madagascar, including *B. clevai*, *C. caeruleopunctatum*, *F. maceachrani* and *N. insolita*. Five are endemic to the WIO region, comprising the grinning spotted izak *Holohalaelurus grennian*, Kaja's sixgill sawshark *Pliotrema kajae*, Austin's guitarfish *Rhinobatos austini*, slender guitarfish *R. holcorhynchus* and Comoro catshark *Scyliorhinus comoroensis*. Research should also be prioritized for these nine Data Deficient species.

6.3.3 Chondrichthyan fisheries, catch and trade

Fisheries

Fishing has been regulated in Madagascar since the 1920s; however, the first management policies only emerged in 1973, with the issuing of licenses to fishing vessels (de Young 2006). There are currently three main types of fishing in Madagascar, which are defined according to Decree 94-112 of 18 February 1994, as: 1) traditional fishers who fish from the shore, from unmotorized boats or from boats with engine power <15HP, and retain their catch for consumption or sale on local markets; 2) artisanal fishers, who fish from boats with engine sizes ranging from 15 to 50HP and who sell the majority of their catch locally; 3) industrial fishing vessels, which have engines >50HP, and which are able to reach further offshore and thus able to target a greater diversity of species. The development and extent of chondrichthyan fisheries in Madagascar, including the artisanal sector, are well documented.

Chondrichthyans are heavily exploited in all three fisheries sectors, both directly and indirectly (Kiszka and van der Elst 2015). Small-scale and artisanal fisheries (excluding subsistence) accounted for more than 75% of national fisheries in 1994 (Cooke 1997). This exploitation has been fuelled by the high value of shark fins, population growth and ecosystem degradation (Cooke 1997, McVean et al. 2006). Sawfish (Pristidae) were historically targeted but are now thought to have declined to the point that any exploitation is likely negligible (Cooke et al. 2003, Leeney and Adouhouri in prep). The fins of wedgefish species (Rhinidae) are more valuable than shark fins and so the family Rhinidae is likely to be among the most targeted groups of chondrichthyans (Cripps et al. 2015, although the family name used in this report – Rhynchobatidae – is no longer valid). There is sport fishing in Madagascar, particularly in Nosy Be, but captured sharks are apparently released alive (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017).

Traditional and artisanal fisheries

Legal traditional and artisanal fisheries targeting chondrichthyans exist in Madagascar's waters and have done so for at least 100 years. These fisheries extend along Madagascar's entire west coast, from Itampolo/Androka in the south to Antsiranana in the north (Cripps et al. 2015). Prior to 2004, MPRH regarded sharks as an under-utilized marine resource to be targeted, and so shark fisheries were promoted by development organizations as a means of increasing income in coastal fishing communities (Cooke 1997, Cripps et al. 2015).

Throughout Madagascar, fishers report that shark catches are utilized as a source of income from the sale of fins and meat, as well as a direct source of food (Cripps et al. 2015). Traditionally, shark liver oil was used for cooking and to waterproof wooden boats, and today it is used in medicine and other products (Cooke 1997, Le Manach et al. 2012). Although artisanal fishers target sharks specifically for the fin market, the bodies are usually consumed locally and rarely discarded (Le Manach et al. 2011b). Traditional and artisanal fishers also tend to utilize incidentally caught sharks and most rays – even if they have no commercial value – for local consumption (R. Leeney, pers. obs.). Dried and/or salted shark and ray meat is often sold in markets as 'maskita', and fresh meat is also sold locally (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017), but the fins are generally sold to collectors – either Malagasy or Chinese – for export (McVean et al. 2006).

Traditional fisheries

Traditional fisheries use a wide range of gears (gillnets, lines, traps, seine nets, and barrages) in shallow coastal and pelagic waters to target a range of resources including elasmobranchs, cephalopods, turtles, and echinoderms (Everett et al. 2017). Most traditional fishers use *palangre*[69], *jarifa*[70] and 'GTZ' or 'ZDZD'[71] to catch sharks, and handlines often lead to incidental shark catch (Cripps et al. 2015). However, *jarifa* are very expensive and some fishers have abandoned this technique (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017).

Traditional fisheries are extensive (~20,000 fishers) in the Toliara region of southwest Madagascar, where an active export market for chondrichthyan fins is an important source of income and the meat is an important source of food protein (Cripps et al. 2015, Everett et al. 2017, Humber et al. 2017). Here the nomadic *Vezo* fishers fish in hard-to-reach, remote areas, driven largely by the high market demand for chondrichthyan fins (Cripps 2010). The number of fishers is increasing in this region, and new intensive methods are being employed, such as weighted barrage nets of several kilometres long, used by teams of artisanal fishers to target Rhinobatidae (guitarfishes) and sharks in the remote Barren Isles archipelago and around Morondava (Cripps 2010).

McVean et al. (2006) recorded landings in two villages in the southwest region between 2001 and 2002, documenting at least 13 species of chondrichthyans. A more recent study of 24 villages in the region documented 20 elasmobranch species in landings between 2007 and 2012, with sliteye sharks *Loxodon macrorhinus*, Critically Endangered scalloped hammerhead sharks *Sphyrna lewini* and the Rhinobatidae family making up 75% of traditional landings, with landed individuals having decreased in size over time (Humber et al. 2017). *Sphyrna* spp. represented nearly one third of landings in both studies (McVean et al. 2006, Humber et al. 2017).

In Antongil Bay, northeast Madagascar, a traditional fishery is present which does not primarily target chondrichthyans, although they are caught incidentally. From 2001 to 2003, 273 elasmobranchs were caught by this traditional fishery, comprising 17 different species (Doukakis et al. 2007, 2011).

Artisanal fisheries

Artisanal fisheries, most developed in the northwest, use a range of nets to target fish, crustaceans, and chondrichthyans (Cripps et al. 2015, Everett et al. 2017). Gillnets (100 m long, 7 m high, and set in water depths of 50 to 200 m) are most commonly used to target some species of sharks and other pelagic fishes, and it is these nets that are most likely to impact the populations of sharks and other large vertebrates (Kiszka and van der Elst 2015). WIOFish reported Critically Endangered *Sphyrna mokarran,* bowmouth guitarfish *Rhina ancylostomus* and whitespotted wedgefish *Rhynchobatus djiddensis* (although this probably refers to *R. australiae*), Endangered shortfin mako sharks *Isurus oxyrinchus,* whale sharks, zebra sharks *Stegostoma tigrinum*, sicklefin lemon sharks *Negaprion acutidens* and *H. uarnak,* and Vulnerable silvertip sharks *Carcharhinus albimarginatus,* as well as tiger sharks and whiptail stingrays (Dasyatidae) to be caught in gillnet fisheries and small net fisheries (Everett et al. 2017). Stingrays are also reportedly caught in small nets, gillnets and cast nets for shrimp and fish (Everett et al. 2017).

In Antsiranana, northern Madagascar, a directed shark fishery began around 1990 and has evolved into an important artisanal shark fishing area (Robinson and Sauer 2013). A study of this fishery identified 23 chondrichthyan species, comprising 19 shark and four batoid species (Robinson and Sauer 2013). Carcharhinidae (mostly *C. amblyrhynchos*, now Endangered) and Sphyrnidae (mostly *S. lewini*, now Critically Endangered) accounted for 69% and 24% of the elasmobranch catch, respectively. While artisanal fishers are believed not to target *Rhina ancylostomus*, *Rhynchobatus djiddensis* (more likely *Rhynchobatus australiae*) or whale sharks, these species may be caught incidentally (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017). In a separate, more recent study from northern Madagascar, at least 21

[69] Palangre is a type of long line using high-strength nylon fishing line and 8-cm hooks with trace made from steel cable.

[70] Jarifa are large, baited gillnets set in deep water to target sharks. They are generally around 100–200 m long with a fall length of around 5 m and a mesh size of 12-25 cm.

[71] GTZ/ ZDZD are gillnets up to 150 m long with a fall length of 6–8 m and mesh size of 8–10 cm. Its name comes from GTZ, the German government's development agency that introduced it in northwest Madagascar in 1992 with the objective of reducing fishing pressure on near shore reefs through development of offshore fishing (Langley 2006).

species of chondrichthyans were caught either by handline, longline, bottom-set and/or drift gillnets (Temple et al. 2019). The drift gillnet fisheries operated primarily in shallow water environments and caught primarily benthic species such as guitarfishes and wedgefishes, most of which are threatened (Temple et al. 2019).

Some artisanal fishers from northeast Madagascar and from Mahajanga in the northwest (Figure 6.3.1) travel to the Barren Isles in the southwest (Cripps 2010). Shark fishers first started arriving in the Barren Isles in 1995 (Muttenzer 2015), but the number of fishers in this region is increasing (Gardner et al. 2018), and new intensive methods are being employed, such as weighted barrage nets (which can be several kilometers in length), which sit on the seafloor and are used to target guitarfishes and sharks (Cripps 2010).

In Antongil Bay, some artisanal fishers (comprising roughly six vessels) were known to target sharks for fin export (Doukakis et al. 2007). At least 15 different species of shark are known to have been caught in this fishery, including pregnant *S. lewini*. Although guitarfish in this area have in the past been protected by a local "fady" (taboo), artisanal fishers choose to ignore this custom due to the extremely high prices they receive for guitarfish fins – which are considered to be of high quality in the Asian market (Doukakis et al. 2011). Antongil Bay was declared a shark sanctuary in 2015, and it is not clear whether sharks remain a target in this area. However, there are records of shark and ray catches here, suggesting that fisheries (target or not) are still impacting chondrichthyan populations in this Bay, despite the sanctuary status.

Industrial fisheries

Industrial fisheries operating in Madagascar's waters are mainly foreign longliners, purse seiners and IUU vessels, but also include a domestic shrimp trawl fleet, a small domestic longline fleet and converted shrimp trawl vessels now acting as longliners (Cripps et al. 2015). These fisheries either target chondrichthyans or catch them as bycatch. In a reconstruction of total catch, Le Manach et al. (2012) estimated total annual catches of sharks by domestic (3,800 t) and foreign fishers (4,300 t) in Madagascar's waters to be well over 8,000 t, and incidental shark catch to be 4,000 t. However, recording of catches, particularly over long periods of time, has been limited, and mainly in the industrial fisheries.

Directed shark fisheries

Industrial fisheries have been targeting sharks in Malagasy waters since the 1990s, but the true scale of the catch is unknown (Le Manach et al. 2012). Several foreign fishing rights agreements were developed in Madagascar since 1990, for foreign vessels intending to export shark meat, fins and oil (Cooke 1997, Cripps et al. 2015). An experimental shark fishery was established in 2011 to evaluate shark stocks (Cripps et al. 2015), allowing targeting of all shark species within Madagascar's EEZ by five longline vessels, except great white sharks *Carcharodon carcharias*, basking sharks *Cetorhinus maximus* and whale sharks. Other short-term prospecting of experimental fisheries for sharks has taken place in 2007, 2010 and 2011, authorizing the targeting of sharks for their meat, but these activities likely also took the fins and livers of any sharks captured (Cripps et al. 2015).

Several IUU vessels formerly targeting Patagonian toothfish *Dissostichus eleginoides* in the Southern Ocean have converted to shark fishing in southern and western Madagascar, using bottom-set gillnets to catch sharks, likely targeting the nurse sharks *Nebrius ferrugineus* and possibly *Pseudoginglymostoma brevicaudatum* for their liver oil (MRAG and CapFish 2008). Some vessels also have machinery on board to extract shark liver oil and thus can further conceal actual catch levels (Cripps et al. 2015).

Shark bycatch fisheries

Domestic shrimp fishery

A domestic shrimp fishery officially started in 1967, with the number of vessels increasing six-fold between 1993 and 2003 when licenses were controlled (Le Manach et al. 2011b). The fishery operates primarily along Madagascar's west coast, although they also operate along the north and north-west coasts and have been observed operating off the northeast coast. A decline in the number of vessels in operation has been reported and ascribed to conflict with the artisanal shrimp fishery and a decline in economic viability (Razafindrainibe 2010).

In the 1990s, the incidental shark catch rate in the shrimp trawl fishery was estimated to be up to one shark per hour of trawling around the island of Nosy Be (Cooke 1997), and up to ten per day in western Madagascar (Cooke et al. 2003). By the late 1990s, the catches of sharks had declined, and sharks had all but disappeared from shallow water trawls by the early 2000s (Cooke et al. 2003, Le Manach et al. 2011b). Unfortunately, there is no species-specific shark information from these catches, and no regulations have been implemented to reduce shark bycatch in this fishery. However, the use of turtle exclusion devices (TEDs) became mandatory in 2004, which may allow larger species, such as sharks, to evade capture (Razafindrainibe 2010), if they are implemented.

Owing to overexploitation of Madagascar's shrimp populations, some shrimp trawlers were refitted for longline fishing along the edge of Madagascar's continental shelf, and now operate as longliners from the ports of Morondava and Majunga (Cripps et al. 2015). These vessels catch mainly demersal species (likely to include deepwater chondrichthyans – many of which are Data Deficient) and reef-associated species, and reports from fishers suggest that juvenile sharks are often caught and increasingly landed (Cripps et al. 2015).

Domestic longline fishery

A domestic longline fishery developed after the decline of shrimp stocks in western Madagascar in 2007, and following exploratory fishing in 2008 and 2009, it has become a main fishing technique for tuna and tuna-like species (Rahombanjanahary 2012, Joachim and Razafimandimby 2015, Razafimandimby and Joachim 2017). The number of fishing vessels ranges between four and eight per year, with the majority being <25 m in length. The main species targeted are tuna and swordfish; although some billfish species and sharks are also caught. Shark catch comprised on average 12% of total catch from 2010 to 2016, with dominant species comprising blue shark *Prionace glauca* (61%) and shortfin mako shark *Isurus oxyrinchus* (32%; Razafimandimby and Joachim 2017). However, since 2013, the only species of shark recorded in the logbooks is *P. glauca*. The trend in shark catches has decreased from 85 t in 2010 to 36 t in 2016 (Razafimandimby and Joachim 2017).

Foreign fleets

Foreign fishing fleets, predominantly from developed nations outside of the WIO, have fished Madagascar's waters since at least the 1980s (Cooke et al. 2003, Cripps et al. 2015), targeting mainly tuna-like species, with a chondrichthyan bycatch component, although sharks are also targeted in some instances, particularly in recent years (Cripps et al. 2015). Most of these vessels are flagged to European Union (EU) States, such as France and Spain. Madagascar has concluded various FPAs with the EU since 1986, allowing EU vessels – primarily from Spain, Portugal, Italy and France – to fish in Malagasy waters (EU 2007a). In the most recent agreement (valid from 2015 through 2018), nearly 100 vessels were authorized to operate purse seine and longline gears in Malagasy waters (EU 2014a). This agreement set a catch limit of 250 t of whole sharks per year as incidental catch within the EU fleet targeting tuna and associated species, providing none of the species were under retention bans defined by IOTC resolutions (Lankester et al. 2012, EU 2014a), which at that time included thresher sharks (family Alopiidae), oceanic whitetip sharks *Carcharhinus longimanus* and whale sharks. However, the quota was not species-specific, therefore any species other than those protected by the IOTC could be caught. Vessels were also prohibited from catching species protected by international conventions, as well as *Carcharodon carcharias,* silky sharks *Carcharhinus falciformis* and *Cetorhinus maximus* (EU 2014a). This agreement expired at the end of 2018 (European Commission 2020); however, Madagascar and the EU have since failed to agree on new terms, preventing EU vessels from fishing in Malagasy waters in recent years[72].

There are also foreign fisheries partnership agreements with Asian nations, and the most recent agreement was set to allow 330 Chinese fishing vessels to fish in the Malagasy EEZ for ten years[73]. This would have devastating impacts on already unsustainable local fisheries, including negative impacts on shared stocks thus impacting the WIO region and other States

[72] https://news.mongabay.com/2019/10/madagascar-opaque-foreign-fisheries-deals-leave-empty-nets-at-home/

[73] https://mihari-network.org/news/concerns-soar-over-sustainability-of-madagascar-chinese-fisheries-deal/

within the WIO. The status of this deal remains unclear, although some discussion has been raised that suggests that the deal has been abandoned. In contrast to Malagasy-EU fisheries partnership agreements, whereby the EU publishes its deals once they are signed, agreements with Asian countries appear to be kept confidential by the ministry of fisheries, making it difficult to determine how much and what kind of catch is allowed.

Industrial purse-seine fishery

Since 1984, a European tuna purse-seine fleet has fished the western and northern areas of Madagascar's EEZ (Cooke et al. 2003). In 2011, 35 industrial purse seiners were licensed to fish in Madagascar's EEZ, with 23 being flagged as European vessels, and the rest from Asia (Indonesian, Korean and Taiwanese) and Seychelles (Cripps et al. 2015).

The industrial purse seine fishery results in considerable bycatch of chondrichthyans (Filmalter et al. 2013b, Poisson et al. 2014), including multiple species of primarily carcharhinids, especially *Carcharhinus falciformis* (79%) and *C. longimanus* (11%) (Ardill et al. 2013), with *C. falciformis* often caught as juveniles and discarded (Amandè et al. 2008). Total catches of sharks taken by foreign vessels based on incidental rates from the tuna fisheries showed a steep increase since 1950 and were estimated at 4,300 t per year (Le Manach et al. 2011b). However, Garcia and Herrera (2018) estimated that only 0.15% of the shark fishing mortality in the Indian Ocean is attributable to the purse seine fishery. Additionally, they also support the fact that *C. falciformis* are the most common bycatch species for purse seiners, but suggest that their levels of fishing mortality are extremely low, at just 1.3%.

Industrial Longline fishery

Foreign fisheries operating in Malagasy waters also include offshore longline vessels, which mainly target yellowfin and skipjack tuna in the northern part of the EEZ (Cooke et al. 2003). However, catches are uncertain as the catch is not landed in Madagascar, reporting requirements are not enforced, and there are unlicensed vessels operating (Cripps et al. 2015). In the early 2000s, at least 30 European pelagic longliners were reported to be in operation (Kiszka and van der Elst 2015), as well as an Asian longline fleet operating without access agreements (Fowler et al. 2005). There was also a longline fleet from La Réunion targeting swordfish, tuna and other large pelagic species in Madagascar's eastern EEZ (René et al. 1998). Whether this fishery remains in operation is unclear and chondrichthyan catch rates in this fishery are not known. Overall, reported chondrichthyan catch by longliners amounts to an estimated 5 to 11% of total catch (Cooke 1997, Fowler et al. 2005), however incidental catches are believed to be considerably higher (Ardill et al. 2013). Although these vessels primarily target tuna and tuna-like species, there is evidence they also target sharks, with *Isurus oxyrinchus*, *Prionace glauca*, *Sphyrna lewini,* smooth hammerhead sharks *Sphyrna zygaena*, and thresher sharks *Alopias* spp. all recorded as incidental longline catch in Madagascar (René et al. 1998, Le Manach et al. 2012, Ardill et al. 2013, Everett et al. 2017), almost all of which are now threatened.

Fisheries monitoring and reporting

There are several national orders (Arrêtés) and Decrees relating to fisheries reporting requirements. Arrêté No. 12665/2014 of 28 March 2014 requires the captain of a vessel fishing in the IOTC area of competence to record all incidental catch and release of live thresher sharks in the fishing logbook. Decree No. 2006-097 of 31 January 2006 requires the CITES management authority to record wildlife species trade data and report annually to the relevant authorities and CITES. However, there is limited capacity to enforce these requirements (Le Manach et al. 2012).

According to WIOFish, catch and effort monitoring is conducted in about 63% of recorded fisheries, through the required submission of catch returns, creel surveys, observers (onboard and landing sites), satellite emissions and/or interviews (Everett et al. 2017). Biological monitoring is also carried out in 41% of recorded fisheries in the form of bycatch composition, sex, lengths, reproductive state, species composition, size frequency, and weights (Everett et al. 2017). Madagascar currently has 22 fisheries recorded in WIOFish, and all have some catch composition data (Everett et al. 2017).

Official statistics indicate limited monitoring and reporting in the traditional and artisanal fisheries, poor taxonomic information, and an absence of incidental catch and discards from shrimp trawls (Le Manach et al. 2012). A reconstruction of Madagascar's total marine fish catches, not including foreign fishing, was found to be two times the figure reported to the FAO by Madagascar (Le Manach et al. 2012).

More recently, smart phone-based community fisheries data collection programs have been implemented at numerous sites along the southwest, northwest and northeast coasts of Madagascar, by NGOs such as Blue Ventures (Blue Ventures 2015, Jeffers et al. 2019) and the Wildlife Conservation Society (WCS, unpublished data). These surveys are improving the quality of catch data recorded in Madagascar's artisanal fisheries through the collection of catch data on chondrichthyans, among other species.

Reported chondrichthyan catches

Madagascar does report some chondrichthyan catches to the FAO, but most are not identified to species or family level; instead, most chondrichthyan species landed are recorded together in a broader group named 'Sharks, rays, skates, etc. nei' (FAO 2021). However, catches of *Prionace glauca* have been recorded in small quantities since 2013.

From 2012 to 2019, Madagascar reported landings to the FAO with an annual average of 4,982.6 t of chondrichthyans from FAO Major Fishing Area 51 (hereinafter FAO Area 51) (Figure 6.3.2; FAO 2021). Figure 6.3.2 shows an almost uniform trend of reported catches from 2012 to 2018, suggesting Madagascar is reporting estimated catch, and these data are therefore not reliable representations of actual chondrichthyan catch. Of all the Nairobi Convention Member States, Madagascar reported the third largest catch, accounting for 12.8% of the total Nairobi Convention Member State chondrichthyan catches in all oceans and 24.4% of their catches from FAO Area 51. Given the unreliable nature of national statistics, however, these catches are likely to be conservative.

Reports of sharks caught in Madagascar by foreign vessels (directed or incidental catch e.g., the foreign longline tuna fishery) should be reported to the IOTC, but these reporting requirements are not enforced and reports are inconsistent (Cripps et al. 2015), and in most cases only the retained catch is reported (Ardill et al. 2013).

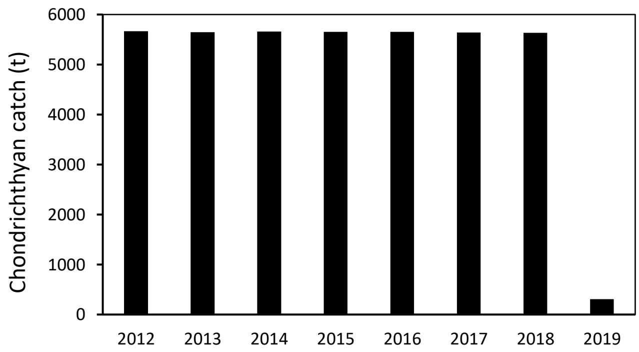


Figure 6.3.2: Total chondrichthyan catch from FAO Major Fishing Area 51 by Madagascar, 2012–2019 (FAO 2021).

Trade in chondrichthyan products

Trade in shark products has existed in Madagascar for at least 100 years (Cooke 1997) and continues today (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017). Fresh shark meat is salted and dried and exported to the Comoros and Hong Kong (Cripps et al. 2015). The value and production of shark fins in Madagascar was relatively modest until around 1990, when there were rapid rises in local prices and export volumes (Cooke 1997). By 2006, Malagasy fishers in many regions had reported notable declines in shark catch rates, but the high value of shark fins on East Asian markets continued to drive the targeting of sharks (Cripps et al. 2015).

Shark fin exports were reaching the international market mostly through two principal buyers and exporters – both of which were Chinese companies based in Antananarivo (Cripps et al. 2015). There is an active export market for shark fins along the west coast, especially in the region around Toliara (Kiszka and van der Elst 2015). This trade is likely to be of socioeconomic importance to the communities of western Madagascar. In northern Madagascar, fins are primarily sold to Chinese buyers as they apparently tend to offer better prices, but fins are also sold to Comorian, African and Malagasy buyers (Whitty et al. 2010).

Official chondrichthyan trade data

Madagascar imports of shark products

There is one report of chondrichthyan products imported into Madagascar from 2012 to 2019 (2 t of shark fin imported from Hong Kong), but no reports of countries exporting chondrichthyan products to Madagascar (UN Comtrade 2021), suggesting discrepancies in trade volume reports.

Madagascar exports of shark products

Over the same period, Madagascar reported an annual average export of 7.3 t of chondrichthyan products, 96% of which was shark fin with an apparent increase in volume from 2014 to 2019 (Table 6.3.1; Figure 6.3.3a; UN Comtrade 2021).

Table 6.3.1: Total catch, exports and reported imports of all chondrichthyan products (metric tonnes) originating in Madagascar as reported by Madagascar (catches and exports), and the importing countries.

Year	Total catch [a]	Exports from Madagascar - all codes [b]	Imports from Madagascar; reported by the world, all codes [b]	Shark fin imports by Hong Kong [c]
2012	5,665	0	14.73	14.73
2013	5,650	0.73	13.68	13.68
2014	5,660	0.60	10.66	10.67
2015	5,654	5.14	15.28	12.93
2016	5,651	10.56	9.10	9.10
2017	5,639	14.83	6.65	7.70
2018	5,632	11.42	21.38	7.43
2019	310	15.47	27.51	8.78
Total	39,861	58.76	119.02	85.03
Average	4,983	7.34	14.88	10.63

a) Source: FishStatJ (FAO 2021)
b) Source: UN Comtrade (2021)
c) Source: Hong Kong Bureau of Statistics (2021)

However, the Hong Kong import data indicate imports of shark fin into Hong Kong from Madagascar every year from 2012 to 2019, with an annual average of 10.6 t (Figure 6.3.3b), thus exceeding the reported Madagascar export volumes.

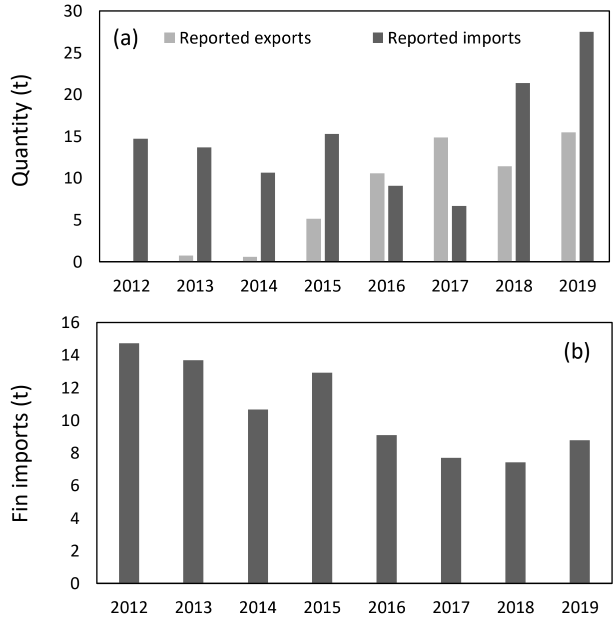


Figure 6.3.3: (a) Madagascar exports of chondrichthyan products to the World, and World imports of chondrichthyan products from Madagascar, 2012–2019 (UN Comtrade 2021); (b) Hong Kong (SAR of China) imports of shark fin from Madagascar, 2012–2019 (Hong Kong Census and Statistics Department 2021).

Trade in CITES-listed chondrichthyan species

In all instances of trade in CITES-listed elasmobranch species from Madagascar, the overall reported quantity from the exporter (i.e., Madagascar) does not match the overall quantity reported by the importing country (Table 6.3.2). While there are several reasons for why export and import records do not match (see Chapter 4 for details), the export quantity and descriptions of 30 largetooth sawfish *Pristis pristis* specimens from Madagascar are significantly different to the 18 reported bone pieces imported by the USA (Table 6.3.2).

Overall, there are major discrepancies between Madagascar's reported trade volumes and those from the other countries (Table 6.3.1, Figure 6.3.3a), and clear evidence of underreporting of both exports of elasmobranch products (including fins) from Madagascar, and imports of shark products into Madagascar.

Table 6.3.2 CITES-listed elasmobranch species exported from Madagascar and imported into various importer countries, as determined from the CITES Trade Database[74], for the period 2011–2019. Importer country, importer reported quantity and exporter (i.e., Madagascar) reported quantity, export purpose and source of the export specimen are given. App. refers to CITES Appendices. Where no units are given, the quantity represents the total number of specimens/products traded.

Year	App.	Taxon	Importer	Importer reported quantity	Exporter reported quantity	Term	Unit	Purpose	Source
2015	I	*Pristis pristis*	USA		30	Specimens		Scientific	Wild
2016	I	*Pristis* spp.	USA	5		Bone pieces		Scientific	Confiscation/seizure
2016	I	*Pristis pectinata*	USA	5		Bone pieces		Scientific	Confiscation/seizure
2016	I	*Pristis pristis*	USA	2		Bone pieces		Scientific	Confiscation/seizure
2016	I	*Pristis pristis*	USA	6		Bone pieces		Scientific	Confiscation/seizure
2016	II	*Carcharodon carcharias*	France	2		Bones		Commercial	Wild
2019	II	*Carcharodon carcharias*	France	1		Skeletons		Educational	Pre-Convention
2019	II	*Carcharodon carcharias*	France		1	Teeth		Educational	Pre-Convention

6.3.4 Conservation status

As a consequence of high levels of legal and illegal fishing pressure, chondrichthyans in Madagascar are heavily overexploited, with 56 species (52%) currently considered threatened on the IUCN Red List of Threatened Species (IUCN 2021). These include 28 Vulnerable, 21 Endangered and seven Critically Endangered species (IUCN 2021). Surprisingly, only three of the 17 species which occur in Madagascar and are endemic to the WIO are threatened; these include the Vulnerable *Dipturus crosnieri*, the Endangered *Holohalaelurus punctatus*, and Critically Endangered *Pseudoginglymostoma brevicaudatum*. Other than *Acroteriobatus andysabini*, which has not yet been evaluated, the other four species endemic to Madagascar (*Bythaelurus clevai*, *Chiloscyllium caeruleopunctatum*, *Fenestraja maceachrani* and *Narcine insolita*) are all Data Deficient.

Certain chondrichthyans in Madagascar used to receive some protection due to local beliefs. In northern Madagascar, many *fadys* (traditional beliefs, or taboos) relate to chondrichthyans. For example, some individuals would not eat sharks due to a belief that they may have saved their ancestors from drowning, or that sharks had eaten their ancestors and now possessed their spirits (Whitty et al. 2010). In north-eastern Madagascar, it was *fady* to capture and kill guitarfish, however artisanal fishers tend to ignore this *fady* as guitarfish fins fetch a high price due to their good quality (Doukakis et al. 2011). It thus appears that any conservation value that chondrichthyans previously derived from local *fadys* in Madagascar is now being eroded, by virtue of the monetary remuneration that can be obtained from chondrichthyan products.

6.3.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

The Ministry of Marine Resource and Fishing (Ministère des Ressources Halieutiques et de la Pêche, MRHP) is the designated national authority for fisheries management and research in Madagascar, and its Fisheries Monitoring Centre (Centre de Surveillance des Pêches, CSP) is responsible for enforcement of fisheries legislation (Table 6.3.3).

The Directorate of Marine Resources and Fishing (Direction Generale des ressouces Halieutique et de Peche, DGRHP) is responsible for fisheries permitting. MRHP’s Fisheries Health Authority (Autorité Sanitaire Halieutique, ASH) is responsible for export and import trade controls, and enforcement relating to trade is overseen by the Directorate of Forestry (Direction Generale des Forets, DGF), part of the Ministry of Environment and Sustainable Development (Ministère

[74] https://trade.cites.org/en/cites_trade

de l'Environnement et du Développement Durable, MEDD) (Table 6.3.3). MEDD is also the CITES Management Authority for Madagascar, and thus responsible for the trade in CITES products and the permitting thereof, while the Ministry of Higher Education's Department of Plant Biology and Ecology, in the Faculty of Sciences at Antananarivo University, is the CITES scientific authority (Table 6.3.3). The tuna focal point at the Directorate for Fisheries and Aquaculture (Direction Generale des Ressources Halieutiques et de la Peche, DGRHP) at MPRH is responsible for IOTC-related provisions.

Species conservation and environmental protection are overseen by the Directorate for the Conservation of Biodiversity and the System of Protected Areas (Direction de la Conservation de la Biodiversité et du Systeme des Aires Protégées, DCBSAP) within the DGF (Table 6.3.3).

Coastal zone management is jointly overseen by the National Committee for the Integrated Management of the Coastal Zone (Gestion Intégrée des Zones Côtières, GIZC), and the Unit for Coordination and Planning of the Maritime Territory (Cellule de Coordination et de Planification du Territoire Maritime, CCPTM) (Table 6.3.3) at the Ministry of Territory management (Ministere d'Etat en charge de l'Amenagement du territoire et des Equipements, MEPATE). The Agency for Marine Protected Areas (Direction de l'Aire Marine Protégée, DAMP) at MEDD's Directorate of the Sea (Direction Generale de la Mer, DGM) is responsible for MPA management and enforcement, together with MRHP's Secretary of State in Charge of Sea (Secrétaire d'État en chargé de la Mer, SE Mer) (Table 6.3.3). Madagascar's Protected Areas Code (Code des Aires Protégées), developed in 2005 (Décret d'Application No 848-05) allows for non-government bodies to manage protected areas, therefore MPA management is the responsibility of Madagascar National Parks, several NGOs, community organizations and the private sector (Rabearivony et al. 2010, Gardner 2011).

Malagasy authorities have insufficient capacity for MCS (Cooke 1997, Le Manach et al. 2011b). Some efforts are being made to increase surveillance of industrial fisheries through cooperation between Madagascar and neighbouring countries.

Table 6.3.3: Designated national authorities involved in chondrichthyan management in Madagascar.

Area of management	Designated national authorities
Fisheries management and research	Ministry of Marine Resources and Fishing (MRHP)
Export and import trade controls (including permitting)	Fisheries Health Authority (ASH) at the MRHP; Ministry of the Environment and Sustainable Development (MEDD) (as designated CITES management authority); Ministry of Higher Education, through Antananarivo University (as designated CITES scientific authority)
Permitting of fisheries	Directorate of Marine Resources and Fishing (DGRHP)
Enforcement of fisheries legislation	Fisheries Monitoring Centre (CSP) at MRHP
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	Directorate of Forestry (DGF) at MEDD
IOTC-related provisions	Tuna focal point at Directorate for Fisheries and Aquaculture (DGRHP) at MPRH
Species conservation and environmental protection	Directorate for the Conservation of Biodiversity and the System of Protected Areas (DCBSAP, at the DGF/MEEMF)
Coastal zone management	National Committee for the Integrated Management of Coastal Zone (GIZC); Unit for Coordination and Planning of the Maritime Territory (CCPTM);
MPA management and enforcement	Madagascar National Parks; NGOs; community organizations; private sector; Agency for Marine Protected Areas (DAMP) at Direction Generale de la Mer (DGM); Secretary of State in Charge of Sea (SE Mer) at the MRHP

National legislation and regulations

The 2015 Fishing and Aquaculture Code (Code de la pêche et de l'aquaculture, Loi n°2015-053), provides the legal framework for fisheries management in Madagascar, and regulates fishing activities. The law states that the fishing and possession of protected species is prohibited under national legislation and through international conventions to which Madagascar is signatory, which by definition must include the measures defined under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and Indian Ocean Tuna Commission (IOTC), to which Madagascar is Party (Table 5.2, in Chapter 5). However, the law makes no provision for species-level regulations, for chondrichthyan species or other marine species, and does not define what is meant by the term "protected". Having been implemented in 2015, it would be appropriate for this law to be revised, and there is some discussion that such a revision of the Code will be undertaken in the near future. Madagascar should thus include provisions for species-level regulations in the revised version.

Similarly, no chondrichthyan species are listed in Decree 2006-400 for protected species (Humber et al. 2015). However, there are several national laws and decrees that are pertinent to chondrichthyan conservation and management in Madagascar. Under Article 1 of Arrêté No. 3270-2001, species which pose a risk to human health (through consumption) are prohibited from being sold and consumed, including hammerhead sharks, mako sharks, bluntnose sixgill sharks *Hexanchus griseus* and thresher sharks (family Alopiidae) (which are considered to possess high toxicity levels). Under Arrêté No. 19815/2017 of 21 August 2017, catches resulting from recreational and sport fishing must either be used for personal or family consumption or otherwise released immediately. The sale of catches from recreational and sport fishing is strictly prohibited.

Loi No. 2015-005 of 26 February states that the fishing, trading, capturing and consumption of protected species within protected areas is prohibited, with only conservation, restoration and monitoring activities being authorized. Decree No. 2016-1352 states that, among things, the exploitation of protected species is prohibited; fragile ecosystems (e.g., mangroves, coral reefs) shall be preserved and may be declared as marine reserves; and that any operator of marine resources shall contribute to the restoration and sustainable management of marine resources.

Furthermore, the retention of certain chondrichthyan species, as defined by the IOTC, is prohibited within tuna and tuna-like fisheries under the management of the IOTC, through several national decrees. Thresher sharks (family Alopiidae) and oceanic whitetip sharks *Carcharhinus longimanus* are prohibited through Arrêté No. 12665/2014 of 28 March 2014 and Decree No. 20510/2003 of 01 December 2003, respectively (IOTC Secretariat 2021c). Under Arrêté No. 12665/2014, recreational and sport fishers are also required to release alive all thresher sharks. Furthermore, the capture and hooking of mobulid rays and intentional setting of nets around whale sharks, as well as shark finning, are apparently prohibited through permitting conditions in tuna fisheries (IOTC Secretariat 2021c). However, such permit conditions have no relevance beyond the specific fisheries or vessels for which they are set.

No national legislation exists relating to incidental catch or discards (Razafindrainibe 2010), despite the specification by Decree 94-112 that the State can manage and limit incidental catch (Madagascar 1994). Since 2005, all relevant vessels (such as trawl vessels) are mandated to be equipped with TEDs and BRDs (Decree 2003-1101; Razafindrainibe 2010), which can considerably reduce the amount of incidental catch – including chondrichthyans (Fennessy and Isaksen 2007, Fennessy et al. 2008). However, it is not clear whether these TEDs and BRDs are actually used when vessels are not under surveillance. In the 1990s, legislation was also introduced (Decree 1999/2000) requiring industrial vessels to retain at least 50% of bycatch to supply fish to local markets, but the effectiveness of this has been questioned (Randriarilala et al. 2008).

Chondrichthyans and their related products are governed by commercial export requirements. Any species listed under CITES must be exported in line with CITES regulations for Appendix II species (see section 5.3.1), which are also nationally legislated through several laws. Loi No. 2005-018 of 17 October 2005 requires that trade in CITES-listed species is conducted according to CITES requirements and legislates for the confiscation of unlawfully traded products, penalisation of persons caught trading in CITES-listed products illegally and the relevant reporting of such activities to the CITES management body. Arrêté n°3032-2003 states that the CITES management body, with the assistance of the CITES Scientific authorities, shall give their agreement for trade of CITES-listed species according to the relevant regulations. Decree No. 2006-097 of 31 January 2006 stipulates that trade in CITES-listed species requires relevant authorisation under Loi No. 2005-018. Decree No. 2006-098 regulates trade specifically for great white sharks *Carcharodon carcharias*, basking sharks *Cetorhinus maximus* and whale sharks; however, subsequent to publication of this Decree, all three of these species were listed on CMS Appendix I, thereby requiring national level protection and they should thus not be traded at all.

Fisheries partnership agreements (FPAs) with foreign fleets can mention sharks as a prohibited species, and whether sharks must be landed with fins attached, but this clause is subject to negotiation and it is likely not retained in every agreement (M. Andriamahefazafy, unpublished data, in Humber et al. 2015).

Overall, existing national legislation and international measures are not providing effective protection for chondrichthyans in Malagasy waters.

Status of NPOA-sharks

A national roadmap and draft National Plan for the Management and Conservation of Sharks and Rays in Madagascar (*Plan National de Gestion et de Conservation des Requins et Raies à Madagascar 2022-2024*) were developed in Madagascar in 2018–2019. The process was led by the Ministry of Environment, Ecology and Forests (MEEF) with the participation of fishers' representatives, industrial fishers, research centres, NGOs working in marine conservation, and representatives from the Ministries of Tourism and Finance. The NPOA development was delayed by changes in government and issues defining responsibilities of each department in this process. However, the issue was overcome and, in January 2019, a broad stakeholder meeting was held for technical validation of the plan. Final comments were addressed at a meeting in February 2019, to finalize the strategic objectives and the areas of intervention, finalize institutional arrangements, and allocate responsibilities for implementing the plan. Six key objectives are defined in the NPOA, including to:

1. Improve collection, reporting and use of data;
2. Strengthen policy and legislation;
3. Strengthen management and conservation measures;
4. Strengthen regional and national capacities;
5. Improve compliance and enforcement of regulations;
6. Improve awareness and communication.

A parallel document (*Plan de mise en oeuvre du Plan National de Conservation et de Gestion des Requins et de Raies à Madagascar 2020-2024*), was developed to guide to the implementation of the NPOA work plan. The final documents were approved in 2022 by both the Ministry of Agriculture, Livestock and Fisheries and the Ministry of Environment and Sustainable Development—both newly created ministries after the governmental restructuring—and the updated NPOA was publicly communicated during a press release in Madagascar in July, on Shark Day. The NPOA has, however, not yet been formally signed or implemented.

Marine protected areas

Since 2003, Madagascar has been in the process of expanding the coverage of its protected areas (Durbin 2007), and at the IUCN World Parks Congress in Sydney, in 2014, the Madagascar government committed to tripling the number of Madagascar's MPAs by 2025 (Rajaonarimampianina 2014). According to Madagascar's Protected Areas System (Système des Aires Protégées de Madagascar), Madagascar has 22 MPAs, which span 14,451 km^2, equating to approximately 1.26% of its EEZ (Ramahery et al. 2021). However, as not all of these are recognized internationally, UNEP's World Database on Protected Areas recognizes a total coverage of 11,018 km^2, equating to approximately 0.91% of Madagascar's EEZ (UNEP-WCMC and IUCN 2021c).

Despite the number of MPAs in Madagascar, none of these was developed specifically for chondrichthyans. However, in February 2015, MPRH established a shark sanctuary in northeast Madagascar, spanning almost the entirety of Antongil Bay (Baie d' Antongil; MRHP 2014), a large coastal embayment in northeast Madagascar (Figure 6.3.1). The Antongil Bay Shark Sanctuary includes a network of locally managed marine areas (LMMAs) in which shark fishing is prohibited, and in which international vessels are prohibited from fishing, while granting coastal communities exclusive use and management rights for local fishing areas (WCS 2015). The no-take zone is the first community-level shark fisheries management measure established within a legal text in Madagascar (Humber et al. 2015), and is the only designated shark sanctuary (fully no-take for shark species) within the WIO region, and should therefore be seen (and managed) by Madagascar as a flagship protection zone for chondrichthyan species in the WIO. As one of few large shallow water habitats on the east coast of Madagascar, Antongil Bay is of great ecological importance. Within the boundaries of this shark sanctuary, at least 19 shark species (Doukakis et al. 2011) and four batoid species (WCS/SAIAB, unpublished data) have been recorded, and the area is thought to be a breeding area for Critically Endangered scalloped hammerhead sharks *Sphyrna lewini*, and Vulnerable milk sharks *Rhizoprionodon acutus* and spinner sharks *Carcharhinus brevipinna* (Doukakis et al. 2011). The legislation (Ministerial Decree N° 37.069/2014) prohibits foreign vessels from fishing in the Bay (i.e., within the shark sanctuary), and limits the number of trawlers operating in the Bay to two vessels at a time (MRHP 2014). However, this decree does not prohibit the catch of batoid species, and shark fishing within the Bay continues at the artisanal level, including the catch of Critically Endangered *S. lewini* and Endangered zebra sharks *Stegostoma tigrinum* (WCS, unpublished data). In addition, at least 18 shark species are known to have been caught in Antongil Bay (Doukakis et al. 2011) before the establishment of the shark sanctuary. The ongoing illegal harvesting of chondrichthyans is likely to negate any protective effect of the sanctuary. Furthermore, the shark sanctuary is not reflected in Madagascar's Protected Areas System database (Ramahery et al. 2021), nor in UNEP's World Database on Protected Areas (UNEP-WCMC and IUCN 2021c), which both recognize only the LMMAs within the Bay.

There are several other MPAs in Madagascar that are important for one or more chondrichthyan species. The Ankarea and nearby Ankivonjy MPAs (together covering 2,750km^2), in northwest Madagascar, are refuges for whale sharks *Rhincodon typus*, mobulid rays (family Mobulidae) and (at least were previously known to have) sawfishes (family Pristidae) (Ramahery et al. 2021). There is a new corridor MPA being developed that links these two existing MPAs, and partly overlaps a large and important aggregation area for whale sharks (Diamant et al. 2018)

The Velondriake and nearby Soariake MPAs in southwest Madagascar cover extensive coral reef habitat, and at least seven chondrichthyan species have been recorded, including shorttail nurse sharks *Pseudoginglymostoma brevicaudatum* and bowmouth guitarfish *Rhina ancylostomus,* both of which are assessed as Critically Endangered on the IUCN Red List, and the Endangered grey reef shark *Carcharhinus amblyrhynchos* (WCS unpublished data).

In 2014, the Malagasy government also granted legal protection to the Barren Isles archipelago for an initial period of two years, prohibiting industrial fishing in nearly 4,300 km^2 of coastal waters, and placing fisheries management in the hands of local communities (Blue Ventures 2015). The LMMA harbours numerous species of chondrichthyans and supports traditional small-scale fisheries (including those targeting chondrichthyans). This area is now proposed to become a permanent MPA (Ramahery et al. 2021).

In 1996, the Malagasy Government introduced the Gestion Locale Sécurisée (GELOSE), a legal framework designed to integrate the *Dina*, a traditional local social code, with governmental laws to enable community-based management of natural resources (Rakotoson and Tanner 2006, Bérard 2011). Later, a new decree (Décret d'Application No 848-05) for the existing Code des Aires Protégées simplified and redefined the legal process used in protected area creation (Durbin 2007). Under this more flexible model, community organizations, NGOs and the private sector are permitted to manage protected areas, in addition to the parastatal protected areas agency Madagascar National Parks (Rabearivony et al. 2010, Gardner 2011). Since then, at least 200 LMMAs have been established along the coast, which are largely or wholly managed at a local level by the coastal communities, land-owning groups, partner organizations, and/or collaborative government representatives who reside or are based in the immediate area (Govan et al. 2008, Mayol 2013, Rocliffe et al. 2014, Ramahery et al. 2021). The first of these was Velondriake (700 km^2), which began as an initiative supported by the NGO Blue Ventures to improve the sustainability of the octopus fishery, and which has since been replicated across Madagascar (Rocliffe et al. 2014). It is now a locally managed IUCN Category VI MPA.

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Madagascar is signatory to several MEAs and RFBs (see Table 5.2). The State became Party to CMS in 2007. There are nine chondrichthyan species listed on Appendix I and a further 11 listed on Appendix II of CMS (excluding those also listed on Appendix I), which are known to occur in the Madagascar EEZ (Table 3.3, Chapter 3). Madagascar is thus obliged to protect the nine species listed on Appendix I, and to implement the CMS concerted actions for whale sharks and mobulid rays (Mobulidae; see section 5.2.1). However, none of these species are protected within Madagascar. As a Party State, Madagascar is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. Madagascar should also develop regional management plans for the species listed in CMS Appendix II (Table 5.1). Many of the Appendix II species are shared with other Nairobi Convention Member States; therefore, Madagascar should participate in the development of regional management plans, where appropriate, for these species (Table 5.1). Madagascar is also signatory to the CMS Sharks MOU (Table 5.2), which it signed in 2017, and should thus implement measures to effectively manage the species listed in Annex I of the MOU (Table 5.1).

Madagascar ratified CITES in 1975 and is thereby required to implement means by which to ensure that international trade in chondrichthyan species listed on Appendices I and II is regulated appropriately (see section 5.2.2). Twenty chondrichthyan species known from Madagascar are listed on CITES Appendices, including just one (*Pristis pristis*) on Appendix I (Table 3.3, Chapter 3), for which international trade should be prohibited. Madagascar integrated CITES provisions into national legislation, which is generally considered to meet the CITES implementation requirements and has so for some time (CITES 2016, 2021). However, it is believed to be unlikely that systems are in place to implement CITES trade controls and report on CITES shipments. There have been reports of limited application of CITES in Madagascar, due to a range of constraints (Reeve 2004, 2007, Anon 2007). Although export permits are required for any fisheries export, exportation of protected chondrichthyan products is known to occur (Leeney and Adouhouri in prep.). *Sphyrna lewini,* listed in Appendix II of CITES and Appendix II of CMS (Table 5.1), is regularly landed in Madagascar and likely forms a substantial proportion of exports (Humber et al. 2015). No NDF assessments or stock assessments have been conducted and no data are currently being collected to ensure that export of CITES-listed shark and ray species is not detrimental to the survival of the species in the wild.

In terms of RFBs, Madagascar is a member of SWIOFC and became a member of the IOTC in 1996, and while the State is signatory to SIOFA, the Agreement has not yet been ratified in Madagascar (Table 5.2). Under the IOTC, shark, tuna and swordfish fisheries in Madagascar must report their catches and follow the IOTC regulations concerning chondrichthyan species, retention bans, finning and reporting (see section 5.4.1). These measures call for retention bans in IOTC-managed fisheries for nine species of chondrichthyans that occur in Malagasy waters (Table 3.3). The 2021 IOTC compliance report for Madagascar indicates that measures have been taken for the prohibition of use of large-scale drift nets and of shark finning, prohibition on the capture of thresher sharks (Alopiidae) and *Carcharhinus longimanus*, as well as measures prohibiting capture and hooking of mobulid rays (Mobulidae) and intentional setting of nets around whale sharks, through permitting conditions (IOTC Secretariat 2021c). However, the report identified Madagascar as being only partially compliant with the requirements to report nominal catch, catch and effort, and size frequency data on sharks to IOTC, and on reporting of fishery interactions with whale sharks (IOTC Secretariat 2021c). Furthermore, industrial vessels legally able to circumvent the ban on removal of fins at sea, on the basis that shark fins must be detached from the carcass to preserve their quality. The fins are kept with the carcasses on board, but it is too time consuming for law-enforcement officers to confirm that the number of fins on board corresponds with the number of carcasses. This situation also allows for shark carcasses of low value to be discarded, whilst their fins are retained alongside the carcasses of higher-value sharks (Cripps et al. 2015). Since 2010, the IOTC's 'total allowable bycatch' has been 20% of total catch, but longline vessels regularly exceed this (Cripps et al. 2015).

Madagascar is also a Member of the Nairobi Convention and Indian Ocean Commission and acceded to the PSMA in 2017 (Table 5.2). While none of these instruments specifies management measures or commitments for chondrichthyan species, the Nairobi Convention does list species-specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future. The IOC does not impose management commitments on Members, but promotes regional cooperation among the WIO island States. The Nairobi Convention and PSMA, however, are binding on Member States, and Madagascar is thus obliged to implement the required management and enforcement measures defined in these agreements (see sections 5.4.4 and 5.3.5, respectively). Both instruments have the potential to facilitate improved chondrichthyan management and decreased IUU fishing of chondrichthyans in Madagascar. In addition, the Ramsar Convention entered into force in Madagascar in 1999, and there are currently 21 sites designated as Wetlands of International Importance (Ramsar 2021). Six of these are marine or coastal and cover important habitat for chondrichthyans. The Barren Islands, for example, represent an important area for several threatened chondrichthyan species.

Madagascar is also Party to UNCLOS and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments under UNCLOS and the UN General Assembly Resolution on sustainable fisheries, which both impose specific chondrichthyan measures on Parties, towards sustainable fisheries, such as reduced chondrichthyan mortality and strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). Furthermore, as a Member of the FAO since 1961, Madagascar is also encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, many of which present specific chondrichthyan measures (see section 5.3).

6.3.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Madagascar

Catch and trade of chondrichthyan products have taken place in Madagascar for at least a century (Petit 1930, Robinson and Sauer 2013), and still persist today (Barnes-Mauthe et al. 2013, Cripps et al. 2015, Humber et al. 2017, Temple et al. 2019, Baker-Médard and Faber 2020). However, Madagascar is among the poorest nations, with a very high dependence on small-scale fisheries, for food security and income, including chondrichthyan species, with small-scale fisheries accounting for the vast majority of Madagascar's annual fishery catch.

- There is extensive fishing pressure throughout Madagascar, and chondrichthyans are targeted or caught as bycatch in most fisheries.
- Chondrichthyans remain an important target in most fisheries in Madagascar, in certain areas, particularly for domestic meat consumption and for the global fin trade. There are many highly effective fishing gears in use for chondrichthyans in Madagascar, such as longlines and large-mesh "shark" gillnets. There is considerable bycatch even in shark-directed fisheries, including several threatened batoid species.
- One particularly lethal gear is weighted barrage nets – large-mesh benthic gillnets of several kilometers in length that are used to target wedgefishes and sharks (Cripps 2010).
- There are also high numbers of threatened chondrichthyans in the catches of many fisheries, as well as pregnant females and large proportions of juveniles, which are not sustainable (Cripps et al. 2015).
- Chondrichthyan species in Madagascar's waters are thus under high levels of threat, with 57% categorised as threatened, on the IUCN Red List.

- BRUV surveys have also reflected low abundances of chondrichthyans in coastal habitats in Madagascar, in comparison with some other WIO countries (MacNeil et al. 2020, WCS unpublished data).
- Considering this poor conservation status of Madagascar's chondrichthyans, the high marine diversity in Madagascar (including the high diversity of chondrichthyan species) and the high dependence of coastal communities on fishing, Madagascar should be seen as a key country in the WIO for chondrichthyan management and conservation.
- However, the effective management of chondrichthyan species in Madagascar is constrained by shortcomings in the national governance framework, limited knowledge of national chondrichthyan fisheries and trade, limited knowledge of the management actions needed, inadequate funding, inadequate political will and limited enforcement capacity (Blue Ventures 2015, Humber et al. 2015).
- Effective conservation of chondrichthyans in Madagascar is also constrained by the dependence of many thousands of fishers on catches of chondrichthyans or catches that include chondrichthyan species. Effective chondrichthyan management must consider the needs of the fishers.

Legislation

- Chondrichthyan species are poorly protected by current legislation, and local management associations and their supporting NGOs are powerless to work with communities to reduce chondrichthyan catches within the current legal framework (Humber et al. 2015).
- There is limited protection for chondrichthyans within industrial distant water fleets fishing in Madagascar's waters (Humber et al. 2015).
- There are few MPAs that are suited for chondrichthyans, or which span ecologically important areas for chondrichthyan species. The Antongil Bay shark sanctuary could provide refuge but there is evidence of the capture of chondrichthyan species within this sanctuary. Therefore, the sanctuary should be evaluated to determine its effectiveness for, and measures should be implemented to improve, the protection of shark and ray species.
- There are known exports of products from threatened chondrichthyan species, including CITES-listed species, yet the reporting of export information is inadequate. There have been some exports of CITES Appendix II species, yet no NDFs have been completed for chondrichthyans in Madagascar.
- Madagascar is signatory to numerous conservation agreements, and while some aspects are well implemented, the State falls short in the implementation of many others, e.g., IOTC reporting standards.

Enforcement and monitoring

There is extensive IUU fishing in Madagascar, with inadequate capacity for effective enforcement or MCS. Many fishing areas are remote and difficult to reach; fishers are highly mobile and may be difficult to locate by monitoring teams; sharks can be landed on islands or may even be traded at sea, meaning that in some cases only the meat is landed as the fins can change hands prior to landing; and Madagascar's coastline is extensive, whilst human resources and transport options are limited. There is also a complicated chain of buyers and middlemen, which can make chondrichthyan products difficult to track.

Knowledge

- There is limited ecological information on chondrichthyans in Madagascar, such as the locations of important areas for breeding, or nurseries, and there remain several queries relating to taxonomy and species present in Madagascar's waters. There are also many Data Deficient chondrichthyan species in Madagascar (including four chondrichthyan species endemic to Madagascar), and several threatened species for which there are biological or ecological data gaps. However, constraints to enhancing knowledge of chondrichthyans in Madagascar include funding and logistics (Blue Ventures 2015).

- There is limited species-level catch data on chondrichthyans, in certain fisheries, which complicates management. This is particularly the case with foreign vessels that fish in Madagascar's waters, which do not land their catch in Madagascar, and for IUU and unlicensed vessels for which limited information is available on actual catches.
- Despite being one of the greatest contributors to total WIO shark catches, there remains poor reporting of catch data to national and regional authorities, and in some cases it seems the catch data reported to FAO comprise estimated catch volumes as opposed to actual catch volumes.
- There are also clear discrepancies in trade data, with Madagascar's chondrichthyan export volumes largely underestimated, in comparison with import volumes into other countries, originating in Madagascar.

Required and recommended actions

Governance, policy, legislation, enforcement and capacity needs

- The protection and/or management of chondrichthyan species should be specified in fishery laws or implementing texts (Humber et al. 2015; pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017).
- All chondrichthyan species requiring protection through a binding agreement (such as CMS or IOTC) should be protected, and those in need of protection by virtue of their conservation status should be considered for protection, at least in certain fisheries (see section 6.3.7 and Table 6.3.4 on priority chondrichthyan species for protection in Madagascar).
- Legislation should be clearly understood and supported by all stakeholders, and developed in consultation with all stakeholders, including local fishing communities, and must be published and shared nationally, regionally within Madagascar and locally (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017).
- The NPOA-Sharks should provide a useful framework for the management and conservation of Madagascar's chondrichthyans, once approved and implemented.
- The high level of dependence of fishers on chondrichthyan catches needs to be considered in any decision-making for chondrichthyans in Madagascar, so that appropriate measures can be implemented without negatively impacting the rights of coastal communities and their economic and cultural needs.
- Given the limited capacity for monitoring and enforcement of legislation, efforts should focus on development and use of the *Dina,* increasing coverage of LMMAs, awareness campaigns, and engagement of the private sector.
- Most fishing communities no longer take GELOSE into account because of the country's economic and political state, and poor work conditions for many young people who become fishers. The decree laying down the GELOSE Law should thus be updated (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017).
- The Madagascar government should support the establishment of further MPAs/LMMAs and shark sanctuaries, like that in Antongil Bay, in ecologically important areas for chondrichthyans, such as nursery, breeding or aggregation areas (pers. comm., Clay Obota, CORDIO East Africa, June 2017). These should be established in consultation with local fishing communities, in a manner that considers the needs and ensures the support of local communities.
- It is important that future fishing access agreements clearly define target species, recognizing that sharks are not 'bycatch' but a valuable target species, and include strict regulatory limits on their take and strict enforcement on those limits (Cripps et al. 2015).
- 100% observer coverage of industrial vessels that catch sharks, whether as target or incidental catch, would provide data required for monitoring incidental catch and for stock assessment (Cripps et al. 2015).
- Given the considerable challenges facing fisheries MCS in Madagascar, legislation focusing on trade is likely to be more effective than means such as limits on fishing effort (Cripps et al. 2015). Trade data may be the best way to assess exploitation levels if authorities record chondrichthyan exports under separate customs codes, including accurate weights, quantities and sizes of dried,

frozen, processed and unprocessed fins (Cripps et al. 2015).

- The main constraint to the implementation of CITES and other international trade controls for chondrichthyans in Madagascar is the lack of monitoring of the species from which fins are sourced (Blue Ventures 2015). Requiring all chondrichthyans to be landed with their fins attached should help with this identification.

Humber et al. (2015) recommended the following:

- All CITES- and CMS-listed chondrichthyans should be protected in Madagascar (where appropriate);
- Malagasy authorities should consider export quotas (which may include zero quotas) for certain chondrichthyan species;
- National implementing texts for the CMS and the Nairobi Convention should be set up and adopted to provide further protection to the species;
- A specific action should aim to clarify CITES procedures; and
- Understanding the drivers of international trade may help to identify weaknesses in enforcement.

Data collection and research priorities

Priority needs for improved management and conservation of Madagascar's chondrichthyans include the creation of a program to monitor trade in chondrichthyan commodities, the creation of a national fisheries monitoring program which includes chondrichthyans, training for government fisheries and conservation staff, and general research on chondrichthyans (Blue Ventures 2015). Monitoring of artisanal landings should be expanded, through co-management structures (pers. comm., Clay Obota, CORDIO East Africa, June 2017).

This should include research to estimate abundance levels and collect data that can inform management decisions (Cripps et al. 2015). The collection of ecological and biological data should also be a priority – see section 6.3.2 for research and species priorities.

Awareness raising

Awareness-raising should occur with stakeholders at local and national levels on the poor conservation status of chondrichthyans, and their vulnerable biological and ecological characteristics, in order for appropriate legislation to be put in place and understood by all (pers. comm., Aly Bachiry Adouhouri, CNRO, May 2017). While knowledge of the poor conservation status may not result in changes in fisher behaviour, a better understanding of the ecological roles of chondrichthyan species in maintaining healthy ecosystems may encourage fishers towards more sustainable fishing practices.

6.3.7 Priority chondrichthyan species for protection

There are ten chondrichthyan species either confirmed or reported from Madagascar's waters that are listed on CMS Appendix I and, as a signatory to CMS, Madagascar is obliged to declare national level protection for these species (Table 6.3.4). There are also 11 species of chondrichthyans in Madagascar that require, through several IOTC resolutions, retention bans in the tuna-associated fisheries under IOTC management, eight of which are also listed on CMS Appendix I (Table 6.3.4). The IOTC prohibited species include all thresher sharks (Alopiidae) and all mobulid rays (Mobulidae), as well as oceanic whitetip sharks and whale sharks, and apparently all of these species are banned from retention in tuna fisheries in Madagascar (IOTC Secretariat 2021c). However, few chondrichthyan species are currently fully protected in Madagascar, and in order to adhere to the binding commitments to CMS, Madagascar should prohibit the capture of all CMS Appendix I species.

There are six Critically Endangered and 16 Endangered chondrichthyan species in Madagascar, other than those listed in CMS Appendix I or prohibited by IOTC resolutions, which should be considered for protection (at least from commercial harvesting and trade) by virtue of their poor conservation status. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (i.e., including Critically Endangered) species should not be harvested (UNEP 1985, FAO 1995); therefore, as a Member State of both Organizations, Madagascar should implement the precautionary principle and prohibit the taking of Endangered and Critically Endangered species (Table 6.3.4).

Table 6.3.4. Chondrichthyan species confirmed or reported (*not confirmed) from the waters of Madagascar, for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Species already fully protected at national level are shaded in green, while those under some level of regulation (such as permit conditions in certain fisheries) at national level are shaded in blue (see National legislation section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). (Species in bold = WIO endemic). Critically Endangered and Endangered species for which prohibition is recommended are also presented.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN RL	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus *	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula alfredi*	Reef manta ray	I, II	Yes	II	VU	CMS I; IOTC
	Mobula birostris	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula eregoodoo *	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula thurstoni	Bentfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Pristis pristis*	Largetooth sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Critically Endangered and Endangered species for which prohibition is recommended							
Ginglymostomatidae	***Pseudoginglymostoma brevicaudatum***	**Shorttail nurse shark**				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
	Rhynchobatus australiae	Bottlenose wedgefish	II		II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey reef shark				EN	EN
	Carcharhinus obscurus	Dusky shark	II			EN	EN
	Carcharhinus plumbeus	Sandbar shark				EN	EN
	Negaprion acutidens	Sicklefin lemon shark				EN	EN
Centrophoridae	*Centrophorus granulosus*	Gulper shark				EN	EN
	Centrophorus lesliei	African gulper shark				EN	EN
	Centrophorus uyato	Little gulper shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Oxynotidae	*Oxynotus centrina*	Angular rough shark				EN	EN
Pentanchidae	***Holohalaelurus punctatus***	**African spotted catshark**				EN	EN
Rajidae	*Rostroraja alba*	Spearnose skate				EN	EN
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray				EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN
Triakidae	*Mustelus manazo* *	Starspotted smoothhound				EN	EN

6.4 Republic of Mauritius

6.4.1 Introduction

The Republic of Mauritius (hereinafter Mauritius) is an island nation of volcanic origin, situated 800 km east of Madagascar (Figure 6.4.1), with an EEZ of about 2.3 million km^2 (see Figure 2.2 in Chapter 2). Another 400,000 km^2 is co-managed with the Seychelles after the two countries made a joint submission to the United Nations in 2011 (Leckraz 2021).

Mauritius comprises the islands of Mauritius, Rodrigues, and the outer islands of Agalega, St. Brandon (also known as the Cargados Carajos shoals), the Chagos Archipelago including Diego Garcia, and Tromelin (Republic of Mauritius 1968, 2013). The latter two are currently occupied by the United Kingdom and France, respectively. St. Brandon is uninhabited and mostly used as a fishing base. Mauritius and Rodrigues, together with French Department La Réunion, form the Mascarene Islands.

The island of Mauritius is surrounded by the world's third largest coral reef, and many of the 49 surrounding uninhabited islets are nature reserves, while 18 islets are located inside the lagoon of Rodrigues (Leckraz 2021). The island is part of a biodiversity hotspot that has recently been identified as a priority location for marine conservation due to its high species richness and relatively low levels of human impact (Myers et al. 2000, Selig et al. 2014).

The population of Mauritius is approximately 1.3 million (Leckraz 2021). Annual fish consumption in Mauritius in 2016 was estimated at 23 kg per person (FAO 2019), with fish comprising over 20% of total animal protein for the population (Kimani et al. 2019). In 2017, capture fisheries produced approximately 25,000 t, and fisheries employed approximately 29,000 people (2.2% of the population).

Mauritian fisheries comprise industrial (national and foreign), semi-industrial, small-scale commercial, artisanal and recreational fisheries (van der Elst and Everett 2015). Inshore fisheries of Mauritius and Rodrigues have long been a key source of income and food security for local communities (Boistol et al. 2011). Mauritius is an important transhipment base for tuna fisheries, and thus for sharks (Mamode 2011), and has developed into an important seafood hub and fishing business centre in the WIO (FAO 2019).

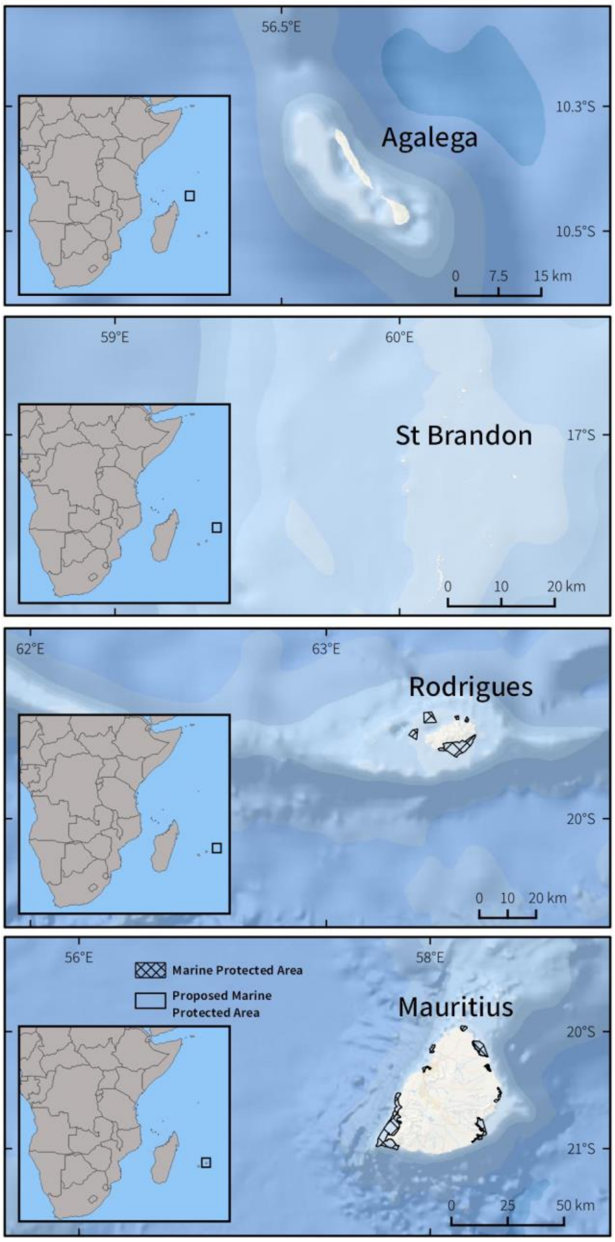


Figure 6.4.1: Map of The Republic of Mauritius and its islands, showing its position in the Western Indian Ocean.

6.4.2 Chondrichthyan biodiversity and status of knowledge, Mauritius

Biodiversity

Mauritius, excluding Chagos Archipelago and Tromelin, has the fourth lowest chondrichthyan species richness in the WIO, with 56 chondrichthyan species documented to date, comprising 42 shark and 14 batoid species (Table 3.1), representing 18 and 7 families, respectively, and an additional 5 shark and 6 batoid species that possibly occur there, but have not been confirmed (Table 3.3). No chimaera species have been recorded in Mauritius.

Requiem sharks (Carcharhinidae) represent the most species rich shark family, with 17 species. All other shark families in Mauritius comprise three or fewer species. Dasyatidae (whiptail stingrays) is the most species rich batoid family, with five species, while all other batoid families comprise two or fewer species.

No chondrichthyan species are endemic to Mauritius, although Kaja's sixgill sawshark *Pliotrema kajae* is known only from Mauritius and Madagascar (Weigmann et al. 2020). This is also the only regionally endemic species that occurs in Mauritius (Table 3.3). Of the 26 chondrichthyan species described from the WIO since 2011, only three are known from Mauritius, including *P. kajae,* Human's whaler shark *Carcharhinus humani* and the bluespotted maskray *Neotrygon caeruleopunctata* (Table 3.3).

Blue sharks *Prionace glauca* and shortfin mako sharks *Isurus oxyrinchus* are the most commonly-caught species in pelagic longline fisheries (Mamode 2011). Great white sharks *Carcharodon carcharias* have also been recorded in Mauritius (Cliff et al. 2000).

There is uncertainty as to the presence of sawfish in Mauritius. While largetooth *Pristis pristis* and green *P. zijsron* sawfishes have been reported from Mauritius (Fricke 1999, Government of Mauritius 2015), these records are unconfirmed and may have been traded from Madagascar (Pierce 2014, Dulvy et al. 2016).

Status of biological and ecological knowledge

Although there have been very few studies focusing specifically on chondrichthyans in Mauritius, research on this group in the Republic dates back to at least the 1970s. A shark survey conducted at St. Brandon in 1970 recorded 10 shark species (Bass 1970). Fricke (1999) listed 42 shark and 16 batoid species as occurring in Mauritius, and Heemstra et al. (2004) listed four shark and one batoid species as occurring in Rodrigues. An assessment of bycatch in Mauritian artisanal fisheries recorded 11 shark and four batoid species (Kiszka 2012) while a separate study of the same fishery yielded 10 shark and one batoid species in the fisher's catches (Poonian 2015).

Historically there were aggregation sites for grey reef sharks *Carcharhinus amblyrhynchos* and whitetip reef sharks *Triaenodon obesus* in the north of Mauritius (Kiszka et al. 2009; personal observation by author DvB). Whether these aggregations persist is uncertain.

There have been no genetic studies on chondrichthyans from Mauritius, although a study investigating the global population structure of bull sharks *Carcharhinus leucas* revealed genetic differentiation between sharks from the Western Atlantic and those from the Western Pacific and Western Indian oceans, with no evidence of contemporary gene flow (Pirog et al. 2019c). However, genetic connectivity was high within the WIO, including among Madagascar, Mozambique, La Réunion, Rodrigues, Seychelles, South Africa and Zanzibar. The results suggest that gene flow occurs along coastlines and highlights the need for management of this species at the regional level.

Carcharhinus leucas breeds in deep channels off the south-east of Mauritius, and young-of-the-year of this species are present in the summer months (Government of Mauritius 2015), suggesting this area may be used as a nursery. Although there are very few records worldwide of whale shark *Rhincodon typus* neonates (Rowat and Brooks 2012), the only record of a whale shark neonate in the WIO came from an individual off the northern coast of Mauritius in 1993, which was found alive inside the stomach of a blue marlin *Makaira mazara* (Colman 1997). This suggests that whale sharks likely breed and/or give birth within the vicinity of Mauritius. There is no other information regarding chondrichthyan reproduction in Mauritius.

Knowledge gaps and research priorities

The lack of research focused on chondrichthyans in Mauritius has left numerous knowledge gaps for the majority of chondrichthyan species in the Mauritian EEZ. As such, there should be a focus on prioritizing research relating to chondrichthyans in Mauritius, particularly for threatened species. Of the 42 data-poor[75], threatened chondrichthyan species identified

[75] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

in Chapter 3, seven are present in Mauritius, comprising five batoid species (representing four families) and two shark species (from two families). All of the data gaps identified for these species should thus be prioritized for future research (as outlined in Table 3.7).

There are two data-poor, threatened species in the family Dasyatidae that occur in Mauritius, including the Endangered honeycomb stingray *Himantura uarnak* and Vulnerable blotched stingray *Taeniurops meyeni*. Litter size is known for both species, and breeding season, gestation period and migratory status are known for *H. uarnak*; however, all other aspects relating to movement and reproduction, as well as age at maturity, maximum age and female size at maturity remain poorly known for both species (Table 3.7).

The family Rhinidae is represented by two data-poor, Critically Endangered species in Mauritius, the bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae.* Other than litter size, which is known for both species, all other aspects of reproduction, all aspects of movement, and age at maturity and maximum age remain poorly understood for these two species.

The families Mobulidae and Myliobatidae are each represented in Mauritius by one data-poor, threatened species, comprising the Endangered sicklefin devil ray *Mobula tarapacana* and the Critically Endangered common eagle ray *Myliobatis aquila*, respectively. Other than litter size and migratory status, which is known for both species, and gestation period, which is known for *M. aquila*, all other aspects of movement and reproduction remain poorly known for these species, in addition to age at maturity and maximum age (Table 3.7).

The two data-poor, threatened shark species in Mauritius are the Endangered little gulper shark *Centrophorus uyato* (family Centrophoridae) and Vulnerable tawny nurse shark *Nebrius ferrugineus* (Ginglymostomatidae). Other than migratory status, which is known for *N. ferrugineus*, all other aspects of movement remain poorly known for these two species and should be prioritized for future research. Age at maturity and maximum age are unknown for both species, while in the reproduction categories reproductive periodicity and litter size are known for *C. uyato*, and breeding season is known for *N. ferrugineus*, but all other aspects for each species remain poorly known (Table 3.7).

Although not data-poor, there are three additional shark species which are Critically Endangered and occur in Mauritius, the oceanic whitetip shark *Carcharhinus longimanus*, scalloped hammerhead shark *Sphyrna lewini* and great hammerhead shark *S. mokarran*. All three species are caught in Mauritius; therefore, future research should prioritize these species, particularly areas important for reproduction.

There are also four Data Deficient (as defined by IUCN) chondrichthyan species in Mauritius (as defined by the IUCN category Data Deficient), comprising two shark and two batoid species (Table 3.3, Chapter 3). At least one of these is a deepwater species – *Pliotrema kajae*, and is therefore infrequently encountered, limiting available information, although this species was first described in 2020 (Weigmann et al. 2020) and thus is expected to have limited ecological knowledge. The remaining three species, Human's whaler shark *Carcharhinus humani*, the blackspotted electric ray *Torpedo fuscomaculata* and marbled electric ray *T. sinuspersici* have coastal distributions and are exposed to coastal fisheries, and therefore further research is needed to establish their conservation status to help inform their effective management.

6.4.3 Chondrichthyan fisheries, catch and trade

Fisheries

Fisheries in Mauritius include artisanal fisheries around Mauritius, Rodrigues, Agalega and St. Brandon islands, offshore semi-industrial fishing on the oceanic banks along the Mascarene Ridge stretching from St. Brandon to Saya de Malha and around the Chagos Archipelago, and foreign-flagged industrial purse seiners (Boistol et al. 2011).

Although chondrichthyans are rarely targeted around Mauritius, they are frequently taken as incidental catch in all sectors (Kiszka and van der Elst 2015). However, there are very little data available on species composition of incidental catch (Everett et al. 2017).

Artisanal fishery

Approximately 1,620 vessels were registered in the artisanal fishery in 2010, all 7- to 9-m boats targeting mainly shallow-water demersal species (Sweenarain 2011), and in 2018 there were approximately 1,900 registered artisanal fishers (Government of Mauritius 2018). These fishers generally sell their catches (Boistol et al. 2011), although there are some fishers who fish purely for subsistence, but they are not included in these numbers. Artisanal fishers operate in lagoon and non-lagoon areas using a range of gears including coastal seine nets, gillnets, harpoons, basket traps, and handlines (Kiszka 2012, Poonian 2015). Although elasmobranchs are caught incidentally in nets, there is also a targeted artisanal elasmobranch fishery in Mauritius using lines, and any elasmobranchs caught (targeted or incidentally) are generally retained for consumption or sale (Poonian 2015). The handline fishery also extends further offshore, targeting large pelagic fish under FADs and drifting handlines which are set up to 350 m deep (Kiszka 2012, Government of Mauritius 2015). A small-scale FAD fishery was developed to offset the depleted artisanal lagoon fish stocks, targeting mainly tuna around approximately 27 FADs (Kiszka and van der Elst 2015), however few sharks are taken incidentally in this fishery (Mamode 2011).

Recreational fishery

Given the popularity of Mauritius as a tourist destination, a recreational lagoon fishery and pelagic sport fishery have developed. Although billfish and tuna are targeted by sport fishers using trolling lines, shark species such as silvertip sharks *Carcharhinus albimarginatus, Carcharhinus leucas,* blacktip reef sharks *Carcharhinus melanopterus,* shortfin mako sharks *I. oxyrinchus* and smooth hammerhead sharks *Sphyrna zygaena* are sometimes caught (Boistol et al. 2011, Government of Mauritius 2015). Approximately 60 vessels are involved in the recreational big game fishery (Shung and Jhumun-Foolheea 2020).

Industrial and semi-industrial fisheries

The domestic semi-industrial fleet consists of longline and purse seine vessels. The Mauritian tuna fleet comprised 15 longliners in 2019, with 10 of them fishing outside the EEZ and the other five fishing inside the EEZ (Shung and Jhumun-Foolheea 2020). A single purse seiner was operational in 2013, while seven purse seiners were registered in 2014 (Government of Mauritius 2015), however as of 2019 there were only three Mauritian purse seiners, operating primarily outside the EEZ on the high seas, and within the EEZ of Seychelles (Shung and Jhumun-Foolheea 2020). The domestic industrial longline fleet comprises vessels less than 24 metres in length, while the purse seine vessels are approximately 90 m in length.

The large EEZ is also open to numerous Asian and European tuna fleets. Most foreign licences from 2006 to 2010 were issued to Taiwanese longliners (Mamode 2011). In 2013, 94 foreign longliners and 37 purse seiners were issued licences to fish for tuna and tuna-like species (Mamode et al. 2014). A Sustainable Fisheries Partnership Agreement with the European Union, valid until December 2021, permitted 38 purse seiners from Spain, France and Italy, and 45 surface longline vessels from Spain, France and Portugal to target tuna in the Mauritius EEZ (EU 2018).

There are also reports of illegal fishing operations in the Mauritian EEZ, as Sri Lankan vessels operating longlines and gillnets have been reported to target sharks illegally, notably on Hawkins Bank, West of Rodrigues (pers. comm., David Ardill, independent fisheries consultant, October 2021).

Fisheries monitoring and reporting

WIOFish reported 71% of Mauritian fisheries to have catch and effort monitoring in place – either through observers or through the required submission of catch returns (Everett et al. 2017). They reported 37% of fisheries have some biological monitoring: lengths, weights, stomach contents, sex ratios, reproductive state and otolith collection of the catches. However, no Mauritian fishery has been comprehensively studied and management-related research is considered a high priority for 73% of fisheries. Monitoring of the artisanal fishery is particularly limited (Boistol et al. 2011); however, under the Fisheries and Marine Resources Act of 2007, a record is meant to be kept of all fishing vessels (of all sizes) that fish in Mauritian waters, and any person wanting to fish commercially (artisanal or otherwise) is meant to apply for registration as a fisher (Republic of

Mauritius 2007). In addition, licensed Mauritian fishing vessels are supposed to land their catch only in Port Louis harbour or a designated fish landing station. On Mauritius Island, artisanal fishery landings have been monitored since 1946, but the estimates have fluctuated over time, mainly due to modifications in sampling and estimation methods. Since the mid-1990s, with the support of the FAO, a data collection system was established and the Mauritius Catch Assessment Survey (MAUCAS) was developed to monitor the artisanal fishery (pers. comm., Trishna Sooklall, AFRC, May 2017). Artisanal fishery catch and effort data are now collected by a team of enumerators that monitor 61 Fish Landing Stations around Mauritius, and records are kept regarding the daily catch statistics of the sport fishery (Government of Mauritius 2018). However, chondrichthyan catches specifically are recorded poorly, or not at all.

Although marine catches are reported to the IOTC and FAO, a catch reconstruction estimated the total marine catch (including estimates of the part-time artisanal and recreational catches that go unrecorded) to be 42% higher than the figures reported to the FAO (Boistol et al. 2011). Furthermore, fishery statistics in Mauritius generally list sharks and batoids as a group (sometimes they are not reported at all), with very limited catch data at species level (Government of Mauritius 2015). Therefore, no data are available for chondrichthyan stock assessments in Mauritius. As such, stock status assessments and management measures should be conducted and coordinated through relevant RFMOs, such as the IOTC (Government of Mauritius 2015).

Records of incidental chondrichthyan catch are available, through the WIOFish database, for only two fisheries in Mauritius – the semi-industrial longline fishery and the longline tuna fishery – and these are recorded only as 'Carcharhiniformes' (Everett et al. 2017). None of the fisheries reported to WIOFish recorded discarded chondrichthyans in their catches, implying that any chondrichthyans caught are landed. Although greater efforts to record catch composition to the species level are essential, and improved data collection and monitoring of shark fisheries in Mauritius have been highlighted as a priority in the Mauritian NPOA-Sharks (Government of Mauritius 2015), licensing conditions in the national fleet require that sharks caught (both retained and discarded catch) in the IOTC area of competence are to be reported to the IOTC (Shung and Jhumun-Foolheea 2020).

The biggest harbour in Mauritius, Port Louis, is a main transhipment hub for tuna and tuna-like species caught by longliners in the WIO (Beeharry et al. 2013, Government of Mauritius 2015). One of the conditions of licensed foreign vessels allowed to fish in Mauritian waters is that appropriately-filled logbooks must be submitted and these are subject to inspection by the Port State Control Unit (Beeharry et al. 2013). Vessels entering the port are inspected by Mauritian health, customs and fisheries officials, and shark carcasses and fins are weighed to ensure that shark catch complies with the 5% fin-to-carcass ratio. No shark landings take place in Mauritius, and over 95% of sharks that are transhipped through Mauritius have their fins attached (Government of Mauritius 2015).

Mauritius is known to operate a Flag of Convenience system (ITF 2021), although this practice has been linked to IUU fishing by some authors (EJF 2009). Mauritian-flagged vessels are subject to strict licence conditions which are drafted based on Mauritian legislation and IOTC resolutions, they are closely monitored using VMS, and they are required to land their catch in Mauritius where they are inspected by the Port State Control Unit officers (pers. comm., Trishna Sooklall, AFRC, May 2017). Patrols run by the Regional Plan for Fisheries Surveillance (PRSP) have recorded only minor infractions (e.g., exceeding the 5% fin-to-carcass ratio) by Mauritian-flagged vessels (pers. comm., David Ardill, independent fisheries consultant, May 2017).

Any import or export of fish and fish products into and out of Mauritius must be done with a permit issued by the Permanent Secretary.

Reported chondrichthyan catches

Very little data exist on chondrichthyans caught incidentally in artisanal fisheries, but through questionnaire surveys with four important artisanal fisheries (i.e., line fishing around FADs, bottom gillnetting, handlining and beach seining), Kiszka (2012) reported at least 15 species of chondrichthyan to be caught incidentally, including Indian eagle rays *Aetobatus ocellatus*, oceanic whitetip sharks *Carcharhinus longimanus,* tiger sharks *Galeocerdo* *cuvier,* shortfin mako sharks *Isurus oxyrinchus*, *Sphyrna lewini,* blotched stingrays *Taeniurops meyeni* and whitetip reef sharks *Triaenodon obesus*. In a separate study, which also conducted interviews with artisanal fishers around the island, 11 chondrichthyan species were reported by fishers, with blacktip sharks *Carcharhinus limbatus, G. cuvier,* hammerhead sharks (*Sphyrna* spp.) and *T. obesus* being the most frequently caught species (Poonian 2015). The Albion Fisheries Research Centre reported artisanal chondrichthyan landings in Mauritius in 2013 as 0.46 t, comprising only 0.8% of total fisheries landings by weight (Temple et al. 2019). Contrastingly, based off a crude extrapolation of chondrichthyan catch by artisanal fishers, Poonian (2015) reported that approximately 6,000 chondrichthyans (whole animals) are caught annually by artisanal fishers, a number that would equate to significantly greater total weight than the 0.46 t reported in 2013. Although interview surveys are anecdotal, the magnitude of this disparity between reported catch by artisanal fishers and official catch records suggests that official reports are significant underestimates (Temple et al. 2019).

In the domestic longline fleet, less than one tonne of shark was landed annually between 2011 and 2015, and it was thought that the nylon leader used in this fishery enables any hooked sharks to bite through the leader, which could explain the low shark bycatch in this fishery (Government of Mauritius 2015). However, between 2016–2018, and average of 5.18 t of shark was caught in this fishery inside the Mauritian EEZ, with a peak of 6.60 t in 2018, although shark catch declined to just 0.69 t in 2019 (Shung and Jhumun-Foolheea 2020). From 2013 to 2019, 71% of retained chondrichthyan catch by the Mauritian longline and purse seine fleet comprised *I. oxyrinchus* and 15% comprised blue sharks *Prionace glauca* (Shung and Jhumun-Foolheea 2020).

Incidental shark catch by licensed and unlicensed industrial and semi-industrial pelagic fishing vessels in 2013 (from logbooks and transhipment data) suggest that 2,624 t of shark were landed (Mamode et al. 2014). The majority were *P. glauca* (79%) and *I. oxyrinchus* (16.9%). In the same year, the catch of licensed foreign tuna longliners was reported to be 4.1% shark, whereas the landed catch for transhipment by non-licensed foreign longliners targeting swordfish was approximately 25.2% sharks (Mamode et al. 2014). In 2015, over 93% of *P. glauca* catch was transhipped, and the proportion of chondrichthyans landed by EU longliners (20.5%) was higher than that landed by non-EU foreign longliners (4.7%; pers. comm., Trishna Sooklall, AFRC, May 2017).

Chondrichthyans are generally not identified to species or even family level in reports to the FAO, but rather grouped as 'Sharks, rays, skates, etc. nei' and 'Rays, stingrays, mantas nei' (FAO 2021). From 2012 to 2019, the second lowest chondrichthyan catch of all Nairobi Convention Member States was landed in Mauritius, accounting for 0.03% of the total Nairobi Convention Member State chondrichthyan catch in all oceans and 0.06% in FAO Major Fishing Area 51. In this period, Mauritius reported an annual average of 11.4 t of domestic shark landings exclusively from FAO Major Fishing Area 51 (FAO 2021; Figure 6.4.2), all of which was classified as 'Sharks, rays, skates, etc. nei'. During this period, chondrichthyan catch reported for the majority of years was less than 10 t, with 2017 standing out as an unusual year with 48 t of chondrichthyans landed (Figure 6.4.2).

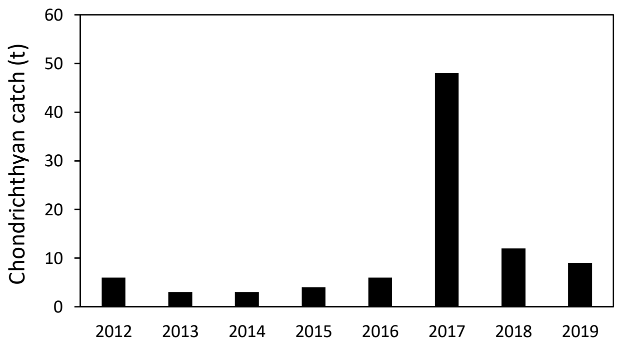


Figure 6.4.2: Total chondrichthyan catch by Mauritian-flagged vessels from FAO Major Fishing Area 51, as reported by Mauritius for the period 2012–2019 (FAO 2021).

The unreliable nature of national catch statistics indicates that these chondrichthyan catches are probably conservative, and the comparison of official chondrichthyan catch statistics with trade statistics highlights this potential underestimate (Table 6.4.1). However, the majority of this catch is landed by foreign-flagged vessels which use Mauritius as a port for transhipment, not by Mauritian-flagged vessels; the recorded chondrichthyan catch by Mauritian vessels ranged from 0.1–6.0 t per year from 2011 to 2015, compared to 63–534 t per year by foreign vessels, and 2,318–3,420 t of transhipments per year (pers. comm., Trishna Sooklall, AFRC, May 2017). Discard data provided by EU purse seiners fishing within the Mauritian EEZ in 2013 are not presented at species-level, however no sharks were reported as being landed, as any sharks caught were reportedly released (Government of Mauritius 2015).

Trade in chondrichthyan products and official chondrichthyan trade data

Mauritius reported imports averaging 36 t of total shark product per year from 2012 to 2019 (UN Comtrade 2021), with the majority being shark fin (94%; 2012–2014) and shark meat (86%; 2016–2019). However, many of these 'imports' are rather transhipments (pers. comm., David Ardill, independent fisheries consultant, May 2017), and/or landings by foreign fleets that land tuna for processing in Mauritius. Imports of shark products by Mauritius were reported from numerous countries including China, France, Indonesia, Japan, Spain and the Republic of Korea.

Mauritius reported limited export of chondrichthyan products from 2012 to 2019, averaging 51.57 t per year (Figure 6.4.3; Table 6.4.1). However, a number of countries reported imports of shark fin and meat from Mauritius during this period – on average 338.43 t per year (Figure 6.4.3; Table 6.4.1). There is a clear discrepancy between exports of chondrichthyan products from Mauritius and imports into other countries that originated in Mauritius (Figure 6.4.3; Table 6.4.1), which may be attributed to many of these 'imports' reflecting shark products in transit through Mauritius that were not caught in Mauritius but rather transhipped after capture outside of the EEZ. Furthermore, Mauritius reported shark fin exports of 143 t and 126 t, in 2012 and 2013, respectively, from Port Louis (Government of Mauritius 2015), which is substantially different to the values of 80.49 t and 179.20 t, respectively, reported for the same years through UN Comtrade (Table 6.4.1), further highlighting the discrepancies in reporting of chondrichthyan trade in Mauritius.

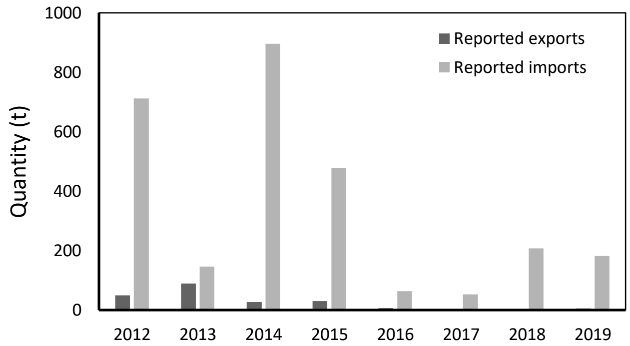


Figure 6.4.3: Reported exports of chondrichthyan products by Mauritius, and imports from Mauritius as reported by the World, 2012–2019 (UN Comtrade 2021).

Data sourced from the Hong Kong Census and Statistics Department (2021) indicate that shark fins were imported from Mauritius by Hong Kong during 2012–2014 (0.4 t in 2012, 1.3 t in 2013, and 2.1 t in 2014), and a once-off import of 0.2 t in 2018 (Table 6.4.1). The low levels of shark fin import by Hong Kong during this time reflect a change in importing countries, from mainly Asia in the years preceding 2007, to Portugal and Spain by 2012–2013 (Government of Mauritius 2015).

Table 6.4.1: Total catch and export of chondrichthyan products as reported by Mauritius, and reported imports of chondrichthyan products by other countries and by Hong Kong alone that originated in Mauritius (metric tonnes).

Year	Total Catch [a]	Exports from Mauritius - all codes [b]	Imports from Mauritius as reported by the world, all codes [b]	Shark fin imports by Hong Kong [c]
2012	6	99.80	712.25	0.4
2013	3	179.52	116.35	1.3
2014	3	52.83	895.30	2.1
2015	4	60.11	478.33	0
2016	6	12.55	63.01	0
2017	48	2.43	52.21	0
2018	12	0	207.92	0.2
2019	9	5.35	182.07	0
Total	**91**	**412.58**	**2,707.44**	**3.9**
Average	**11.4**	**51.57**	**338.43**	**0.5**

[a]FishStatJ (FAO 2021); [b]UN Comtrade (2021); [c]Hong Kong Bureau of Statistics (2021)

Trade in CITES-listed chondrichthyan species

According to CITES trade regulations, there are numerous steps which must be followed to ensure that any trade in CITES Appendix II-listed species is not detrimental to their populations in the wild (see Chapter 5 for details), including the requirement to report all exports of such species in the CITES trade database. However, the only recorded trade in CITES-listed chondrichthyan species from Mauritius during the last 10 years (i.e., since 2011) were two wild-sourced bodies of the CITES Appendix II-listed great hammerhead shark *Sphyrna mokarran*, exported to Germany for personal use in 2019[76], although no importer quantity was reported (i.e., by Germany). Furthermore, there is no evidence suggesting that non-detriment findings (NDF) have been concluded for any CITES-listed chondrichthyan species in Mauritius, in which case, trade in the above-mentioned *S. mokarran* products would be in breach of CITES trade controls.

CITES trade controls also require that transhipments, such as those in Mauritian ports, would require numerous export and import permits, if catches occurred outside of the EEZ. This would require introduction-from-the-sea permits for import into Mauritius from the high seas, and re-export permits from Mauritius. Considering that Mauritius is a hub for transhipments, the transhipment of chondrichthyan products would be expected. However, the CITES trade database indicates no such imports or exports relating to Mauritius for chondrichthyan products.

Furthermore, the fact that there are no records of any mako sharks (*Isurus* spp.) being exported from Mauritius since they were listed on CITES Appendix II in November 2019 suggests that either no mako sharks have been exported from Mauritius, or that exports have been in breach of CITES trade controls. Considering again that Mauritius is a hub for transhipments and that mako sharks are a major component of industrial and semi-industrial catch (Shung and Jhumun-Foolheea 2020), it seems highly likely that mako sharks would have been exported from Mauritius. This suggests that it is more likely that mako shark products have been exported, but not appropriately reported.

6.4.4 Conservation status

As a consequence of these high levels of legal and illegal fishing pressure, chondrichthyans in Mauritius are heavily overexploited, resulting in 32 (57%) of the 56 confirmed chondrichthyan species in Mauritius being threatened with extinction (IUCN 2021). These include 15 Vulnerable, 11 Endangered and 6 Critically Endangered species, according to the IUCN Red List of Threatened Species (IUCN 2021; Table 3.4).

Considering the high proportion of threatened chondrichthyan species in Mauritius, and that landings in Mauritian artisanal fisheries have declined between 2000 and 2013 (Temple et al. 2018), it is apparent that fisheries are having a major impact on their population in Mauritius, and improved conservation and management are urgently needed.

6.4.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (MoEMRFS) is responsible for fisheries management and research in Mauritius (Government of Mauritius 2018) (Table 6.4.2), which are governed by the Fisheries and Marine Resources Act of 2007, which in turn provides a policy framework for fisheries conservation and management (Republic of Mauritius 2007). The Albion Fisheries Research Centre (AFRC) is the technical arm of MoEMRFS. It houses the Marine Science and Conservation Division, Marine Resources Division, Aquaculture and Laboratory Divisions and Fisheries Monitoring Centre, and carries out applied research, development and management activities. The Fisheries Protection Service (FPS) is the enforcement arm of MoEMRFS, and responsible for enforcement of fishery regulations and MCS activities, in conjunction with the National Coast Guard. The Port State Control Unit is responsible for trade controls and enforcement of trade controls. The National Parks and Conservation Service (NPCS, within the Ministry of Agro-Industry and Food Security) is responsible for CITES provisions, as the CITES national management and scientific authorities,

[76] https://trade.cites.org

together with the Customs Department within the Mauritius Revenue Authority, and both are responsible for CITES enforcement (Table 6.4.2). Species conservation and environmental protection are the responsibility of NPCS and the Ministry of Environment and Sustainable Development, while coastal zone management and MPA management and enforcement are the responsibility of MoEMRFS.

Table 6.4.2: Designated national authorities for chondrichthyan management in Mauritius.

Area of management	Designated national authorities
Fisheries management and research	Albion Fisheries Research Centre (AFRC); and Fisheries Training and Extension Centre (FiTEC) (both within the Ministry of Ocean Economy, Marine Resources, Fisheries, and Shipping, MoEMRFS)
Export and import trade controls (including permitting)	National Parks and Conservation Service (NPCS) (within the Ministry of Agro-Industry and Food Security); Port State Control Unit (within the MoEMRFS, comprised of Competent Authority Seafood; Customs Department; Ministry of Health and Quality of Life; and Passport and Immigration)
Permitting of fisheries	MoEMRFS
Enforcement of fisheries legislation	Fisheries Protection Service (FPS, within MoEMRFS); National Coast Guard
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	NPCS; Port State Control Unit
Species conservation and environmental protection	NPCS; Ministry of Environment and Sustainable Development
Coastal zone management	MoEMRFS
MPA management and enforcement	MoEMRFS

National legislation and regulations

Fisheries within Mauritius are governed by the Fisheries and Marine Resources Act of 2007 (Republic of Mauritius 2007). The law includes restrictions on fishing gears, spatial closures and specific temporal restrictions during which some or all fishing activities are prohibited. Prohibited gears and methods in Mauritius include 'gunny bags, canvas or cloth, creeper, leaf or herb'; as well as lime or any poisonous substance, explosives, spear guns and drift nets. Underwater fishing (i.e., snorkelling or by scuba) is also not permitted, while baited gears, basket traps and any type of authorized net gear require the appropriate gear license. In addition, no person may have on board their vessel any tool that can be used to alter a gear type. FADs may not be used without authorisation, but the Fisheries Training and Extension Centre (FiTEC) deploys and maintains anchored FADs as part of its development activities.

There is also a prohibition on the import and use of small hooks, to prevent the capture of juvenile fish inside the lagoon areas. The fishing of "undersized" fish is prohibited, but there is no definition for this and no species are listed specifically in relation to this measure.

No national legislation exists specifically for the protection of chondrichthyan species in Mauritius and chondrichthyan species are not listed for protection in any general fishery legislation. However, there is a provision[77] within the Fisheries and Marine Resources Act (Republic of Mauritius 2007) that prohibits the landing, selling or possession of "fish taken in contravention of any international fishery conservation and management measure to which Mauritius is a Party". As a Party to CMS and to IOTC, this provision by definition renders illegal the capture of species prohibited by CMS (Appendix I) and prohibited in the IOTC resolutions; however, the somewhat indirect basis of such a prohibition, without a more direct and species-specific prohibited list, may render such a regulation open to interpretation and thus reduce its potential enforceability.

[77] Part IV, Article 17 (2): "No person shall land, sell or have in his possession any fish which he knows or has reasonable cause to believe has been taken in contravention of any international fishery conservation and management measure to which Mauritius is a party."

All fishers must be registered with the FPS, which limits the number of permits issued for specific gear types to be used around each island. Any foreign fishing vessel fishing in Mauritian waters must also be licensed by the Mauritian authorities. Permits are required for the import and export of fish products, and all transhipment of any fish or fish products must be done in a Mauritian fishing port.

Mauritius does not issue licenses to vessels targeting sharks, other than through a Sustainable Fisheries Partnership Agreement (SFPA) (EU Regulation 2018/76) with the EU (mainly for *Prionace glauca*), and the unloading of sharks caught incidentally by foreign licensed vessels is authorized subject to compliance with the 5% weight ratio of fins to carcasses onboard. Shark finning is banned in Mauritius.

The SPFA with the EU allows vessels from Italy, France, Portugal and Spain to fish in Mauritian waters (40 purse seiners and 45 longliners), in exchange for financial contributions to the development of the fisheries sector (EU 2018). This SFPA was due to expire in December 2021, although it is tacitly renewable for additional periods of three years.

Status of NPOA-sharks

Mauritius finalised its *National Plan of Action for the Conservation of Sharks (NPOA-Sharks, Mauritius)* in 2015 (Government of Mauritius 2015). The document focuses on actions needed to exercise influence on foreign fishing through the IOTC process and licence conditions, as well as improving the national legislation and the skills and data handling systems available for managing sharks. The document expands on the following key objectives:

- Decrease fishing effort in any fishery where shark catch is unsustainable;
- Improve data collection and monitoring of shark fisheries;
- Train all concerned in identification of shark species;
- Facilitate and encourage research on sharks;
- Improve the utilization of sharks caught; and
- Ascertain control over access of fishing vessels exploiting shark stocks.

The Mauritius NPOA-Sharks was finalized in 2015 and submitted to the IOTC Secretariat; however, the extent to which the NPOA has been implemented in Mauritius remains unclear.

Marine protected areas

There are several laws in Mauritius that govern marine conservation: the Environmental Protection Act of 2002 which provides for environmental protection and management; the Maritime Zones Act of 2005 which provides the legal framework for the conservation and protection of the marine environment and prevention and control of marine pollution; and the Fisheries and Marine Resources Act of 2007 which provides for the declaration and management of marine protected areas (MPAs; Leckraz 2021). Under the Fisheries and Marine Resources Act, the Minister may designate an MPA as a Fishing Reserve, a Marine Park or a Marine Reserve.

Six Fishing Reserves were established in Mauritius in 1983, comprising one Reserve for each coastal district to protect and conserve fisheries resources in key areas of high biodiversity across the island, while five Fishing Reserves were established around Rodrigues in 1984 (Leckraz 2021). To ensure that fisheries resources and critical habitats are protected, only sustainable fishing gears are permitted in Fishing Reserves, specifically basket traps and line fishing gear (Leckraz 2021). Marine Parks in Mauritius are multiple use areas, with controlled recreation and limited extraction in certain zones, with the aim of providing some degree of conservation, education and research. Marine Reserves provide the highest degree of protection, with extractive activities not being permitted without written authorization by the relevant authorities. Overall, eight MPAs have been designated in Mauritius and ten in Rodrigues, however their total area of coverage is only ~139 km^2, which represents only 0.006% of the vast EEZ of Mauritius (~2.3 million km^2) (Leckraz 2021). Furthermore, the only no-take Marine Reserves are located around Rodrigues.

Although MPAs in Mauritius cover a wide variety of habitats which are suitable for various chondrichthyan species, including mangrove forests in the Blue Bay Marine Park, the majority of these MPAs are less than 10 km^2, and the largest MPA (the South East MPA in

Rodrigues) covers an area of 43 km^2 from the shoreline to the 20-m isobath (Leckraz 2021). Furthermore, none of these MPAs was established specifically for the protection of chondrichthyan species. As such, unless certain species are highly resident within the few no-take Marine Reserves, MPAs in Mauritius do not currently afford chondrichthyans much protection from fisheries or other threats.

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Mauritius is signatory to several MEAs and RFBs (see Table 5.2). Mauritius ratified CMS in 2004, for which the NPCS is the designated competent authority. There are five chondrichthyan species listed on Appendix I and 13 listed on Appendix II of CMS (eight of which are listed on Appendices I and II), which are known to occur in the Mauritius EEZ (Table 3.3, Chapter 3). Mauritius is thus obliged to protect the five species listed on Appendix I, and to implement the CMS concerted actions for whale sharks and mobula rays (see section 5.2.1); however, no chondrichthyan species are specifically protected in Mauritius. In this instance, Article 17 (2) of the Fisheries and Marine Resources Act (Republic of Mauritius 2007), prohibiting the taking of fish in contravention of any international fishery conservation and management measure to which Mauritius is a Party, is assumed to apply, in which case Mauritius indirectly protects CMS Appendix I species present in Mauritian waters.

As a Party State to CMS, Mauritius is also obliged to conserve or restore the habitats occupied by CMS Appendix I species, mitigate obstacles to migration and control other factors that might endanger them. Many of the CMS Appendix II species are shared with other Nairobi Convention Member States; therefore, Mauritius should participate in the development of regional management plans, where appropriate, for these species (Table 5.1). Mauritius is not signatory to the CMS Sharks MOU (Table 5.2); however, it is a Range State to many of the species listed in Annex I of the MOU (Table 5.1), and should therefore consider joining the Sharks MOU, to improve regional management of these species.

CITES was ratified by Mauritius in 1975 and the provisions have been integrated into national legislation, which is generally believed to meet the requirements for implementation of CITES (CITES 2016, 2021). Thirteen chondrichthyan species known from Mauritius are listed on CITES Appendix II (no CITES Appendix I chondrichthyan species are known from Mauritius; Table 3.3, Chapter 3), for which CITES trade controls should be implemented. However, despite trade in chondrichthyan products, including imports, exports and trade that meets the definition of "imports from the sea" (as defined by CITES), no non-detriment findings (NDF) or stock assessments have been concluded and no data are currently being collected to ensure that export of CITES-listed chondrichthyan species is not detrimental to the survival of the species in the wild. This suggests that trade does not involve CITES-listed chondrichthyan species, or that some trade is in breach of CITES trade regulations. Considering that Mauritius in a hub for transhipment, that large quantities of shark fins have been traded into, out of and through Mauritius, particularly originating from foreign industrial vessels (the chondrichthyan catches of which are predominantly CITES-listed species), it is likely that at least a proportion of the international trade is CITES-listed chondrichthyan species.

Mauritius is a member of three relevant RFBs: SWIOFC, SIOFA, and IOTC. The State should therefore work with SWIOFC, and is bound by the commitments under SIOFA, which include *inter alia* a prohibition on the use of gillnets, as well as several measures specific to deep-sea chondrichthyan species, such as research on and setting of bycatch limits for these species, and prohibiting targeting of the deep-sea chondrichthyans listed in Annex I of SIOFA's Sharks CMM (SIOFA 2019, see section 5.4.2). There are just five chondrichthyan species in Mauritius that are prohibited in tuna fisheries, through IOTC resolutions (Table 3.3). Mamode et al. (2014) detailed the steps that have been taken to implement the Scientific Committee recommendations and resolutions of the IOTC. Masters of the Mauritius-flagged vessels have been sensitised on the need to comply with IOTC resolution 13/05 on the conservation of whale sharks, and there are no reports of any encounters with this species. The 2021 IOTC compliance report for Mauritius indicates that measures have been taken through permitting conditions, which prohibit the use of large-scale drift nets, shark finning, the capture of thresher sharks and oceanic whitetip sharks *Carcharhinus longimanus*, the capture and hooking of mobula rays and intentional setting of nets around whale sharks (IOTC Secretariat 2021d).

Mauritius is also a Member of the Nairobi Convention and one of the five Member States of the Indian Ocean Commission (IOC) and acceded to the PSMA in 2015 (Table 5.2). While none of these instruments specifies management measures for chondrichthyan species, the Nairobi Convention does list specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future. The IOC does not impose management commitments on Members, but promotes regional cooperation among the WIO island States. The Nairobi Convention and PSMA, however, are binding on Member States, and Mauritius is thus obliged to implement the required management and enforcement measures defined in these agreements (see sections 5.4.4 and 5.3.5, respectively). Both instruments have the potential to facilitate improved chondrichthyan management and decreased IUU fishing of chondrichthyans in Mauritius. In addition, the Ramsar Convention entered into force in Mauritius in 2001, and there are currently three sites designated as Wetlands of International Importance, two of which are coastal, and one of which (Blue Bay Marine Park) has mangrove forest that could be providing important habitat for chondrichthyans.

Mauritius is also Party to UNCLOS and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments under UNCLOS and the UN General Assembly Resolution on sustainable fisheries, which both impose specific chondrichthyan measures on Parties, towards sustainable fisheries, such as reduced chondrichthyan mortality, strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). The latter obliges the State to implement its NPOA-Sharks. Mauritius is also signatory to the UN Fish Stocks Agreement, which imposes strong commitments on Parties, for sustainable fisheries. Furthermore, as a Member of the FAO since 1961, Mauritius is encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, several of which present specific measures for chondrichthyans (see section 5.3).

6.4.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Mauritius

In Mauritius, like most other countries, fisheries are the main threat facing chondrichthyans, with the capture of sharks around the island dating back to at least the 1950s (Boistol et al. 2011). Although all shark catches reported to the IOTC from Mauritius were recorded as bycatch, artisanal fishers are known to target chondrichthyans, and their bycatch is generally retained (Poonian 2015). Some shark products are sold locally, including fins to Chinese restaurants on the island, to be used for shark fin soup, and in traditional medicines by the Mauritian-Chinese community to treat renal illness (Mahomoodally and Muthoorah 2014, Mootoosamy and Fawzi Mahomoodally 2014, Poonian 2015). Mauritius is a hub for transhipment of shark species, with the main species landed being *Prionace glauca* and *Isurus oxyrinchus* (Mamode 2011, Kiszka and van der Elst 2015, Shung and Jhumun-Foolheea 2020), the latter now Endangered and listed on CITES Appendix II.

Around Rodrigues, local fishers state that sharks are rarely encountered, suggesting that fisheries have depleted chondrichthyan populations in the area (Heemstra et al. 2004). Off Mauritius, the absence of chondrichthyan species in the inshore areas is attributed to net fishing, leading to chondrichthyan population declines (Government of Mauritius 2015). Specific threats to chondrichthyans are listed in the sections that follow.

Governance

- No national legislation exists specifically for chondrichthyan species in Mauritius.
- Although there is a prohibition on fishing undersized fish species, the term undersized is not defined, and there is no clear application of this regulation to any specific species.
- The Mauritius NPOA-Sharks was finalized in 2015 and submitted to the IOTC Secretariat, but the extent to which it has been implemented remains unclear and the recommended timeframe for review of the NPOA-Sharks is every four years, rendering the existing time frame outdated and due for review.

- None of the MPAs in Mauritius was established specifically for the protection of chondrichthyans, there are no no-take MPAs on Mauritius island, and existing MPAs are small and thus likely offer minimal protection to chondrichthyan species.

Fisheries and monitoring

- Owing to overexploitation, 31 (56%) of the 55 confirmed chondrichthyan species in Mauritius are threatened with extinction (IUCN 2021).
- No Mauritian fishery has been comprehensively studied, and monitoring of the artisanal fishery is particularly limited.
- Only 37% of fisheries in Mauritius are reported to have some biological monitoring (i.e., one or more of length, weight, stomach content, sex ratios, reproductive state).
- Chondrichthyan catches are generally not identified to species or family level in reports to the FAO, but rather grouped as 'Sharks, rays, skates, etc. nei' and 'Rays, stingrays, mantas nei'.
- Chondrichthyans are frequently taken in all sectors as incidental catch, including the small-scale FAD fishery (Mamode 2011), but minimal data are available on species composition of incidental catch.
- Incidental chondrichthyan catch data are available only for the semi-industrial longline fishery and the longline tuna fishery, yet these are recorded only as 'Carcharhiniformes'.
- None of the fisheries that report data to WIOFish reported discarded chondrichthyan species.
- Total marine catch (including part-time artisanal and recreational catches that go unrecorded) is estimated to be 42% higher than the figure reported to the FAO (Boistol et al. 2011).
- No population or stock assessments have been conducted on chondrichthyans in Mauritius.
- There is a targeted artisanal chondrichthyan fishery, and any chondrichthyans caught (targeted or incidentally) are generally retained for local consumption or sale (Poonian 2015).
- Artisanal fishers catch Critically Endangered sharks and batoids, including *Carcharhinus longimanus*, *Sphyrna lewini* and *Rhynchobatus djiddensis* (Poonian 2015) (the latter more likely to be the bottlenose wedgefish *R. australiae*).
- It is uncertain whether known aggregations of whitetip reef sharks *Triaenodon obesus* persist, or whether these aggregations have been reduced or eliminated as a result of fishing pressure.
- Significant disparities between catches reported by fishers and official catch records suggest official reports are considerably underestimated (Temple et al. 2019).
- The higher proportion of chondrichthyans reported in total landings by EU longliners (20.5%) than non-EU foreign longliners (4.7%) suggests underreporting of chondrichthyan catches by the latter.
- Sharks are landed as dressed carcasses, which is a key obstacle to reporting size-frequency to the IOTC, and to accurate species identification.

Trade

- Mauritius is a transhipment hub for the WIO, with considerable chondrichthyan import and export, but adherence to CITES trade controls is poor.
- Discrepancies exist between chondrichthyan exports reported by Mauritius and imports from Mauritius reported by other countries.

Information

- Historically there has been limited research on chondrichthyans in Mauritius, and there remains limited biological and ecological information to inform their management at national level.

Required and recommended actions

Governance, policy, legislation, enforcement and capacity needs

- Fishing effort should be decreased, where chondrichthyan catch is unsustainable.
- Chondrichthyan-specific rules and regulations should be legislated, including full protection or minimum legal catch sizes for threatened species.
- Species requiring full protection in Mauritius, including CMS Appendix I species and any others that require protection, should be listed in a prohibited species list, rather than indirectly in the Fisheries Act, for easier recognition and improved adherence with such measures.

- The laws and regulations needed to meet IOTC resolutions should be promulgated.
- The NPOA-Sharks should be reviewed, and the revised recommendations and workplan should be implemented.
- “Large nets” in the coastal fishery should be phased out.
- MPAs in Mauritius should be managed to consider chondrichthyan conservation goals. This needs to be assessed and incorporated into the development of new MPAs. The potential protective benefits of existing MPAs should be assessed, to identify how their contribution to chondrichthyan conservation could be improved.
- Data collectors, and fisheries/customs inspectors should be trained to identify chondrichthyan species, and dentification guides must be available to enable species-level data collection.
- Observer coverage (including automated electronic monitoring) should be expanded to greater proportions (or all) industrial fishing vessels that catch chondrichthyan species, whether as target or incidental catch.
- Adherence with the conservation measures of the MEAs to which Mauritius is signatory, such as CMS, CITES and IOTC, must be improved, and the binding provisions regarding chondrichthyans must be incorporated into the management and conservation of chondrichthyan stocks.
- NDFs must be concluded for all CITES Appendix II chondrichthyan species that are exported from Mauritius, to determine whether such species can be traded and fished for export without detrimental impacts to wild populations.

Data collection and research priorities

- Research on chondrichthyans should be facilitated and encouraged. Research priorities for chondrichthyans include movement behaviour, including migratory patterns, temporal movement patterns, fine-scale movements, habitat use and identification of critical chondrichthyan habitats (e.g., mating areas, breeding grounds, parturition/pupping grounds, nursery areas, aggregation sites and migration corridors); genetic connectivity studies; and aspects of age and growth (in particular age at maturity and maximum age).
- Stock assessments should be conducted for all chondrichthyan species caught in fisheries.
- Management-related research is considered a high priority for most of Mauritius’ fisheries.
- Greater efforts to record catch composition to species level are essential, including discards.
- Improved data collection and monitoring of chondrichthyan fisheries in Mauritius have been highlighted as a priority in the Mauritian NPOA-Sharks, and therefore long-term, species-level catch monitoring should be implemented (or improved) across all fisheries sectors in Mauritius. The use of a data collection mobile phone application, such as those currently being used to monitor artisanal fisheries in other WIO countries, could be implemented in Mauritius with minimal effort.
- An integrated database system to record Mauritian fisheries statistics and verify and integrate historical records should be developed.

6.4.7 Priority chondrichthyan species for protection

There are five chondrichthyan species either confirmed or reported from Mauritian waters that are listed on CMS Appendix I and a further four that have not been confirmed but are suspected to be present (Table 6.4.3). As a signatory State to CMS, these species should be fully protected in Mauritius. No chondrichthyan species are currently protected in Mauritius, although the Fisheries and Marine Resources Act (Republic of Mauritius 2007), prohibits the taking of fish in contravention of any international fishery conservation and management measure to which Mauritius is a Party; this implies that CMS Appendix I species present in Mauritian waters are prohibited from capture. However, an indirect prohibition such as this is likely to result in limited, if any, awareness thereof or compliance. There are also five confirmed species and four species suspected in Mauritius that are required to be prohibited in certain fisheries through IOTC resolutions (six of which are also listed on CMS Appendix I), including thresher sharks, oceanic whitetip sharks, whale sharks and mobulid rays (Table 6.4.3). As a signatory State to IOTC, retention of these species in the relevant fisheries under IOTC management should be prohibited in Mauritius (see section 5.2.2 for details).

All nine of these IOTC-listed species are reportedly restricted or prohibited in relevant Mauritian fisheries, through permit conditions (IOTC Secretariat 2021d), although CMS Appendix I species are not specifically prohibited.

There are also four (possibly five) Critically Endangered and eight Endangered chondrichthyan species in Mauritius, other than those listed in CMS Appendix I or prohibited by IOTC resolutions, which should be prohibited (at least from commercial harvesting and trade) by virtue of their poor conservation status. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (the assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1995); therefore, as a Member State of both instruments, Mauritius should implement the precautionary principle and prohibit the take of Endangered and Critically Endangered species (Table 6.4.3). However, none of these 12 (or possibly 13) species is currently protected under Mauritian law.

Table 6.4.3: Chondrichthyan species confirmed or reported (*not confirmed) from the waters of Mauritius, for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Species prohibited in IOTC-related fisheries, through permit conditions, are shaded in blue. Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). (Species in bold = WIO endemic). Critically Endangered and Endangered species for which prohibition is recommended are also presented.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN RL	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus* *	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus *	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula birostris*	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula eregoodoo *	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii *	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula tarapacana	Sicklefin devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Pristis pristis* *	Largetooth sawfish	I, II		I	CR	CMS I
	Pristis zijsron *	Green sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Critically Endangered and Endangered species for which prohibition is recommended							
Myliobatidae	*Myliobatis aquila*	Common eagle ray				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
	Rhynchobatus australiae *	Bottlenose wedgefish	II		II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN
	Carcharhinus plumbeus	Sandbar shark				EN	EN
	Negaprion acutidens	Sicklefin lemon shark				EN	EN
Centrophoridae	*Centrophorus uyato*	Little gulper shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN

6.5 Republic of Mozambique

6.5.1 Introduction

The Republic of Mozambique (hereinafter Mozambique) is situated along the SWIO coastline, between South Africa (to the south) and Tanzania (to the north; Figure 6.5.1). Mozambique has a coastline of approximately 2,470 km, one of the longest in Africa, and an EEZ of 571,452 km^2 (Claus et al. 2014, Souto 2014). The waters of the Mozambique EEZ span the tropical Western Indian Ocean Province, encompassing the Bight of Sofala/Swamp Coast and Delagoa ecoregions, as well as the Natal ecoregion in the temperate Agulhas Province (Spalding et al. 2007). Accordingly, Mozambique's coastal biodiversity, particularly the coral and fish communities, is split into three general faunal groups, a southern (Delagoa; parabolic dune coast) region adjacent to and shared with part of South Africa, a small north-central region encompassing the Primeiras and Segundas Archipelago (Sofala, swamp coast) and a northern region (East African Coral Coast) that is shared with Tanzania (Obura 2012, Gamoyo et al. 2019, Pereira 2021). There are also three major rivers entering the sea along Mozambique's coastline (the Limpopo, Zambezi and Save), which have a profound effect on coastal ecosystems, offer nursery habitats for many species (including chondrichthyans) and support productive fisheries.

Figure 6.5.1: Map of The Republic of Mozambique, showing its position in the Western Indian Ocean, and place names mentioned in text.

Owing to WIO oceanography, and the biogeography and habitat diversity within Mozambique, the country has a rich marine biodiversity (Pereira 2021), and has been identified as a priority country for marine biodiversity conservation due to its high species richness and the presence of multiple threatened marine taxa, such as dugongs *Dugong dugon* and several turtle species (Pereira 2021). Southern Mozambique is also recognized as forming part of a global hotspot (shared with northeast South Africa) for chondrichthyan species richness, endemism and evolutionary distinctiveness (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020). Mozambique has also been identified as one of 12 countries in the world that are hotspots for imperilled endemic chondrichthyans (Davidson and Dulvy 2017). Mozambique is therefore a southern African and global priority area for chondrichthyan conservation (Pollom et al. in prep.).

Chondrichthyan ecotourism, which focuses on whale sharks *Rhincodon typus*, hammerhead sharks *Sphyrna* spp., giant manta rays *Mobula birostris* and reef manta rays *M. alfredi* is economically significant, particularly along the Inhambane coast, and should provide an incentive for the conservation of at least these few chondrichthyan species (Gallagher and Hammerschlag 2011, Tibiriçá et al. 2011, Venables et al. 2016), all of which are Vulnerable, Endangered or Critically Endangered.

Mozambique, however, is considered a low-income country (World Bank 2018). The human population size exceeded 31 million people by 2019 (IMF 2021), of which approximately 70% live along the coast, and the country is heavily dependent on fishing and fish resources, with fish comprising 50% of the population's protein consumption (Doherty et al. 2015c, Groeneveld 2015). Marine fisheries, particularly small-scale fisheries, are thus very important for both food security and the national economy in Mozambique (FAO 2007, Jacquet et al. 2010, Benkenstein 2013). The high dependence on fisheries and fishery species is a major threat to Mozambique's marine resources, particularly to threatened species.

6.5.2 Chondrichthyan biodiversity and status of knowledge, Mozambique

Biodiversity

In Mozambique, 131 chondrichthyan species have been documented to date (Table 3.1), comprising 77 shark species (representing 27 families), 51 batoid species (representing 17 families) and three chimaera species (representing two families), and a further 17 shark and nine batoid species which are thought to occur in Mozambique, but have not been confirmed (Table 3.1; Table 3.3). Mozambique therefore has the second highest chondrichthyan species richness in the WIO, after South Africa (Table 3.1). This is a result of the length and complexity of the Mozambique coastline, spanning multiple biogeographic regions, the diversity of habitats within Mozambique's waters, and WIO oceanography. The most common shark families in Mozambique include the Carcharhinidae (requiem sharks), comprising 20 species, followed by Pentanchidae (deepwater catsharks – eight species), Centrophoridae (squaliform sharks – six species) and Etmopteridae (lantern sharks – five species). Dasyatidae (whiptail stingrays) and Rajidae (skates) are the most common batoid families, representing 14 and nine species, respectively. There are two species in the family Rhinochimaeridae (long-nose chimaeras), making this the most common family of chimaeras in Mozambique.

At least two chondrichthyan species are endemic to Mozambique, the mud catshark *Bythaelurus lutarius* and sparsethorn skate *Rajella paucispinosa*, and an additional 22 chondrichthyan species which occur in Mozambique are endemic to the WIO (Table 3.3, Chapter 3). However, limited taxonomic work has been conducted on chondrichthyans in Mozambique and it is highly likely that there are other chondrichthyan species present in Mozambique that have not yet been recorded. Indeed, the presence of the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum* in Mozambique was first recorded in 1967, but not again until baited remote underwater video (BRUV) surveys in Inhambane Province confirmed its continued presence in Mozambique in 2019 (Bennett et al. 2021), resulting in a confirmed range extension for this species, which is currently the single most threatened chondrichthyan species that is endemic to the region (Pollom et al. in press). Furthermore, the smalleye stingray *Megatrygon microps* was not known from the SWIO, until visual observations confirmed its presence in Mozambique in 2008, with the first ever records west of India (Pierce et al. 2008b).

Of the 26 chondrichthyan species described from the WIO since 2011 (see Table 3.3, Chapter 3) 14 have distributions which occur in Mozambique, including the narrowhead catshark *Bythaelurus tenuicephalus*, Human's whaler shark *Carcharhinus humani*, African gulper shark *Centrophorus lesliei*, whitecheek lanternshark *Etmopterus alphus,* Barrie's Lanternshark *E. brosei*, sculpted lanternshark *E. sculptus*, Baraka's whipray *Maculabatis ambigua*, western blue skate *Notoraja hesperindica*, bluespotted maskray *Neotrygon caeruleopunctata*, African dwarf sawshark *Pristiophorus nancyae*, Austin's guitarfish *Rhinobatos austini*, Sparsethorn sate *Rajella paucispinosa*, long-snouted African spurdog *Squalus bassi* and the Malagasy skinny spurdog *S. mahia*. It is therefore highly likely that there are more chondrichthyan species present in Mozambique, that have not yet been recorded.

Southern Mozambique, in particular, is part of a global hotspot for chondrichthyan species richness, endemism and evolutionarily distinct species (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020). There are large, well-documented aggregations in southern Mozambique of the Endangered whale shark and giant manta ray, as well as the Vulnerable reef manta ray (Marshall and Bennett 2010, Marshall et al. 2011, Rohner et al. 2013, Venables et al. 2020) and bull shark *Carcharhinus leucas* (Daly et al. 2014). Southern Mozambique also appears to be a stronghold for the Critically Endangered whitespotted wedgefish *Rhynchobatus djiddensis* (Wildlife Conservation Society (WCS), Instituto Nacional de Investigação Pesqueira (IIP), South African Institute for Aquatic Biodiversity (SAIAB, unpublished data) and a hotspot for Endangered zebra sharks *Stegostoma tigrinum* (Pottie et al. 2021) and Near Threatened tiger sharks *Galeocerdo cuvier* (Daly et al. 2018).

Status of biological and ecological knowledge

Chondrichthyans in Mozambique have been poorly studied in comparison to other regions globally, but relatively well studied in comparison to many WIO countries. There is good information on species present, although new country records and taxonomic changes have been common in recent years. There has also been considerable effort put into ecological studies on chondrichthyan species in Mozambique in the past two decades, particularly assessing movement behaviour, aggregation dynamics and reproductive biology. Much of the focused research has been conducted on large charismatic species, such as whale sharks, bull sharks and manta and mobulid rays (*Mobula* spp).

In the 1970's, longline fishing surveys recorded eight shark species, which comprised 23% of total fish catch (Sætre and Silva 1979). The two most common species caught during these surveys were the blue shark *Prionace glauca* and blacktip shark *Carcharhinus limbatus*. An analysis of longline fishery-observer data from 2006 to 2010 indicated that the most abundant shark species were, at that time, the spottail shark *Carcharhinus sorrah*, *Galeocerdo cuvier*, unidentified dogfish shark species *Squalus* cf. *megalops* and scalloped hammerhead sharks *Sphyrna lewini* (Palha de Sousa 2011).

In the 1970s and 1980s, surveys were carried out by Soviet and German trawlers to estimate the potential nominal catch of fish, crustaceans and molluscs, and all of these surveys recorded data on chondrichthyan catch (e.g., Parin et al. 2008). The most commonly caught shark species were silky sharks *Carcharhinus falciformis*, dusky sharks *Carcharhinus obscurus*, starspotted smooth-hounds *Mustelus manazo* and smooth hammerhead sharks *Sphyrna zygaena* (see Sousa et al. 1997) and deep-sea shark species such as the Portuguese dogfish *Centroscymnus coelolepis* and lantern sharks *Etmopterus* spp. (Parin et al. 2008).

In the early 2000s, research on manta rays in Mozambique resulted in the *Manta* genus being revised to include two species; the reef manta ray *Mobula alfredi* and giant manta ray *M. birostris* (Marshall et al. 2009), although this genus has since been revised globally for inclusion in the *Mobula* genus. Off southern Mozambique, there is a major *M. alfredi* aggregation with a super-population estimated to include at least 800 individuals, making it one of the largest known *M. alfredi* aggregation sites in the world (Marshall et al. 2011), and sufficient to trigger a marine Key Biodiversity Area in 2020 (KBA Partnership 2020).

In Sofala Bank, recent studies have identified Zalala (Zambezia Province) as an important aggregation area for hammerhead sharks *Sphyrna* spp., as these sharks are captured in high numbers, including juveniles and pregnant females (S. Fernando, IIP, unpublished data).

Around Tofo in southern Mozambique, there is an important whale shark aggregation (Cliff et al. 2007). Although there has been low observed connectivity with other known regional aggregation sites for the species (Brooks et al. 2010, Andrzejaczek et al. 2016, Diamant et al. 2018, Prebble et al. 2018), the local population structure (74% males, predominantly juvenile) suggests that these sharks constitute a sub-set of a larger population (Rohner et al. 2015).

Habitat use patterns and migration events of adult *Carcharhinus leucas* have been assessed using acoustic telemetry, revealing aggregations around reefs within the Ponta do Ouro Partial Marine Reserve (POPMR), primarily during the summer months (Daly et al. 2014). The POPMR has also been identified as an important area for the Critically Endangered *Rhynchobatus djiddensis*, as determined through baited remote underwater video (BRUV) surveys conducted by IIP in collaboration with WCS and SAIAB, while ongoing tracking studies have determined that Critically Endangered *Sphyrna lewini* also aggregate in large numbers for months at a time within the boundaries of this MPA (pers. comm., Ryan Daly, ORI, July 2021). The grey reef shark *Carcharhinus amblyrhynchos* is known to aggregate in large numbers (100+) between Vamizi Island and Metundo Island in Cabo Delgado province (Hill et al. 2009, Marques da Silva 2015), with some of these individuals having been fitted with acoustic and satellite tags to monitor their movements (Marques da Silva 2015). Great white sharks *Carcharodon carcharias* tagged in the Western Cape region of South Africa have also been recorded swimming to Mozambique[78].

[78] www.ocearch.org

Similarly, tiger sharks *Galeocerdo cuvier* tagged in Kenya were recorded moving among the EEZs of eight countries, including Mozambique, within a year (Barkley et al. 2019). These movement studies demonstrate the importance of regional collaboration for shared chondrichthyan stocks, and the need for regional management measures. Most recently, a study using Local Ecological Knowledge and photographs from researchers and citizen scientists identified a hotspot for Endangered zebra sharks *Stegostoma tigrinum*, in Tofo, southern Mozambique (Pottie et al. 2021).

Genetic studies assessing chondrichthyan geographic population connectivity and biogeography, and using samples obtained from specimens in Mozambique to compare against the broader region, include studies focused on bull sharks *Carcharhinus leucas* (Pirog et al. 2019c), reef mantas *Mobula alfredi* (Venables et al. 2020) and whale sharks (Vignaud et al. 2014).

A global baited remote underwater video (BRUV) study, which surveyed three areas in central and southern Mozambique, found higher chondrichthyan abundance than most other WIO countries (MacNeil et al. 2020). Additional BRUV surveys conducted throughout the southwest Indian Ocean suggest that species richness and relative abundance are higher in southern Mozambique, particularly within the Ponta do Ouro Partial Marine Reserve, which borders South Africa (WCS/IIP/SAIAB, unpublished data).

There are also several areas which are either known or thought to be of importance for shark and ray reproduction. Breeding and parturition for *Rhynchobatus djiddensis* is known to take place between December and February in northern KwaZulu-Natal Province in South Africa, with breeding possibly also taking place in shallow waters off sandy beaches in southern Mozambique (Wallace 1967b, Smith and Heemstra 1991, van der Elst 1993). The Endangered honeycomb whipray *Himantura uarnak* is known to breed in summer in shallow waters off sandy beaches in southern Mozambique, with parturition possibly occurring in estuaries and sheltered sandy bays (Compagno et al. 1989, van der Elst 1993, Dunlop 2013a). The Vulnerable reef manta is thought to breed and give birth in Inhambane Province from October to January and during summer, respectively (Marshall and Bennett 2010). Two pregnant giant manta ray females were also observed in southern Mozambique, suggesting nearby parturition sites, although breeding and parturition localities are unknown (Marshall 2009). Blacktip sharks *Carcharhinus limbatus* are known to give birth between September and October in South Africa, with parturition possibly also occurring in the coastal waters of Mozambique, which may also serve as nursery areas for this species (Bass et al. 1973, Dudley and Cliff 1993, Dudley and Simpfendorfer 2006). Critically Endangered pregnant ragged-tooth sharks *Carcharias taurus* are thought to spend some of the early part of their gestation in the waters of southern Mozambique (Dicken et al. 2006), while the smalleye stingray *Megatrygon microps* is also thought to give birth in southern Mozambique, likely in the vicinity between Praia do Tofo and Bazaruto Island between the months of January and June (Boggio-Pasqua et al. 2019).

The Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum* was recently observed (August 2021) mating in southern Mozambique, near Zavora (pers. comm., Fransesca Trotman, Love the Oceans NGO, August 2021). This is the first known instance of this species mating in the wild and also provides the first information regarding mating season for this species.

Although sawfishes (*Pristis* spp.) have been extirpated from much of their range in the WIO, parts of Mozambique were previously important for both largetooth sawfish *Pristis pristis* and green sawfish *P. zijsron*, and it is possible that these species are still present in isolated areas in Mozambique, in low numbers (Harrison and Dulvy 2014, Leeney 2017). If this is the case, Mozambique would be one of the last remaining areas in the WIO in which these species persist.

In 2021, the Bren School of Environmental Science and Management, University of California, Santa Barbara, assisted IIP to develop a marine spatial plan for Mozambique, which incorporated important habitat types and aggregation sites for chondrichthyan species present in Mozambique[79].

[79] https://storymaps.arcgis.com/stories/09c10ce92dcd4441b00cd9eadab1eda7; https://storymaps.arcgis.com/stories/7c41cdf79c154ae5b009d22e2c122791

Knowledge gaps and research priorities

Chondrichthyan research in Mozambique to date has primarily focused on charismatic species, and there are still many knowledge gaps for the majority of chondrichthyan species within Mozambique's EEZ. As outlined in this country chapter, research in Mozambique has largely focused on catch trends and movement studies, which is encouraging considering that movement information has been highlighted as a research priority (see Chapter 3). However, there is very little research regarding fine-scale movement behaviour and core use areas, and although there is some information available regarding areas of importance for reproduction, much of this research occurred during the 1960s, 1980s and 1990s, and as such there should be a renewed focus on prioritizing research relating to breeding, parturition and nursery areas in Mozambique, particularly for threatened species. All data gaps identified for these species should thus be prioritized for future research (as outlined in Table 3.7).

Of the 42 data-poor[80], threatened chondrichthyan species identified in Chapter 3, 27 (17 batoid and 10 shark) are present in Mozambique, representing eight batoid and five shark families.

There are seven data-poor, threatened species in the family Dasyatidae that occur in Mozambique, comprising the Endangered honeycomb stingray *Himantura uarnak*, and Vulnerable leopard whipray *H. leoparda*, broad cowtail ray *Pastinachus ater*, pink whipray *Pateobatis fai*, Jenkins whipray *P. jenkinsii*, blotched stingray *Taeniurops meyeni* and porcupine ray *Urogymnus asperrimus*. Research priorities for this family and these species primarily relate to the majority of movement and reproduction categories, and the specific age and growth categories of age at maturity and maximum age for all species, size at birth for *U. asperrimus*, female size at maturity for all species other than *U. asperrimus,* and male size at maturity for *P. ater* (Table 3.7).

In the family Myliobatidae, there are three data-poor, threatened species which occur in Mozambique, the Critically Endangered duckbill ray *Aetomylaeus bovinus* and common eagle ray *Myliobatis aquila*, and the Endangered ornate eagle ray *Aetomylaeus vespertilio.* Although migratory status and litter size is known for all three species, and gestation period is known for *A. bovinus* and *M. aquila*, information relating to all other categories of movement and reproduction is unknown for these three species. In addition, maximum age is unknown for all three species, age at maturity is unknown for *A. vespertilio* and *M. aquila*, and female size at maturity and size at birth is unknown for *A. vespertilio*.

The Critically Endangered *Pristis zijsron* is data-poor, while *P. pristis* is also Critically Endangered, but is not classified as data-poor (Figure 3.6; Table 3.7). However, the most recent records of these two species in Mozambique are from 2014 (Leeney 2017); therefore, identification of areas still used by these species remains a priority. While this family remains a conservation priority, the allocation of conservation and research resources to these species should be carefully weighed up against the needs of other threatened species, which still have viable populations within the region and may still be prevented from further declines and local extirpations, as outlined in Chapter 3.

There are two data-poor, Critically Endangered species in the family Rhinidae which occur in Mozambique (bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*). Other than litter size, all other aspects relating to movement and reproduction for these species should be prioritized in Mozambique, in addition to age at maturity and maximum age (see Table 3.7). Although there is considerable biological and ecological information available for *Rhynchobatus djiddensis* in Mozambique, this species is also classified as Critically Endangered, with nursery areas and critical habitats being unknown for this species in Mozambique, in addition to this species' gestation period and reproductive periodicity (Table 3.7).

The families Mobulidae (shortfin devil ray *Mobula kuhlii*), Rajidae (yellowspotted skate *Leucoraja*

[80] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

wallacei), Rhinobatidae (greyspot guitarfish *Acroteriobatus leucospilus*) and Rhinopteridae (shorttail cownose ray *Rhinoptera jayakari*) are each characterized by one data-poor, threatened species in Mozambique. There is limited information relating to movement and reproduction, age at maturity and maximum age for *A. leucospilus*, *M. kuhlii* and *R. jayakari*, and female size at maturity and size at birth for *R. jayakari*, as outlined in Table 3.7.

There remain numerous taxonomic uncertainties in terms of species present and their associated distributions within Mozambique, therefore further taxonomic research is required, particularly among the batoids. Species of the *Himantura* and *Rhynchobatus* genera*,* as well as the so called "brown rays" (several genera within the family Dasyatidae) are common in southern Mozambique, and require taxonomic clarifications, as outlined in Chapter 3.

Four data-poor threatened shark species representing the family Centrophoridae occur in Mozambique, comprising the Endangered African gulper shark *Centrophorus lesliei*, little gulper shark *C. uyato* and the Vulnerable smallfin gulper shark *C. moluccensis,* and longsnout dogfish *Deania quadrispinosa*. Litter size is known for all species except for *C. lesliei* and reproductive periodicity is unknown for *C. lesliei* and *D. quadrispinosa*, however information is lacking in all other movement and reproduction categories for these four species. In the age and growth categories, age at maturity and maximum age remain unknown for all four species, in addition to size at birth for *C. lesliei*, therefore these categories which lack information should be prioritized in future for these four species (Table 3.7).

Three data-poor threatened species, the tiger catshark *Halaelurus natalensis,* honeycomb catshark *Holohalaelurus favus* and African spotted catshark *Holohalaelurus punctatus*, represent the family Pentanchidae in Mozambique, and one species, the kitefin shark *Dalatias licha*, represents the family Dalatiidae. These sharks all have limited information available regarding movement and reproduction and, particularly for the Pentanchidae species, lack information relating to age and growth (Table 3.7).

The remaining two data-poor, threatened shark species in Mozambique comprise the whitetip weasel shark *Paragaleus leucolomatus* (Hemigaleidae) and tawny nurse shark *Nebrius ferrugineus* (Ginglymostomatidae). Other than maximum length, generation length and litter size, information is lacking for all other age and growth, movement and reproduction categories for *P. leucolomatus* (Table 3.7), therefore these aspects should be the focus of future research efforts for this species. In the age and growth categories, *N. ferrugineus* lacks information relating to age at maturity and maximum age, and, apart from migratory status and breeding season, lacks information in all other movement and reproduction categories (Table 3.7).

Although not data-poor, there are five other Critically Endangered shark species in Mozambique, the oceanic whitetip shark *Carcharhinus longimanus*, ragged-tooth shark *Carcharias taurus,* shorttail nurse shark *Pseudoginglymostoma brevicaudatum*, scalloped hammerhead shark *Sphyrna lewini* and great hammerhead shark *S. mokarran*. There is limited information on parturition and nursery areas within Mozambique, or even whether there are such critical habitats for these species in Mozambique. Artisanal fishery catch data from Zambezia Province in central Mozambique includes a large proportion of juvenile *S. lewini*, suggesting the presence of a nearby nursery area, however this nursery area has not been confirmed or located (WCS/IIP, unpublished data). A recent sighting of *P. brevicaudatum* mating in southern Mozambique (pers. comm., Fransesca Trotman, Love the Oceans NGO, August 2021) is noteworthy, particularly as a separate recording of this species in southern Mozambique extends its known range by over 2,000 km (Bennett et al. 2021). As the only Critically Endangered (and therefore most threatened) shark species endemic to the WIO, *P. brevicaudatum* is a key research and conservation priority, in Mozambique and throughout its range.

Information regarding important areas and critical habitats for chondrichthyan species in Mozambique is generally lacking, although the available research identifies southern Mozambique as a vital area for these important life history stages for several chondrichthyan species. As such, more research should be focused on this broad geographical area to further identify specific areas and habitats that play an important role for reproductive success and can thus inform future protection measures for these threatened species.

There are also 15 Data Deficient (as defined by IUCN) chondrichthyan species in Mozambique, including six shark and nine batoid species (Table 3.3, Chapter 3). At least nine of these – mud catshark *Bythaelurus lutarius*, roughskin spurdog *Cirrhigaleus asper*, rattail skate *Dipturus lanceorostratus*, prownose skate *D. stenorhynchus*, whitespotted bullhead shark *Heterodontus ramalheira*, grinning spotted izak *Holohalaelurus grennian*, Mozambique electric ray *Narcine rierai*, slender guitarfish *Rhinobatos holcorhynchus* and Malagasy skinny spurdog *Squalus mahia* – are considered deepwater species and are therefore infrequently encountered, limiting available information. The remaining six species – the speckled guitarfish *Acroteriobatus ocellatus*, Human's whaler shark *Carcharhinus humani*, smalleye stingray *Megatrygon microps*, Austin's guitarfish *Rhinobatos austini*, blackspotted electric ray *Torpedo fuscomaculata* and marbled electric ray *T. sinuspersici* – have coastal distributions and are exposed to coastal fisheries. Of these, *M. microps* has only relatively recently been recorded in the WIO (Pierce et al. 2008b), with southern Mozambique apparently an important area for the species. However, little information is available on this species in Mozambique. Of these 15 Data Deficient species, *B. lutarius* is endemic to Mozambique, while *R. austini*, *H. grennian*, *N. rierai*, *Dipturus lanceorostratus*, *D. stenorhynchus* and *R. holcorhynchus* are endemic to the WIO region. As such, research should also be prioritized for these Data Deficient species.

6.5.3 Chondrichthyan fisheries, catch and trade

Fisheries

There is extensive fishing pressure throughout Mozambique, with an estimated 60% of Mozambique's population dependent on fisheries (Kiszka and van der Elst 2015). Artisanal and subsistence fisheries together are considered the dominant fishery sector, accounting for 75%–88% of Mozambique's landed marine fish captures, equating to over 100,000 t annually (FAO 2007, IDPPE 2013, Doherty et al. 2015c, UNCTAD 2017). These fisheries are widespread and operate a diversity of fishing gears in coastal waters along most of the coastline (Jacquet et al. 2010, Doherty et al. 2015c, Everett et al. 2017). There are also semi-industrial and industrial fishing fleets, foreign fishing fleets and illegal, unregulated and unreported (IUU) fishing activities (UNCTAD 2017). The industrial and semi-industrial sectors target primarily shrimp, tuna, swordfish, marlin and shark; while the small-scale artisanal sector targets a range of small pelagic species, larger pelagic and demersal linefish species, as well as crustaceans such as shrimp and crab (Benkenstein 2013). Chondrichthyans are targeted or caught as bycatch in artisanal, semi-industrial and industrial catches and by all types of boats using all types of gears, from the coastline to a depth of approximately 1,200 m (Sousa et al. 1997), yet most fisheries remain poorly monitored.

Sharks have been considered an important resource in Mozambique dating as far back as 1979, at which time they were considered to be "lightly exploited" (Sætre and Silva 1979, cited in Sousa et al. 1997). However, exploitation of chondrichthyan species has increased substantially over the past 40 to 50 years (Sousa et al. 1997, Jacquet et al. 2010). There are reports that fishing effort increased during Mozambique's civil war (1975 to 1992) and that catch rates in small-scale fisheries declined significantly during that period as a result (Jacquet et al. 2010, and references cited therein). Since the war ended, fisheries have been a key pillar in economic and poverty alleviation plans in Mozambique, placing further pressure on these resources (UNCTAD 2017). Most chondrichthyans caught in Mozambique are taken as incidental catch by shrimp trawlers (Kiszka and van der Elst 2015). Shark meat has not traditionally been a staple food for local consumption in Mozambique, and incidental catch may be utilized or discarded. However, more recently sharks and rays are also being targeted directly – particularly Carcharhinid sharks and wedgefishes (*Rhynchobatus* spp.) – due to the high value of their fins in eastern Asia (Pierce et al. 2008a). Catch data from bather-protection nets off the South African coast of KwaZulu-Natal showed declines in some shark species that have been partially attributed to mortality in Mozambique's artisanal and shrimp fisheries (Dudley and Simpfendorfer 2006, Daly et al. 2020). There are recreational and sport fisheries in Mozambique, particularly on the southern coast, using rod and line and speargun, but these are thought to have a negligible impact on sharks (Chacate and Mutombene 2015).

Artisanal fisheries

An estimated 280,000 small-scale artisanal fishers are thought to operate in Mozambique (Benkenstein 2013). Gears used include gillnets, beach seines, longlines, handlines, fish traps, corrals and artisanal 'shark nets'; gillnets and beach seines are most likely to catch chondrichthyans (Everett et al. 2017). Artisanal fishers catch chondrichthyans as target and incidental catch; the high value and demand for shark fins over recent years means that incidental catches are unlikely to be released alive, at least in areas where fin buyers are present (Pierce et al. 2008a). In the 1980s, supported projects aiming to develop the artisanal shark fishery in Mozambique, providing training in fishing methods with a particular focus on longline techniques (Fowler et al. 2005).

Artisanal shark fisheries have been reported from the Sofala Bank (FAO 1990), and Quirimbas Archipelago (Johnstone 2004) and Vamizi Island (Hill 2005) in northern Mozambique. At Sofala Bank in particular local fishers target sharks for their fins using bottom-set gillnets (pers. comm., Isabel Chauca, IIP, May 2017). *Mobula alfredi*, *M. birostris* and *M. kuhlii* were fished intensively at Ligogo (Inhambane province) in 2010 (Kiszka and van der Elst 2015), and large *Rhynchobatus djiddensis* are heavily targeted for their fins by artisanal fishers in southern and central Mozambique (Costa Pires 2014). Artisanal fishers operate mostly in nearshore areas, which are likely to act as nursery grounds for chondrichthyans, and these fisheries are expected to be impacting populations of oceanic whitetip sharks *Carcharhinus longimanus*, spinner sharks *C. brevipinna*, pigeye sharks *C. amboinensis* and scalloped hammerhead sharks *S. lewini* (Dudley and Simpfendorfer 2006). There has been an IUU component to the inshore shark fishery in Mozambique, with longline vessels were reportedly operating within the Bazaruto Archipelago National Park (Peterson 2003).

There are no reliable data available on the extent of artisanal chondrichthyan exploitation in Mozambique. Kroese and Sauer (1998) estimated an annual catch of 1,500 t of sharks in artisanal fisheries, while MIMAIP reported a total artisanal chondrichthyan catch of 1,298 t in 2015 and 1,786 t in 2016, the majority of which was caught on Sofala Bank (pers. comm., Isabel Chauca, IIP, May 2017). Catches in 2016 were the highest they have been since 2007, and the main species landed were *S. lewini, S. zygaena,* milk sharks *Rhizoprionodon acutus* and *Carcharhinus* spp. (pers. comm., Isabel Chauca, IIP, May 2017). However, the shark fishery is probably underestimated and increasing in its size and sophistication (Pierce et al. 2008a).

Industrial and semi-industrial fisheries

The semi-industrial sector is dominated by national vessels (mostly shrimp trawlers) fishing inshore, whereas the industrial sector is dominated by foreign shrimp trawlers, purse seiners and longliners – some licensed through joint ventures and partnership agreements, and others unlicensed. Numbers of licenses issued for semi-industrial and industrial fisheries have declined in recent years from about 185 in 2011 to 130 in 2016, particularly in the deepwater shrimp trawl, purse seine and longline fisheries. This trend is thought to be due partially to improved management of these fisheries (Kiszka and van der Elst 2015) and to piracy issues (Chacate and Mutombene 2015).

In the late 1990s, several semi-industrial vessels operated directed shark gillnet fisheries in Maputo Bay, Inhambane Bay and the Vilankulos area, targeting coastal and shelf-associated species (Sousa et al. 1997, Compagno et al. 2005). Demersal gillnet fisheries for deepwater sharks still operate (Kiszka and van der Elst 2015). The linefish fishery catches relatively few sharks (pers. comm., Isabel Chauca, IIP, May 2017).

Before the 1980s, most deep-sea species were of little commercial interest, either because of the difficulty of using traditional fishing gears in deep-sea areas, or because of the difficulty in introducing these species to the market (Piñeiro et al. 2001, cited by Machado and Matos 2003). In Mozambique, deep-sea shark fishing began in 2008 with two vessels that operated under an experimental fishing regime until 2011 (IIP 2015). Currently, two vessels are licensed for deep-sea shark fishing, which mainly catch gulper sharks *Centrophorus* spp. (Inacio 2017). Deepwater shark fishing is driven mainly by liver oil markets for lubricating oils, medicines and leather tanning products (Compagno 1984, Ramos et al. 2013).

Shrimp trawl fisheries

Shrimp trawlers are responsible for the largest proportion of incidental chondrichthyan catch in Mozambique, including sawfish (Pristidae) and guitarfish (Rhinobatidae) (Gove et al. 2001, Compagno et al. 2005). Most of the trawling occurs in shallow waters of Sofala Bank; in 2014, 36 vessels were licensed, one of which was semi-industrial and the rest industrial (Chacate and Mutombene 2015). An estimated 1,500 t of elasmobranchs were caught in shrimp fisheries in 1994 (CITES 1997). In 2016, chondrichthyan species mostly reported in deepwater shrimp fisheries were shortnose spurdog *Squalus megalops* (5,783.9 t) and shortspine spurdog *S. mitsukurii* (4,583.4 t), mainly in Inhaca and Boa Paz fishing grounds (pers. comm., Isabel Chauca, IIP, May 2017) (although there remains taxonomic confusion among the *Squalus* species in the WIO). Other species recorded include smallfin gulper shark *Centrophorus moluccensis*, gulper shark *C. granulosus*, kitefin shark *Dalatias licha* and African angelshark *Squatina africana* (pers. comm., Isabel Chauca). Jacquet and Zeller (2007a) estimated discards of almost 19,000 t in 2000 in the Mozambique shrimp fishery, based on a ratio of 1.69 t discarded per ton of shrimp. In tests of bycatch reduction devices in Mozambican shrimp trawl fisheries, Nordmøre grids prevented large sharks from being caught and reduced the number of hauls with bycatch of large rays (Fennessy and Isaksen 2007). Despite requirements for TEDs in Mozambique, anecdotal information suggests that they are not enforced.

Tuna fisheries

The number of fishing licenses issued to foreign vessels to fish tuna in Mozambique has decreased in recent years, from 51 purse seine and 110 longline vessels licenced in 2007, to 7 and 23, respectively in 2016 (Chacate and Mutombene 2015). The purse seine fleet tends to be composed of vessels from France, Spain and Seychelles; the longline fleet is composed of vessels from Belize, Panama, Cambodia, Honduras, Japan, China, Korea, Spain and Taiwan (Palha de Sousa 2012). Catches are conserved on board and transferred to cargo reefer or unloaded at foreign ports, mainly Seychelles, Madagascar, Mauritius and South Africa (Palha de Sousa 2012). Longline tuna fisheries are likely to have had a considerable impact on chondrichthyan populations in Mozambican waters (Pierce et al. 2008a). Reported catch rates were 26 sharks per 1,000 hooks in the early years of the tuna longline fisheries in southern Africa (1964 to 1967) but, several decades later, reported catches for the same area had declined to 2.1 sharks per 1,000 hooks (Kroese and Sauer 1998). According to IIP, sharks represent 11% of the total industrial longline catch, and include silky *Carcharhinus falciformis*, blacktip *C. limbatus,* oceanic whitetip *C. longimanus*, dusky *C. obscurus*, sandbar *C. plumbeus,* blue *P. glauca*, and shortfin mako *I. oxyrinchus* sharks (pers. comm., Isabel Chauca, IIP, May 2017). *Prionace glauca* is the most commonly retained species.

There are also numerous illegal tuna fishing operations in Mozambique. Its extensive coastline and lack of infrastructure for surveillance and enforcement make Mozambique a target for IUU fishing (Lopes and Pinto 2001, Kelleher 2002). Over a decade ago, the IUU fishing industry was estimated to be at least 18% of the size of the legal fishery, and was likely costing Mozambique around USD38 million per year (MRAG 2005). In 2008, it was estimated that 100 unlicensed longliners were fishing illegally in the Mozambique Channel (Doherty et al. 2015c). Foreign vessels are known to fish illegally at night in Mozambican territorial waters, particularly in the regions of Cabo Delgado (Palma and Mocimboa da Praia), Inhambane and Nampula (Angoche and Mussoril), targeting highly migratory species, particularly tuna and shark (Lopes and Pinto 2001). There are also reports of licensed longliners fishing outside the terms of their license by targeting sharks (Pierce et al. 2008a), sometimes by switching to gillnets (Kelleher 2002, MRAG 2005).

A 2005 report estimated that 120 fishing vessels, owned by Taiwan Province of China (TPC), were operating shark-fin fisheries in Mozambique, Tanzania and Madagascar (IOTC 2005). This fleet was reported to fish offshore year-round, particularly in the Mozambique regions of Cabo Delgado province (off Palma and Mocímboa da Praia), Inhambane (in the vicinity of Bazaruto National Park) and Nampula (Lopes and Pinto 2001). These vessels were fishing well into territorial waters, catching (among other species) hammerhead sharks *Sphyrna* spp. and whitespotted wedgefish *Rhynchobatus djiddensis*, both of which have highly valuable fins (Dudley and

Cavanagh 2006). Fins were reportedly offloaded to freezer carriers and transported to China or TPC, to be dried and processed for sale in China, TPC or Hong Kong, with the rest of the shark usually discarded at sea (IOTC 2005). In 2008, a vessel registered in Namibia was found to have been fishing illegally in Mozambican waters (NEPAD 2011). The vessel had 43 t of shark meat, 4 t of shark fin, 1.8 t of shark tail, 11.3 t of shark liver and 20 t of shark oil on board, resulting from the catch of *Dalatias licha*. The vessel and its cargo were confiscated for illegally fishing shark in Mozambican waters, and the vessel was converted to a fisheries patrol vessel (NEPAD 2011).

Fisheries monitoring and reporting

WIOFish reported that catch and effort monitoring occurs in 94% of fisheries in Mozambique (observer monitoring, submission of catch returns and creel surveys), and that biological monitoring occurs in ~80% of fisheries (species, lengths and weights, and sometimes sex and reproductive states; Everett et al. 2017). However, most fisheries have not been adequately assessed, and most require management-related research (Everett et al. 2017).

Since the 1950s, Mozambique has reported primarily industrial catches and has substantially under-reported the country's small-scale fishing sector due to a lack of resources and civil war (Jacquet et al. 2010). In the early 1980s, IIP began collecting fishery-dependent data via logbooks of commercial catch, categorized taxonomically, from the industrial and semi-industrial fisheries (Bandeira et al. 2002). This program was later broadened to include an onboard observer-sampling component; IIP has eight scientific observers who have been trained under the Southwest Indian Ocean Fisheries Program SWIOFP (AU-IBAR 2016). Fishery-independent data have also been collected through a series of scientific surveys that were conducted occasionally between 1976 and 1991 depending on the availability of vessels, but have been conducted systematically after 1991. However, discards are absent from reported data, and incidental catch is underreported (Jacquet et al. 2010). Only two chondrichthyan species are recorded as bycatch in the WIOFish database; the only other entry was 'Elasmobranchii' (Everett et al. 2017). According to information provided by IIP staff in 2014, observers working onboard industrial vessels were not, at that time, required to record any information pertaining to shark or ray bycatch or discards. It has also been reported that accurate quantitative data from offshore fisheries is almost entirely lacking, and so has limited use for effective management (MRAG 2005, Pierce et al. 2008a).

Collection of data from Mozambique's artisanal fisheries did not begin until 1997 (in two provinces, Inhambane and Nampula), but was later expanded to cover all coastal provinces (Dias and Afonso 2011). In practice, the landings of many artisanal fisheries in Mozambique are either infrequently recorded or not at all, particularly in the more remote parts of the northern half of the country (Blythe 2013). Largely because of this underreporting of small-scale fisheries, the total reconstructed marine catch of Mozambique from 1950 to 2010 was estimated to be 4.6 times the official catch reported to the FAO (Jacquet and Zeller 2007b, Doherty et al. 2015c). This is the highest level of underreporting of any of the Nairobi Convention Member States. Through IIP, Mozambique is part of the WIOFish database (WIOFish 2021), which should help to improve the scientific base for fisheries monitoring.

Reported chondrichthyan catches

In Mozambique, chondrichthyan catches reported to the FAO are predominantly recorded as 'Sharks, rays, skates, etc. nei', 'Hammerhead sharks etc. nei', and 'Requiem Sharks nei' although *Prionace glauca*, copper sharks *Carcharhinus brachyurus, C. falciformis, C. longimanus* and *Isurus oxyrinchus* have occasionally been recorded at species level (FAO 2021). From 2012 to 2019, Mozambique reported landing an annual average of 1,920.3 t of chondrichthyans exclusively from FAO Major Fishing Area 51 (hereafter FAO Area 51) (Figure 6.5.2). Of the Nairobi Convention Member States, Mozambique landed the third largest chondrichthyan catch over that period, accounting for 4.9% of the total catch and 9.4% of the catch from FAO Area 51, made by Nairobi Convention Member States (FAO 2021). Given the low reliability of catch statistics in Mozambique, these data are likely to be conservative. Even when reporting of catches occurs, chondrichthyans may not be included in the data collected.

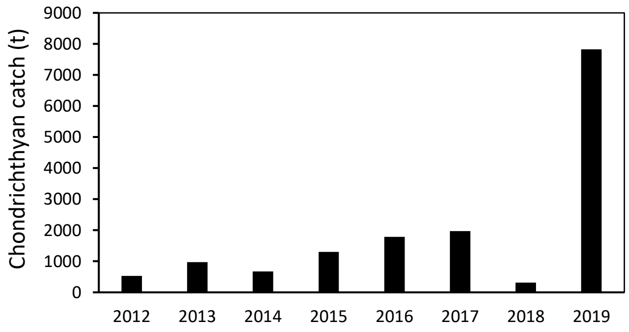


Figure 6.5.2: Total chondrichthyan catch for Mozambique from FAO Major Fishing Area 51, 2012–2019 (FAO 2021).

In 2012, the artisanal fishery was the dominant fishery in terms of annual catch volumes overall, and landed 653 t of "shark" (UNCTAD 2017), with data sourced from the Ministério do Mar, Águas Interiores e Pescas. With at least 45 different chondrichthyan species known to be caught, the artisanal fishery was responsible for catching more chondrichthyan species than any other fishery in Mozambique (Table 6.5.1). In addition, most batoids are only caught in the artisanal fishery, suggesting that this fishery poses the greatest threat to many of the coastal batoid species, and demonstrates the need to manage this fishery appropriately. The line fishery is responsible for catching at least 32 chondrichthyan species, followed by the tuna fishery with 24 species of shark, prawn trawl fishery with 22 chondrichthyan species, deepwater shark fishery with 11 species of shark, and foreign fleets with 5 shark species reported.

Many of the deepwater shark species are caught only by the targeted deepwater shark fishery, including the gulper shark *Centrophorus lusitanicus* (now *C. granulosus*), smallfin gulper shark *C. moluccensis,* leafscale gulper shark *C. squamosus*, little gulper shark *C. uyato,* longsnout dogfish *Deania quadrispinosa* and kitefin shark *Dalatias licha*. Hammerhead sharks are caught in most fisheries in Mozambique, with *S. lewini* the only species caught in all fisheries, and *S. mokarran* and *S. zygaena* caught in all fisheries other than the targeted deepwater shark fishery (Table 6.5.1).

Of the 71 chondrichthyan species caught in Mozambican fisheries, 54 (76%) are threatened (Table 6.5.1), while 10 (91%) of the 11 shark species targeted in the deepwater shark fishery are threatened or Near Threatened. Therefore, improved monitoring and reporting of chondrichthyan catches across fisheries is necessary to ensure that these species are managed appropriately in future.

Trade in chondrichthyan products

Chondrichthyan fisheries in Mozambique appear to be driven in part by a demand for fin exports. Pierce et al. (2008a) noted that, at the time of their research, few permits had been issued for shark fin export, despite apparently high volumes, suggesting widespread illegal export. There is no evidence to suggest that this situation has changed in recent years. Illegal export of dried fins is known to occur by dhow to the Tanzanian border (Marques da Silva 2015). According to licenses issued by Mozambique's National Fish Inspection Unit (INIP), 3 t of rays, 142 t of sharks (meat) and 8 t of dried fins were exported to Hong Kong in 2016 (pers. comm., Isabel Chauca, IIP, May 2017).

Genetic barcoding of a sub-sample of fins confiscated in Maputo in 2018 and 2019, from shipments destined for export, confirmed 13 chondrichthyan species, of which 94% of samples identified to species level were from threatened species (Asbury et al. 2021). These included the Critically Endangered scalloped hammerhead shark *Sphyrna lewini* (alone comprising nearly 50% of identified samples), whitespotted wedgefish *Rhynchobatus djiddensis* and oceanic whitetip shark *Carcharhinus longimanus*; Endangered grey reef shark *C. amblyrhynchos* and shortfin mako shark *Isurus oxyrinchus*; and the Vulnerable snaggletooth shark *Hemipristis elongata*, silvertip shark *C. albimarginatus*, pigeye shark *C. amboinensis*, bull shark *C. leucas*, copper shark *C. brachyurus* and great white shark *Carcharodon carcharias* (Asbury et al. 2021).

Among these, *C. longimanus, C. carcharias, I. oxyrinchus, R. djiddensis* and *S. lewini* are listed on CITES Appendix II, meaning that trade in these species should not be permitted without a positive non-detriment finding (NDF) (as required by CITES, see section 5.2.2, Chapter 5) to ensure the trade is not detrimental to the wild populations. Without a positive NDF, international trade in these species from Mozambique contravenes CITES trade controls.

Table 6.5.1: Chondrichthyan species caught (x) or thought to be caught (?) in the various fisheries operating in Mozambique (Data obtained from Instituto Nacional de Investigação Pesqueira (IIP)), and species identified in the illegal fin trade (Fin trade, Asbury et al. 2021). Also presented are species listings under the Convention on the Conservation of Migratory Species of Wild Animals (CMS Appendix I or II), prohibitions under a resolution of the Indian Ocean Tuna Commission (IOTC), listing in the prohibited (XIII) or regulated (XI) species annexes of the Marine Fishing Regulations (Decree 89/2020, Republic of Mozambique 2020), listings under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES Appendix I or II), and IUCN Red List classifications of each species, where relevant. (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient).

Species	Artisanal fishery	Line fishery	Tuna fisheries	Prawn trawl	Deep shark	Foreign fleets	Fin trade	CMS	IOTC	REP.	CITES	IUCN
Sharks												
Alopias pelagicus		x	x	x				II	12/09	XIII	II	EN
Alopias superciliosus		x	x	x				II	12/09	XIII	II	VU
Alopias vulpinus		x	x	x				II	12/09	XIII	II	VU
Bythaelurus lutarius				x	x							DD
Carcharhinus albimarginatus	x		x				x					VU
Carcharhinus amblyrhynchos	x		x				x					EN
Carcharhinus amboinensis	x		x				x					VU
Carcharhinus brachyurus		?					x					VU
Carcharhinus brevipinna	x						x					VU
Carcharhinus falciformis	x	x	x	x				II		XI	II	VU
Carcharhinus humani	x	x	x				?					DD
Carcharhinus leucas	x	x	x				?			XI		VU
Carcharhinus limbatus	x	x	x				?			XI		VU
Carcharhinus longimanus	x	x	x	x				I	13/06	XIII	II	CR
Carcharhinus melanopterus	x	x	x							XI		VU
Carcharhinus obscurus	x	x	x					II		XI		EN
Carcharhinus plumbeus	x	x	x				?			XI		EN
Carcharhinus sorrah	x	x	x									NT
Carcharodon carcharias				x				I, II		XIII	II	VU
Centrophorus lusitanicus [a]					x					XI		EN
Centrophorus moluccensis					x					XI		VU
Centrophorus squamosus					x					XI		EN
Centrophorus uyato					x					XI		EN
Cephaloscyllium sufflans				x	x							NT
Dalatias licha					x					XI		VU
Deania quadrispinosa					x					XI		VU
Galeocerdo cuvier	x	x					x					NT
Hemipristis elongata	x	x										VU
Heptranchias perlo		x		x								NT
Heterodontus ramalheira		x										DD
Hexanchus spp. (*griseus*?)		x	x	x	x							NT
Holohalaelurus punctatus				x	x							EN
Holohalaelurus regani		x		x								LC
Isurus oxyrinchus		x	x	x			x	II		XI	II	EN
Isurus paucus		x	x	x				II		XI	II	EN
Lamna nasus		x	x			x		II	13/05		II	VU
Loxodon macrorhinus	x	x										NT
Nebrius ferrugineus		x										VU
Negaprion acutidens	x	x										EN
Prionace glauca		x	x			x		II		XI		NT
Rhincodon typus				x				I, II		XIII	II	EN
Rhizoprionodon acutus	x		x							XI		VU
Scoliodon laticaudus	x											NT
Sphyrna lewini	x	x	x	x	x	x	x	II		XI	II	CR
Sphyrna mokarran	x	x	x	x		x	x	II		XI	II	CR
Sphyrna zygaena	x	x	x	x		x		II		XI	II	VU
Stegostoma tigrinum	x									XI		EN
Triaenodon obesus	x											VU
Batoids												
Acroteriobatus leucospilus	x									XI		EN
Aetobatus ocellatus	x											VU
Himantura leoparda	x											VU
Himantura uarnak	x									XI		EN
Maculabatis ambigua	x											NT
Mobula alfredi	x			x				I, II	19/03	XIII	II	VU
Mobula birostris	x			x				I, II	19/03	XIII	II	EN
Mobula kuhlii	x			x				I, II	19/03	XIII	II	EN
Neotrygon caeruleopunctata	x											LC
Pastinachus ater	x											VU
Pateobatis fai	x											VU
Pateobatis jenkinsii	x											VU
Pristis pristis	x							I, II		XIII	I	CR
Pristis zijsron	x							I, II		XIII	I	CR
Rhina ancylostomus	x	x		x						XI	II	CR
Rhinoptera jayakari	x											EN
Rhynchobatus australiae	x	x						II		XI	II	CR
Rhynchobatus djiddensis	x	x					x			XI	II	CR
Rhynchobatus laevis [b]	x	x								XI	II	CR
Taeniura lymma	x											LC
Taeniurops meyeni	x											VU

[a] *Centrophorus lusitanicus* (as reported here) is a junior synonym of *C. granulosus*; [b] *Rhynchobatus laevis* is not thought to occur in the Western Indian Ocean

Official chondrichthyan trade data

Mozambique imports of shark products

According to UN Comtrade (2021), Mozambique imported shark products once from 2012 to 2019, which consisted of 27 t of shark fin from South Africa in 2014. In 2018, Mozambique imported 324 kg of frozen dogfish, other sharks, rays and skates (HS 030488) from Portugal, to the value of USD995. However, countries exporting shark products to Mozambique reported an average of 8.3 t of total shark products per year. South Africa accounted for 97% of these exports and Portugal, Netherlands and the Republic of Korea for the remaining 1%. Other than the fins imported from South Africa in 2014, all imports consisted of whole, frozen shark product.

Mozambique exports of shark products

The UN Comtrade database indicates that Mozambique reported just four exports of chondrichthyan products from 2012 to 2019 – totalling 4.58 t and 21.14 t of frozen ray and skate meat and shark fins in 2018 and 2019, respectively (Table 6.5.2). However, numerous countries reported that they had imported chondrichthyan products from Mozambique during this period, leading to major discrepancies between chondrichthyan export quantities as reported by Mozambique and imports of chondrichthyan products that originated in Mozambique, as reported by other countries (Table 6.5.2). These countries together reported imports of chondrichthyan products from Mozambique every year from 2012 to 2019, with a combined total of 1,634.5 t at an average annual import volume of 204.31 t, mainly comprising frozen shark meat (HS 030381) (UN Comtrade 2021). The total of 1,634.5 t is approximately 65 times greater than the total export volume of 25.72 t as reported by Mozambique (Table 6.5.2). Spain was the largest importer of frozen shark meat, importing an average of 273.46 t per year from 2012 to 2014, but then no records of imports from 2015 onwards. Other countries that reported imports of frozen shark meat from Mozambique were France, Morocco, Portugal, Republic of Korea, Taiwan and Ukraine (UN Comtrade 2021).

Table 6.5.2: Total chondrichthyan catch (metric tonnes) reported by Mozambique from FAO Major Fishing Area 51; chondrichthyan exports (metric tonnes) to the world as reported by Mozambique; chondrichthyan imports (metric tonnes) from Mozambique as reported by the world; and shark fin imports (metric tonnes) by Hong Kong from Mozambique, as reported by Hong Kong.

Year	Total Catch [a]	Exports from Mozambique - as reported by Mozambique, all codes [b]	Imports from Mozambique - as reported by the world, all products [b]	Shark fin imports by Hong Kong from Mozambique [c]
2012	524	0	303.19	7.20
2013	972	0	212.24	0.41
2014	673	0	325.73	3.46
2015	1,298	0	173.86	4.80
2016	1,786	0	115.26	11.63
2017	1,969	0	216.29	11.00
2018	315	4.58	102.94	4.76
2019	7,825	21.14	184.99	5.08
Total	15,362	25.72	1,634.50	48.34
Average	1,920.25	3.22	204.31	6.04

[a] FishStatJ (FAO 2021)
[b] UN Comtrade (2021)
[c] Hong Kong Census and Statistics Department (2021)

Furthermore, in terms of fin exports alone, the Hong Kong Bureau of Statistics (2021) reported that shark fins were imported from Mozambique by Hong Kong every year from 2012 to 2019 at an average of 6.0 t per year, totalling 48.3 t (Table 6.5.2; Figure 6.5.3), while UN Comtrade (2021) reported 38.7 t in total over this period at an average of 4.8 t per year, and INIP reported fin exports only in 2012 to 2014 and in 2018, with a total of 19.6 t at an average of 2.5 t per year over the 2012–2019 period (Table 6.5.3; Figure 6.5.3).

The results highlight the low level of accuracy and high level of underreporting of chondrichthyan trade volumes. Discrepancies also exist between catch and trade statistics, highlighting underreporting of catches by Mozambique. From 1985 to 2000, Mozambique reported shark catches only in 1995 (165 t) and 1996 (21 t; Fowler et al. 2005), yet 78 t of chondrichthyan products were exported to the EU in 1998 (Vannuccini 1999) and 2.9 t (dry weight) of fins were exported to Hong Kong in 2000 (IUCN/TRAFFIC 2002).

Table 6.5.3: Shark and batoid fins (in metric tonnes) exported from Mozambique. The importing country (Destination) and fishery in which the fins were obtained (Fishery) are also given. Data obtained from the National Fish Inspection Unit of Mozambique (INIP) database.

Year	Product	Quantity (t)	Destination	Fishery
2012	Dry fins	29.8	Spain	Artisanal
2012	Dry fins	1.1	Hong Kong	Artisanal
2013	Dry fins	22.7	Spain	Artisanal
2013	Dry fins	0.8	Hong Kong	Artisanal
2014	Dry fins	9.8	Spain	Artisanal
2014	Dry fins	13.4	Hong Kong	Artisanal
2018	Frozen shark	121.9	Morocco	Industrial
2018	Frozen shark	48.0	Portugal	Industrial
2018	Dry fins	4.3	Hong Kong	Artisanal
2019	Frozen shark	190.5	Morocco	Industrial
2019	Frozen shark	18.1	Taiwan	Industrial
2019	Dry fins	6.1	China	Artisanal
	Total	466.5		

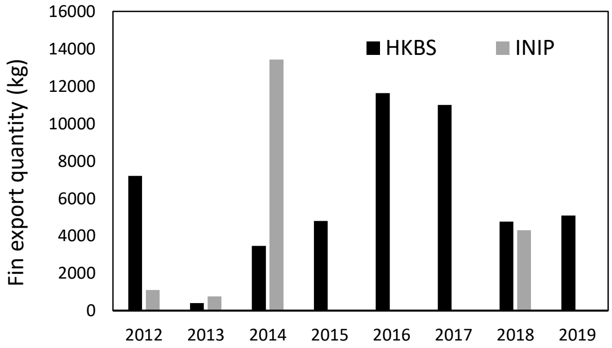


Figure 6.5.3: Imports of shark fin from Mozambique by Hong Kong SAR as reported by the Hong Kong Bureau of Statistics (HKBS, Hong Kong Census and Statistics Department 2021), and exports of shark fin from Mozambique to Hong Kong as reported by the National Fish Inspection Unit of Mozambique (INIP) for the period 2012–2019.

Overall, the prices of fins vary according to the commercial value of the species and size of the captured shark. Price marking follows a categorized classification in terms of fin quality. According to fisher interviews, the price of fins considered as first-grade ranges from 500 meticals (MZN) to MZN 1,500/kg (~US$ 7.80 – 23.50), and for second-grade fins the price ranges from MZN 200 to 500/kg (~US$ 3.10 – 7.80) (Simango 2016). The prices of fins sold by local intermediaries (generally market traders), who buy the fins from fishers and sell them on at an inflated price, generally ranges from MZN 500 to 2,000/kg (~USD 7.80 – 31.30) (Table 6.5.4). These intermediaries sell to Mozambican nationals as well as Chinese, Somali, Nigerian and Tanzanian buyers.

Table 6.5.4: Per kilogram prices, in Mozambican Meticals (US Dollars in parentheses, MZN (USD)/kg)), of shark and shark-like ray fins according to fishers at landing sites (Landing site) and market traders (Traders) in Mozambique. Adapted from Simango (2016).

		Landing site		Traders	
Province	District	First grade fin price, MZN(USD)/kg	Second grade fin price MZN(USD)/kg	First grade fin price MZN(USD)/kg	Second grade fin price MZN(USD)/kg
Inhambane	Massinga	500 (~7.80)	250 (~3.90)	1,000 (~15.70)	500 (~7.80)
Inhambane	Inhambane Bay	-	-	500 (~7.80)	-
Nampula	Angoche	1,500 (~23.50)	500 (~7.80)	2,000 (~31.30)	1,500 (~23.50)
Zambezia	Nicoadala	540 (~8.50)	230 (~3.60)	2,000 (~31.30)	500 (~7.80)
Zambezia	Pebane	-	-	2,000 (~31.30)	1,500 (~23.50)

Trade in CITES-listed chondrichthyan species

The only recorded trade in CITES-listed elasmobranch species from Mozambique since 2011 includes 13 derivatives (i.e., "any processed part of an animal") of *Pristis pristis*, exported in 2016 to Great Britain for scientific purposes, however there were no import quantities recorded by Great Britain. This discrepancy is concerning, as sawfish (Pristidae) populations in the WIO have suffered major declines, and it is uncertain whether they currently persist in Mozambique. Therefore, any trade in either *P. pristis* or *P. zijsron* should be strictly controlled and all reporting requirements should be adhered to, particularly when trading wild-sourced specimens. These may have been tissue samples for genetic analysis, and thus of no impact on wild populations, but their import should nonetheless have been recorded.

It is also of concern that *P. pristis* is the only species officially recorded as being exported by Mozambique, as the fins of at least five CITES Appendix II-listed chondrichthyan species were identified from two batches of confiscated fins in Mozambique (Table 6.5.1). These fins were destined for the export market and were thus being traded illegally, thus demonstrating the need for improved monitoring and enforcement of CITES regulations in Mozambique.

Overall, there are major discrepancies between Mozambique's reported trade volumes and those from the other countries. Unreported catches may be a factor behind the large discrepancies between reported catch and trade data (Table 6.5.2).

6.5.4 Conservation status

Chondrichthyans are targeted or caught as bycatch in most fisheries in Mozambique, yet most fisheries are poorly monitored. As a consequence of the high levels of legal and illegal fishing pressure, chondrichthyans in Mozambique are heavily overexploited, with 65 (50%) of the 131 confirmed species currently considered threatened with extinction (IUCN 2021). These include 29 Vulnerable, 24 Endangered, and 12 Critically Endangered species, according to the IUCN Red List of threatened species (IUCN 2021; see Table 3.4 in Chapter 3). Surprisingly, only four of the 24 chondrichthyan species which occur in Mozambique and are endemic to the WIO are threatened; these include the Endangered greyspot guitarfish *Acroteriobatus leucospilus*, honeycomb catshark *Holohalaelurus favus* and African spotted catshark *H. punctatus*, and the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum*. Although *H. favus* was commonly caught in fisheries and research surveys during the 1960s and 1970s, there has only been one record of this species since the 1970s (Pollom et al. 2020). The only species endemic to Mozambique, mud catshark *Bythaelurus lutarius* and sparsethorn skate *Rajella paucispinosa*, are listed as Data Deficient and Least Concern, respectively.

Owing to high site fidelity, *Mobula alfredi* is highly vulnerable to exploitation in Mozambique (Marshall et al. 2011). From 2003 to 2011, there was a decline in standardised sighting rates for this species off Praia do Tofo, Inhambane province (Rohner et al. 2013), while longer-term (2003–2016) standardised sightings of *M. alfredi*, *M. birostris* and *M. kuhlii* declined by >90% for all three species, likely driven by increased mortality due to fisheries (Rohner et al. 2017).

Declines in whale shark sightings from 2005 to 2016 were also reported (Rohner et al. 2013, Pierce and Norman 2016), which may relate to the increasing use of coastal gillnets along the Inhambane coast (pers. comm., Simon Pierce, MMF, May 2017).

The Critically Endangered whitespotted wedgefish *Rhynchobatus djiddensis* was previously relatively common along the Inhambane coastline; however, informal shark longline fisheries operating in this province reportedly had major impacts on this species in the early 2000s (Pierce et al. 2008a), while catch rates of this species have declined dramatically in neighbouring South Africa, thought to be a result of overfishing in Mozambique (Daly et al. 2020).

Two sawfish species are known from the WIO, *Pristis pristis* and *P. zijsron*. Both were formally abundant in coastal areas of the WIO, but have suffered major population declines and are now considered Critically Endangered. A countrywide baseline assessment in Mozambique revealed no catch or observation records of either species since 2014 (Leeney 2017), therefore further research is necessary to determine whether these species persist, or whether they are now locally extinct in Mozambique, as they are in South Africa (Everett et al. 2015).

There is strong evidence indicating that legal and illegal fisheries, as well as the fin trade, are negatively impacting chondrichthyan species in Mozambique. There is thus a strong need for improved conservation and management of chondrichthyans in Mozambique, particularly as southern Mozambique is a recognised global hotspot for chondrichthyan species richness, endemism and evolutionary distinctiveness (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020). Mozambique is therefore a southern African and global priority area for chondrichthyan conservation (Pollom et al. in press).

6.5.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

The Ministry of the Sea, Inland Waters and Fisheries (MIMAIP) is responsible for fisheries management and research in Mozambique (Republic of Mozambique 2015). It operates through various autonomous organizations which fall under MIMAIP: Fisheries Administration (ADNAP); National Institute of Fisheries and Aquaculture Development (IDEPA); National Fisheries Research Institute (IIP); National Fish Inspection Unit (INIP); Fisheries Promotion Fund (FFP); and Coastal and Marine Research Centre (CEPAM; Table 6.5.5).

MIMAIP is also responsible for enforcement of fisheries legislation. MCS activities are shared within MIMAIP between ADNAP and the National Directorate for Fisheries Surveillance (DNFP). Measures are in place for the monitoring of fishing activities, mainly through daily fishing logbooks, catch reports, satellite-based VMS and embarkation reports. There is also a National Plan for Preventing, Avoiding and Eliminating IUU Fishing (Republic of Mozambique 2009).

Under the Ministry of Land, Environment and Rural Development (MITADER), the National Administration of Conservation Areas (ANAC) is responsible for the control of imports and exports of CITES-listed species, as the CITES management authority, while Universidade Eduardo Mondlane is the CITES scientific authority. MIMAIP and MITADER are also responsible for species conservation in Mozambique.

Management and enforcement of MPAs are the responsibility of the Ministry of Tourism, through ANAC (Table 6.5.5). Some aspects are also addressed by MIMAIP (Gove 2011), while coastal Zone Management is the responsibility of MITADER.

Support for small-scale fisheries has included the implementation of a three-mile exclusive-use coastal zone for small-scale fisheries (Benkenstein 2013). The 2003 General Regulation also led to the development of Fisheries Co-management Committees (Comitês de Co-gestão de Pesca, CGPs) and Fishing Community Councils (Conselhos Comunitários de Pesca, CCPs[81]), now formally established in the legislation (Republic of Mozambique 2007). Fisheries Co-management Committees are multi-stakeholder committees which make decisions on fisheries regulations and advise on conflict resolution among fishers, fishing licences and fee collection. Fishing Community Councils are community-based associations of elected community members involved in artisanal fisheries, which give local stakeholders rights to establish boundaries, control access and promote the sustainable use of marine resources. Once members have been elected and the Fishing Community Council established, they can apply for legal recognition, which empowers them to assume responsibility for fishing licences and enforcement, functions otherwise administered at the district level. However, the lack of human resources, capacity and financial support limit their effectiveness as LMMAs (Benkenstein 2013, Rocliffe et al. 2014). The 2020 REPMAR revision provides further details on the structure and function of Fishing Community Councils.

There is a lack of enforcement capacity within the Mozambican fisheries authorities (NEPAD 2011). However, within the framework of the Fisheries Cooperation Program between Mozambique and Norway, the Nordenfjeldske Development Services (NFDS) has provided MCS expertise to MIMAIP to assist in the coordination, planning, delivery and training to implement the National MCS Strategy (AU-IBAR 2016). As a result, Mozambique has been a key player in other projects such as FISH-i Africa.

[81] Not to be confused with Co-operating Non-contracting Parties (CCPs).

Table 6.5.5: Designated national authorities that cover aspects of chondrichthyan management in Mozambique.

Area of management	Designated national authorities
Fisheries management	National Fisheries Administration (ADNAP), operating under Ministry of the Sea, Inland Waters and Fisheries (MIMAIP)
Fisheries research	Fisheries Research Institute (IIP) and Coastal and Marine Research Centre (CEPAM), both operating under MIMAIP
Export and import trade controls (including permitting)	National Administration of Conservation Areas (ANAC) as National CITES management authority, under Ministry of Land, Environment and Rural Development (MITADER); Universidade Eduardo Mondlane (UEM) as National CITES scientific authority; Customs (Ministry of Finance)
Permitting of fisheries	MIMAIP
Enforcement of fisheries legislation	MIMAIP
Enforcement relating to trade (including CITES and IOTC)	MIMAIP
Species conservation and environmental protection	MIMAIP; MITADER
Coastal zone management	MITADER
MPA management and enforcement	Ministry of Tourism, through ANAC; MIMAIP

National legislation and regulations

Previously, the main law in Mozambique governing fisheries was the Fisheries Law 2013 (Republic of Mozambique 2013a), which set out the legal framework for fisheries management, and applied to all vessels operating in waters under Mozambican jurisdiction and all Mozambican vessels engaged in fishing on the high seas or in the national waters of third-party States. Conservation measures included *inter alia* prohibited species and minimum legal size limits, closed seasons, minimum net mesh sizes, regulation of fishing gears, prohibited fishing gears, maximum catch limits by boat or person in a certain fishery or zone, schemes for limitation of access and fishing effort, prohibition of fishing of marine mammals and other internationally protected species, adoption of conservation measures necessary for preservation of fishery resources, and prohibition on the use of explosives and toxic substances for fishing (Republic of Mozambique 2013b). However, there were no chondrichthyan-specific measures. National legislation and species protections specifically for chondrichthyans comprised only the Regulation for Recreational and Sports Fisheries, Decree 51/99 of 31/08, which limits the catch by recreational fishers to two sharks per person per day and prohibits the capture or great white sharks *Carcharodon carcharias*, with no chondrichthyan restrictions in other fisheries.

However, in 2019–2020, a process was undertaken to revise the 2013 Fisheries Law. In October 2019, a meeting was held among ADNAP, IIP and other stakeholders, to define the criteria for chondrichthyan species requiring protection in Mozambique. Based on outcomes of this meeting, the revised Maritime Fishing Regulation of Mozambique (REPMAR, Decree 89/2020, Republic of Mozambique 2020) now imposes total prohibitions (Table 6.5.6) on the capture of 15 chondrichthyan species in Mozambique (listed in Annex XIII of REPMAR, Republic of Mozambique 2020). These chondrichthyan species were included based on their listings under Appendix I of CMS and retention bans in certain Resolutions of the IOTC. This includes six species of mobulid rays (family Mobulidae) listed at species level, although the decree covers all species within the family Mobulidae, and there is a seventh species thought to occur in Mozambique but not listed by species in the decree; the longhorned pygmy devil ray *Mobula eregoodoo*.

The revised Decree (Annex XI) also lists minimum legal size limits for 26 chondrichthyan species and one genus (*Rhynchobatus,* wedgefishes) (Republic of Mozambique 2020, see Table 6.5.7). However, the minimum size limits for some of the chondrichthyan species listed in Annex XI have no biological basis and many are smaller than the first attainment of sexual maturity, which is likely to limit their effectiveness.

Table 6.5.6. Fifteen chondrichthyan species that are prohibited from capture in Mozambique, under Annex XIII of the revised Marine Fishing Regulations of Mozambique (REPMAR, Decree 89/2020, Republic of Mozambique 2020). Species requiring protection in Mozambique by virtue of their listing in Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS I) or a prohibiting resolution of the Indian Ocean Tuna Commission (IOTC) are also indicated (x). (* denotes species with uncertain distribution in Mozambique, but that are afforded protection by virtue of the whole family being listed as prohibited).

Family	Species name	CMS I	IOTC prohibited
Batoids			
Mobulidae	*Mobula alfredi*	x	x
	Mobula birostris	x	x
	*Mobula eregoodoo**	x	x
	Mobula kuhlii	x	x
	Mobula mobular	x	x
	*Mobula tarapacana**	x	x
	*Mobula thurstoni**	x	x
Pristidae	*Pristis pristis*	x	
	Pristis zijsron	x	
Sharks			
Alopiidae	*Alopias pelagicus*		x
	Alopias superciliosus		x
	*Alopias vulpinus**		x
Carcharhinidae	*Carcharhinus longimanus*	x	x
Lamnidae	*Carcharodon carcharias*	x	
Rhincodontidae	*Rhincodon typus*	x	x

REPMAR also details other regulations that are of relevance for chondrichthyan fisheries or fisheries that catch chondrichthyans; for longlines, the law states that the Ministry can establish rules and regulations for the size of the hooks, the maximum number of hooks used on each line, the maximum length of lines, or the minimum distance between hooks, as well as any other conservation measures as seen fit. The minimum mesh size of a gillnet officially authorized for use in shark fishing is limited to 120 mm, and the maximum length of combined underwater gillnets is limited to 3,000 m. The removal of shark fins at sea is also prohibited. Since 2004, there has also been a legal requirement for the compulsory use of Turtle Exclusion Devices (TEDs) in shrimp trawl fisheries operating in Mozambican waters (Article 110 of REPMAR), which should also have the effect of reducing chondrichthyan bycatch, but implementing regulations are not yet in place. There is little public or industry interest in implementing the TED regulation, possibly because import markets for Mozambican shrimp fisheries do not currently require TEDs.

All fishing operations (excluding subsistence) and businesses connected to fishing in Mozambique are required to obtain an official fishing licence. Mozambique has entered into various bilateral Fisheries Partnership Agreements with the EU, through which the EU provides financial and technical support in exchange for fishing rights (EU 2007b), but the latest protocol expired in 2015 and it is now dormant (EU 2020).

Status of NPOA-Sharks

Drafting of the National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks), following the FAO IPOA-Sharks (FAO 1999), started in 2016. At that time, a baseline assessment was performed and the relevant information on coastal, pelagic and demersal shark species along the Mozambican coast was gathered. The NPOA development process was subsequently delayed, due (according to questionnaire respondents) primarily, to a lack of information, but also to gaps in the legal/regulatory framework, a lack of qualified personnel, and financial limitations (CEPAM 2015, Chacate and Mutombene 2015, Marques da Silva 2015). However, the process gained momentum again in 2019, including a meeting among numerous stakeholders[82]. Further discussions have been held and a revised baseline assessment report completed in 2022, and the NPOA is expected to be drafted by the end of 2023. The NPOA workplan details specific actions under each of six key pillars: 1) Management and conservation of elasmobranchs, 2) Legislation, 3) Inspection, 4) Capacity building and institutional coordination, 5) Education and environmental awareness and 6) Research and knowledge management.

[82] Representatives of Mozambique's government departments of National Administration for Fisheries, National Fisheries Research Institute, National Institute of Fish Inspection, National Institute for Fisheries and Aquaculture Development, National Directorate of Maritime and Fisheries Policies, Department of Environmental Policy Implementation, Customs, Universidade Eduardo Mondlane, National Veterinary Services and Coastal Police, as well as WWF Mozambique, WWF Netherlands, TRAFFIC, and the Wildlife Conservation Society.

Marine protected areas

Marine protected areas (MPAs) are established under the Forest and Wildlife Act (Republic of Mozambique 1999). Although there is no MPA-specific legislation, the General Regulation on Marine Fisheries (REPMAR; Republic of Mozambique 2020) allows the establishment of marine parks, marine reserves and MPAs. Each MPA is established under a specific decree presenting regulatory details for that MPA, sanctioned by the Council of Ministers (Pereira 2021). A proportion of park fees is required to be distributed to local communities and park management bodies (Benkenstein 2013).

There are currently six recognized MPAs in Mozambique, with a significant total area coverage of ~12,000 km^2, which covers at least 18% of Mozambique's territorial waters; however, this represents just 2% of Mozambique's EEZ (Pereira 2021, UNEP-WCMC and IUCN 2021d). Furthermore, the existing MPA network includes only a few, small no-take areas, does not necessarily cover representative distributions of all relevant marine habitats and species that require protection (Pereira 2021), and none of these MPAs were established for the specific protection of chondrichthyan species.

Despite these shortfalls, these are generally large MPAs, and several are known to have high densities of chondrichthyan species (or suitable habitat) and are likely offering at least some spatial protection for these species. The Ponta do Ouro Partial Marine Reserve (POPMR) in the very south of Mozambique, adjacent to South Africa, covers 678 km^2 of coastal waters (Pereira 2021) and is known to host a high species richness and abundance of chondrichthyan species. This IUCN category V MPA falls within a known global hotspot for chondrichthyan diversity, which it shares with northeast South Africa (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020). Aggregations of Vulnerable *Carcharhinus leucas* (Daly et al. 2014) and Critically Endangered *Sphyrna lewini* have been recorded in this MPA. Other threatened shark and batoid species are present in high numbers, such as the Critically Endangered *Rhynchobatus djiddensis* (a potential stronghold for this species), Endangered *Himantura uarnak* and *Carcharhinus amblyrhynchos,* and Vulnerable *Taeniurops meyeni* (WCS, IIP unpublished data). There have also recently been several records of the poorly-known, but Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum* in this MPA (Bennett et al. 2021), the only Critically Endangered shark that is endemic to the WIO (Pollom et al. in press). The POPMR has several prohibited fishing zones, and much of the coastline is poorly accessible to small fishing vessels; therefore, this MPA likely offers considerable protection for species of chondrichthyans. The POPMR abuts the iSimangaliso Wetland Park MPA in South Africa, with which it shares a global chondrichthyan hotspot, and together they form the Ponta do Ouro-Kosi Bay Transfrontier Conservation Area, a multilateral conservation initiative, which may offer protection even for migratory sharks and batoids (Guerreiro et al. 2011, Davidson and Dulvy 2017). The iSimangaliso MPA is also of great value to chondrichthyan species. Considering the high species diversity and abundance of the threatened chondrichthyans they support, and their geographic locations within a global chondrichthyan hotspot, the POPMR and the iSimangaliso MPA may well be two of the most important MPAs for chondrichthyans in the WIO. However, the POPMR faces many threats, such as illegal commercial fishing (which could impact chondrichthyans directly, or indirectly through reductions in prey availability), uncontrolled recreational fishing and a possible deep-water port development, which could all have negative impacts on chondrichthyan populations (Pereira 2021).

Bazaruto Archipelago National Park in south-central Mozambique spans an area of 1,430 km^2 and offers protection for migratory populations of bull sharks *Carcharhinus leucas*, reef *Mobula alfredi* and ginat *M. birostris* manta rays and whale sharks, and several Critically Endangered Rhinidae (wedgefish) species have been recorded. Numerous other chondrichthyan species have been recorded, including *Carcharhinus amboinensis*, *C. obscurus*, *C. limbatus*, blacktip reef sharks *C. melanopterus* and whitetip reef sharks *Triaenodon obesus* (Everett et al. 2008, Sancelme et al. 2020). The Primeiras and Segundas Islands Environmental Protection Area in north-central Mozambique covers an area of 8,357 km^2, including a diversity of coastal and offshore habitat, which is well-suited to batoids, and likely offers some protection for batoid species, potentially even sawfishes (Pristidae).

There are also four marine Key Biodiversity Areas (KBA Partnership 2020) and, although these do not provide protection from fishing, several were triggered by important chondrichthyan populations and may provide the framework for future spatial protections that consider important chondrichthyan populations.

Mozambique's MPAs are, however, characterized by insufficient resources for effective implementation – infrastructure, technical capacity, staffing, and financing – and many lack adequate management, monitoring, research, communications and business plans (Pereira and Fernandes 2014, Louro et al. 2017, Pereira 2021). Significant threats to most MPAs in Mozambique include overfishing, illegal fishing and destructive fishing practices (Pereira 2021).

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Mozambique is signatory to several MEAs and RFBs (Table 5.2, Chapter 5). Mozambique became Party to CMS in 2009 and is thereby bound by commitments prescribed in this Convention (see section 5.2.1 of Chapter 5). There are currently 12 chondrichthyan species listed on CMS Appendix I and 20 on Appendix II (including 11 listed on both appendices), which are known or assumed to occur in Mozambique (Table 3.3, Chapter 3). The State is thus legally mandated to strictly protect the 12 species listed on Appendix I, and this was recently legislated through the 2020 revision of the Maritime Fishing Regulation of Mozambique, Decree 89/2020 (REPMAR; Republic of Mozambique 2020) (Table 6.5.6). As a Party State, Mozambique is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. Mozambique should also develop regional management plans for the species listed in CMS Appendix II (see Table 5.1, Chapter 5). Although Mozambique is Party to CMS, it is not currently Party to the CMS Sharks MOU (Table 5.2). However, Mozambique is a Range State to at least 20 (54%) of the 37 species of chondrichthyans currently listed in Annex I of the MOU**,** and should thus contribute to multilateral efforts to improve the conservation status of these species. Mozambique should therefore sign the CMS Sharks MOU.

Mozambique has been Party to CITES since 1981 and is thereby required to implement means by which to ensure that international trade in chondrichthyan species listed on Appendices I and II is regulated appropriately. Two chondrichthyan species known from Mozambique are listed on CITES Appendix I and 18 species on CITES Appendix II (Table 3.3, Chapter 3). Mozambique developed a specific legal decree in 2016 for the implementation of CITES protocols and regulations, including detailed text on the permitting process for the export of products from CITES-listed species (Decree No. 34/2016 for the Regulation for CITES in Mozambique). However, by 2021, Mozambique was still considered to not meet all legal requirements for the implementation of CITES and is highlighted as requiring the attention of the CITES Standing Committee to address this (CITES 2021). While such issues may not relate specifically to chondrichthyan species, any problems with the CITES management framework are likely to affect trade in chondrichthyan species. Mozambique has, however, initiated the process of conducting NDF assessments for CITES Appendix II chondrichthyan species, and thus is making progress towards improved CITES implementation.

Mozambique is a member of two RFBs, IOTC and SWIOFC (Table 5.2). It has taken an active role in the SWIOFC since its inception, in terms of implementing mechanisms for responsible fisheries management and the MCS scheme to combat IUU fishing, and currently hosts the SWIOFC Secretariat (AU-IBAR 2016). Under the IOTC, shark, tuna and swordfish fisheries in Mozambique must report their catches and follow the IOTC regulations concerning *inter alia* chondrichthyan species, retention bans, finning and reporting (see section 5.4.1, Chapter 5). In 2014, Mozambique developed conditions of licensing for tuna fishing that include aspects relating to the conservation of sharks (Chacate and Mutombene 2015). There are currently 12 chondrichthyan species known or thought to occur in Mozambique's EEZ, which are prohibited by the IOTC (eight or which are also listed on CMS Appendix I), thereby requiring that Mozambique prohibits catches thereof, by their relevant fisheries and fishing vessels under the management of the IOTC (see Table 5.1, Chapter 5; Table 3.3, Chapter 3). The 2021 IOTC compliance report for Mozambique confirms that Mozambique is compliant in terms of prohibitions on the capture of all thresher sharks (Alopiidae), *Carcharhinus longimanus* and all mobulid rays (Mobulidae), through permit terms and conditions, while the prohibition of intentionally setting a purse seine net around whale sharks is not applicable as Mozambique operates no purse seine vessels (IOTC Secretariat 2021e). All 12 of these species are now legally and fully protected under the revised fishing regulations, in all Mozambique fisheries (REPMAR, Republic of Mozambique 2020). However, the IOTC compliance report identified repeated non-compliance issues with reporting requirements and implementation of observer coverage in the artisanal fisheries, including the requirement to report nominal catch, catch and effort, and size frequency of shark catches (IOTC Secretariat 2021e).

Mozambique has also signed SIOFA, but has not ratified the Agreement (Table 5.2); ratification would commit Mozambique to specific measures for deep-sea chondrichthyan species, for which there are active and directed commercial fisheries in Mozambique. It is worth noting that the SIOFA 2019/12 *Conservation and Management Measures for Sharks* (SIOFA 2019) lists in its Annex 1 (see Table 6.5.5, and see section 5.4.2) deep-sea chondrichthyan species that fishing vessels of contracting Parties shall not target, yet these include several species caught in the deep-water chondrichthyan-targeted fishery in Mozambique, and several for which the 2020 Fishing Regulations present minimum size limits, indicating no current adherence to the SIOFA 2019 shark measures. This will need to be addressed if Mozambique ratifies this agreement.

Mozambique is a Member State of the Nairobi Convention and is thereby bound by management measures presented under this Convention. As Mozambique is part of a global hotspot for chondrichthyans, the State should support the inclusion of this group of species in the Convention's work program and listing of relevant species under the appropriate Annexes of the Convention protocols. In 2019, Mozambique also became the host country for the Southern Africa Development Community (SADC) Regional Fisheries MCS Coordination Centre. This regional centre's mission will be to coordinate fisheries MCS and enforcement activities, set up a platform for the implementation of a regional Patrol Plan, support capacity building for implementation of the SADC Protocol on Fisheries, and develop training modules. Mozambique is also a signatory to the PSMA (Table 5.2, Chapter 5), which binds Mozambique to activities aimed at reducing IUU fishing. Chacate and Mutombene (2015) reported that progress is being made in this area. The Ramsar Convention came into force in Mozambique in 2004, and it currently has two Wetlands of International Importance, one of which is coastal (UNEP-WCMC and IUCN 2017).

Mozambique is Party to UNCLOS, the UN Fish Stocks Agreement and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments to these and the UN General Assembly Resolution on sustainable fisheries. While the UN Fish Stocks Agreement does not carry specific measures for chondrichthyans, UNCLOS and the UN General Assembly Resolution on sustainable fisheries present several chondrichthyan measures, such as reduced chondrichthyan mortality and strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). All three instruments impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks, for sustainable fisheries. Mozambique has also been a Member of the FAO since 1977 and is therefore also encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, many of which present specific chondrichthyan measures (see section 5.3).

6.5.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Mozambique

As a consequence of heavy fishing pressure, 50% of the 131 confirmed chondrichthyan species in Mozambique are currently considered threatened with extinction (IUCN 2021), and Mozambique is considered a global "darkspot" for chondrichthyans due to this high proportion of threatened species. Improved management measures are imperative.

- The Mozambican economy and population, particularly in coastal areas, rely heavily on fisheries and there is extensive fishing pressure on coastal and offshore resources.

- Targeted fishing pressure on chondrichthyans has increased over the past few decades, largely driven by the global fin trade. This has already resulted in declines in the populations of certain chondrichthyan species.
- There is excessive mortality of threatened chondrichthyan species, which comprise large proportions of the catch in some Mozambican fisheries, and in exports.
- Certain species are under immense pressure, such as *Sphyrna lewini*, which contributes significant portions of the overall artisanal fishery landings, and shark fin exports.
- There is a high level of non-compliance in fisheries, as well as IUU fishing, and chondrichthyans are a key group in the IUU fishing, particularly for fins. This means that large proportions of the volumes caught and traded go unreported, impacting estimates of catch and fishery mortality.
- The fact that the small-scale and artisanal sectors dominate the catches is of concern, as these fisheries are poorly monitored in comparison to industrial fisheries that have reporting standards.
- Juvenile chondrichthyans contribute large proportions of the catch in certain fisheries, which can have severe negative impacts on their populations.
- There is a lack of governance framework for chondrichthyan management, highlighting the need for completion of the NPOA-Sharks.
- While Mozambique has legally protected several chondrichthyan taxa, a major step towards reduced mortality of threatened chondrichthyans in the WIO, there are many other chondrichthyan species whose populations would benefit from improved management (see section 6.5.7 and Table 6.5.7 on priority species for protection).
- The minimum size limits published in the revised fishery regulations may have some positive effect on wild populations if these limits are adequately enforced. However, for many species, the minimum legal sizes set are below the size at attainment of sexual maturity and will have little protective benefit for wild chondrichthyan populations. Furthermore, size limits will have limited effect in fisheries using gears such as gillnets, where all or most of the captured animals are dead on arrival at the boat.
- While Mozambique is signatory to many MEAs, many are still inadequately implemented, such as CITES and IOTC, including poor enforcement of CITES trade controls (e.g., exports of CITES-listed species without associated NDFs), which limits the intended conservation impact (pers. comm., Isabel Chauca, IIP, May 2017) (although the 2020 revision of REMPAR is noted, which legislated all chondrichthyan protection commitments under CMS and IOTC).
- While Mozambique has several large, well-established MPAs, and some that are of great conservation value to chondrichthyan species, these are under threat from overexploitation and illegal fishing, with inadequate no-take area coverage, and none of the existing MPAs were implemented with chondrichthyan protection as a key outcome.
- There are inadequate trade controls, linked to illegal exports of the fins of sharks and shark-like rays, and reports indicate that large proportions of these come from threatened species.
- Trade monitoring is poor and there are major discrepancies in reported chondrichthyan export volumes from Mozambique and import volumes coming from Mozambique, as reported by other countries. This indicates underreporting and potential illicit trade, both of which hamper effective management. This is of particular concern for CITES-listed and threatened chondrichthyan species.
- Data for management are limited. This includes poor catch data, with very limited data at species level for chondrichthyans in most fisheries, and limited monitoring in many fisheries.
- Despite reporting standards, many of the industrial fisheries fail to meet reporting requirements set by permit conditions, IOTC or other measures.
- These threats will require addressing, before conservation and management of chondrichthyan species in Mozambique can become effective.

Required and recommended actions

Governance, policy, legislation, enforcement and capacity needs

- The high proportions of threatened species in the catch indicate that management interventions are urgent, before further stock declines are caused.
- The fishing of protected chondrichthyan species must be prohibited (pers. comm., Isabel Chauca, IIP, May 2017);
- The effectiveness of management measures currently in place should be assessed (pers. comm., Isabel Chauca, IIP, May 2017) and revised where necessary.
- The general governance and regulatory framework for fisheries management requires improvement (Bayworld 2015, CEPAM 2015). There are uncertainties about which government authority deals with the various elements of chondrichthyan management. This must be resolved to ensure that activities do not overlap and that each authority understands their mandate with regards to chondrichthyan conservation and management in Mozambique.
- Completion of the NPOA-Sharks would be a useful step towards improved policy for chondrichthyans in Mozambique.
- There is a need for specific regulations (gear-, species- and area-specific regulations), and thus the development of a dedicated chondrichthyan fishery regulation may be the most appropriate strategy for managing the fisheries for sharks and batoids, while balancing their conservation, in Mozambique.
- Management plans for artisanal fisheries should be developed or amended, to consider chondrichthyan species, including measures to limit chondrichthyan catches in artisanal fisheries (pers. comm., Isabel Chauca, IIP, May 2017);
- Critical areas in the life history of chondrichthyan species, such as aggregation sites, should be identified and protected, where relevant through the establishment of LMMAs in such critical habitats (pers. comm., Clay Obota, CORDIO East Africa, June 2017).
- Expansion of no-take MPA coverage in Mozambique (and preferably in neighbouring South Africa) could have disproportionately positive benefits for chondrichthyan conservation, due to the numbers of imperilled endemics in Mozambique and this being a global hotspot for this taxonomic group (Davidson and Dulvy 2017). This will, however, require considerable reorganization, increased coverage in priority areas and improved enforcement of regulations, and should be done in consultation with the South African authorities.
- Retention bans for prohibited chondrichthyan species and size limits for chondrichthyan species for which legal minimum size limits have been gazetted under the revised Fishery Regulations (REPMAR, Government of Mozambique 2020) must be enforced.
- Minimum size limits presented in the Fishery Regulations (REPMAR, Republic of Mozambique 2020) should be revised, taking into account the unique age and growth characteristics of each species, preferably from age and growth studies carried out in Mozambique or, at least, the Western Indian Ocean.
- Management and conservation measures (including bans on the capture of certain species) should be adopted in harmony with the various instruments of international and national regulation and conservation to which Mozambique is Party, to facilitate improved adherence to and implementation of these instruments (pers. comm., Isabel Chauca, IIP, May 2017).
- Given that the demand for fin exports is one of the major drivers for shark fishing in Mozambique, national legislation pertaining to international trade controls must be improved, such as those imposed by CITES and additional controls for other threatened chondrichthyan species, and capacity for effective enforcement must be improved (Bayworld 2015, CEPAM 2015).

Data collection and research priorities

There is a strong need for increased monitoring of chondrichthyan catches, to monitor species caught and seasonality of catches in combination with gear types used, so as to provide improved, long-term species-level catch data to inform the management of chondrichthyans in Mozambique's fisheries. There is thus a need to improve and expand the national fishery monitoring program and improve data collection and reporting (at species-level) of chondrichthyan catches and trade in chondrichthyan products (Bayworld 2015, CEPAM 2015, Marques da Silva 2015, pers. comm., Isabel Chauca, IIP, May 2017).

The main data collection and research priorities for Mozambique's chondrichthyans include:

- Monitoring programs to provide accurate current and long-term quantitative data from offshore and inshore fisheries (Pierce et al. 2008a);
- Habitat mapping and identification of critical areas (pers. comm., Isabel Chauca, IIP, May 2017), such as aggregation sites and nursery areas, particularly for threatened species;
- Understanding broad-scale and fine-scale movement behaviour, and determining population structure and genetic connectivity (particularly for migratory species);
- Assessing aspects of the reproduction of chondrichthyans in Mozambique, such as reproductive periodicity, gestation period, breeding season and parturition season;
- Age and growth studies to determine size at maturity for species caught in Mozambique's fisheries;
- Studies to determine maximum age and age at maturity for most species, to allow accurate estimates of generation length;
- Taxonomic clarification is needed for several chondrichthyan species and species-complexes;
- Priority species for further research are identified in section 6.5.2;
- Citizen science programs should be encouraged to facilitate the reporting of chondrichthyan species observed by recreational divers, which can be used to determine important areas for certain species.

Furthermore, as southern Mozambique forms part of a global hotspot for chondrichthyans and appears to exhibit high abundances of several chondrichthyan species, including numerous threatened species, appropriate conservation and management actions are essential. The northeast coast of South Africa shares this global chondrichthyan hotspot with southern Mozambique, therefore further research should focus on the linkages across this political border, such as migrations, genetic connectivity and shared stocks, to provide the necessary support for bilateral management interventions.

Additional required actions

- Increased awareness amongst national and provincial governments would be beneficial in creating political interest for improved chondrichthyan management and conservation of (Pierce et al. 2008a, CEPAM 2015).
- Raising awareness among fishing communities of existing regulations and the threat of overexploitation of threatened species, particularly within spatial protection zones, could improve fisher adherence to regulations.
- Community education programs would improve public support (Bayworld 2015, CEPAM 2015, Marques da Silva 2015).
- Relevant staff require training in monitoring techniques and data management (CEPAM 2015).
- Obtaining a research permit can be difficult and expensive, which restricts research conducted in Mozambique (Bayworld 2015); therefore, improvements to the permitting process are required, to facilitate research to fill the relevant data gaps.

6.5.7 Priority chondrichthyan species for protection

By virtue of being signatory to CMS and a Contracting Party to the IOTC, Mozambique is obliged to protect all chondrichthyan species listed on CMS Appendix I that occur in Mozambique waters (of which there are 12) and to prohibit (within fisheries under the management of IOTC) the capture of any species present in Mozambique waters that are subject to a retention ban under IOTC resolutions (of which there are also 12, of which 9 are shared with CMS Appendix I). This totals 15 chondrichthyan species (includes 4 species with uncertain distributions in Mozambique). It is noteworthy that Mozambique now protects all 15 of these species (Table 6.5.6), since the revision of the Fishery Regulations (REPMAR) in 2020 (Republic of Mozambique 2020), which lists 14 species at species level, and includes a 15th species by protection of the entire family Mobulidae). This was an important step for chondrichthyan conservation in Mozambique, and within the WIO, as this makes Mozambique the only Nairobi Convention Member State that fully protects all CMS Appendix I chondrichthyan species within its waters and all chondrichthyan species with retention bans under the IOTC (South Africa implements retention bans on IOTC prohibited species, through permit conditions in the relevant pelagic fisheries, but these species are not fully or legally protected in South Africa – see section 6.9.5).

There are, however, other chondrichthyan species assessed as threatened by the IUCN Red List of Threatened Species, which should also be considered for national protection in Mozambique, particularly those species which are caught frequently in fisheries and listed as Endangered or Critically Endangered, such as *Sphyrna lewini*, as these species are facing a very high to extremely high risk of extinction in the wild and, as such, efforts should be taken to safeguard the remaining populations of these species to ensure that their stocks do not decline further. Many of the chondrichthyan species listed in Annex XI of REPMAR, for which catches are governed by a minimum legal-size limit, are Endangered or Critically Endangered and should be considered for full protection. Additionally, many of the guiding and binding management instruments require general protection or management of threatened species as a group and do not list specific taxa directly; however, the fact that specific taxa are not listed should not allow such requirements to be ignored.

While Mozambique has not ratified SIOFA, it is a signatory to the Agreement (Table 5.2), and ratification would commit Mozambique to preventing the targeting of at least 14 deepwater chondrichthyan species present in Mozambique's waters (and others in areas beyond national jurisdiction) that are listed under Annex I of SIOFA's 2019/12 *Conservation and Management Measures for Sharks* (SIOFA 2019) (Table 6.5.7). Many of these species are currently caught (and some targeted) in the deepwater chondrichthyan-targeted fishery in Mozambique, and such targeting would need to be prohibited.

Several agreements also call for the development of multinational or regional management plans, to ensure effective management for the sustainable harvesting of threatened species, such as the species listed on CMS Appendix II. As many of these species occur in Mozambique's waters, the need for such management plans should be discussed regionally and with neighbouring States and, where necessary, developed, through multilateral agreement.

Table 6.5.7. Chondrichthyan species confirmed or reported (* not confirmed) from Mozambique for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; retention bans in certain fisheries), respectively. Species recommended for protection by virtue of their Critically Endangered or Endangered IUCN Red List status, and/or as being listed on Annex I of the Southern Indian Ocean Fisheries Agreement (SIOFA) which prohibits targeting, are also presented. Species highlighted in green are already fully protected at national level while those highlighted in yellow have legal minimum size limits (cm total length, or disc width (DW)), under Decree 89/2020 (Republic of Mozambique 2020 - see section 6.5.5 on national legislation). Also presented are relevant listings on the Appendices of CMS, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient). (Species in bold = WIO endemic).

Family	Species name	Common name	IUCN	CMS	IOTC	CITES	SIOFA	Min. size (cm)
Species for which prohibition is binding (some or all fisheries)								
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	CR	I	13/06	II		
Lamnidae	*Carcharodon carcharias*	Great white shark	VU	I/II		II		
Mobulidae	*Mobula alfredi*	Reef manta ray	VU	I/II	19/03	II		
	Mobula birostris	Giant manta ray	EN	I/II	19/03	II		
	*Mobula eregoodoo**	Longhorned pygmy devil ray	EN	I/II	19/03	II		
	Mobula kuhlii	Shortfin devil ray	EN	I/II	19/03	II		
	Mobula mobular	Spinetail devil ray	EN	I/II	19/03	II		
	*Mobula tarapacana**	Sicklefin devil ray	EN	I/II	19/03	II		
	*Mobula thurstoni**	Bentfin devil ray	EN	I/II	19/03	II		
Pristidae	*Pristis pristis*	Largetooth sawfish	CR	I/II		I		
	Pristis zijsron	Green sawfish	CR	I/II		I		
Rhincodontidae	*Rhincodon typus*	Whale shark	EN	I/II	13/05	II		
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	EN		12/09	II		
	Alopias superciliosus	Bigeye thresher shark	VU		12/09	II		
	*Alopias vulpinus**	Common thresher shark	VU		12/09	II		
Species recommended for protection by virtue of being Critically Endangered								
Carchariidae	*Carcharias taurus*	Ragged-tooth shark	CR					
Ginglymostomatidae	***Pseudoginglymostoma brevicaudatum***	**Shorttail nurse shark**	CR					
Myliobatidae	*Aetomylaeus bovinus*	Duckbill ray	CR					
	Myliobatis aquila	Common eagle ray	CR					
Rhinidae	*Rhina ancylostomus* [a]	Bowmouth guitarfish	CR			II		150
	Rhynchobatus australiae [a]	Bottlenose wedgefish	CR	II		II		150
	Rhynchobatus djiddensis	Whitespotted wedgefish	CR			II		150
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	CR	II		II		150
	Sphyrna mokarran	Great hammerhead shark	CR	II		II		150
Species recommended for protection by virtue of being Endangered								
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark	EN					
	Carcharhinus obscurus	Dusky shark	EN	II				150
	Carcharhinus plumbeus	Sandbar shark	EN					150
	Negaprion acutidens	Sicklefin lemon shark	EN					
Centrophoridae	*Centrophorus granulosus*	Gulper shark	EN				x	100
	Centrophorus lesliei	African gulper shark	EN					
	Centrophorus squamosus	Leafscale gulper shark	EN					100
	Centrophorus uyato	Little gulper shark	EN					60
Dasyatidae	*Himantura uarnak*	Honeycomb stingray	EN					80 DW
Echinorhinidae	*Echinorhinus brucus*	Bramble shark	EN					
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	EN	II		II		200
	Isurus paucus	Longfin mako shark	EN	II		II		200

Table 6.5.7 continued

Family	Species name	Common name	IUCN	CMS	IOTC	CITES	SIOFA	Min. size (cm)
Myliobatidae	*Aetomylaeus vespertilio*	Ornate eagle ray	EN					
Oxynotidae	*Oxynotus centrina**	Angular rough shark	EN					
Pentanchidae	***Holohalaelurus favus***	**Honeycomb catshark**	EN					
	Holohalaelurus punctatus	**African spotted catshark**	EN					
Rajidae	*Raja ocellifera**	Twineyed skate	EN					
	Rostroraja alba [b]	Spearnose skate	EN					100
Rhinobatidae	***Acroteriobatus leucospilus***	**Greyspot guitarfish**	EN					
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray	EN					
Stegostomatidae	*Stegostoma tigrinum* [c]	Zebra shark	EN					150
Triakidae	*Mustelus manazo**	Starspotted smoothhound	EN					
Vulnerable and Near Threatened species either listed under SIOFA Annex I, or for which REPMAR defines a minimum legal-size limit								
Carcharhinidae	*Carcharhinus falciformis*	Silky shark	VU	II		II		150
	Carcharhinus leucas	Bull shark	VU					150
	Carcharhinus limbatus	Blacktip shark	VU					150
	Carcharhinus melanopterus	Blacktip reef shark	VU					150
	Prionace glauca	Blue shark	NT	II				150
	Rhizoprionodon acutus	Milk shark	VU					60
Centrophoridae	*Centrophorus lusitanicus** [d]	Lowfin gulper shark						100
	Centrophorus moluccensis	Smallfin gulper shark	VU					60
	*Deania calceus** [e]	Birdbeak dogfish	NT				x	
	Deania quadrispinosa	Longsnout dogfish	VU					60
Dalatiidae	*Dalatias licha*	Kitefin shark	VU				x	150
Dasyatidae	*Maculabatis ambigua* [f]	Baraka's whipray	NT					40 DW
Hexanchidae	*Hexanchus nakamurai*	Bigeyed sixgill shark	NT				x	
Somniosidae	*Centroscymnus coelolepis*	Portuguese dogfish	NT				x	
	*Centroscymnus crepidater**	Longnose velvet dogfish	NT				x	
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead shark	VU	II		II		150
Squatinidae	*Squatina africana*	African angelshark	NT					60
Data Deficient and Least Concern species, listed under SIOFA Annex I								
Chlamydoselachidae	*Chlamydoselachus africana* [g]	Southern African frilled shark	LC				x	
Etmopteridae	*Etmopterus alphus*	Whitecheek lanternshark	LC				x	
	*Etmopterus pusillus**	Smooth lanternshark	LC				x	
Mitsukurinidae	*Mitsukurina owstoni*	Goblin shark	LC				x	
Pentanchidae	*Bythaelurus tenuicephalus*	Narrowhead catshark	LC				x	
Rhinochimaeridae	*Harriotta raleighana*	Narrownose chimaera	LC				x	
Somniosidae	*Scymnodon macracanthus** [h]	Largespine velvet dogfish	DD				x	
	*Zameus squamulosus**	Velvet dogfish	LC				x	

[a] Listed in REPMAR by genus only
[b] Listed in REPMAR as "*Raja alba*", the previous name for this species
[c] Listed in REPMAR as "*Stegostoma fasciatum*", the previous name for this species
[d] *Centrophorus lusitanicus* (as reported here) is a junior synonym of *C. granulosus*
[e] Listed as *Deania calcea* in SIOFA Annex I, the previous name for this species
[f] Previously listed in Mozambique as *Himantura gerrardi;* listed in REPMAR as "*Himantura gerrardi (Maculabatis gerrardi)*"
[g] Listed as *Chlamydoselachus anguineus* in SIOFA Annex I
[h] Listed as *Centroscymnus plunketi* in SIOFA Annex I, the previous name for this species

6.6 La Réunion and Mayotte

6.6.1 Introduction

Mayotte[83], La Réunion and the Îles Éparses (‘Scattered Islands’) are French Indian Ocean Territories, adding 2.7 million km^2 to France’s EEZ (Bouchard 2009). Little is known about chondrichthyans in the Îles Éparses (see Kiszka and van der Elst 2015); hence, this chapter focuses primarily on La Réunion and Mayotte.

Mayotte is situated in the northern Mozambique Channel at the south-eastern tip of the Comoros Archipelago (Figure 6.6.1a), and is composed of the largest island Grande Terre, the smaller island of Petite Terre, and several islets, all surrounded by a barrier reef. It has an EEZ of around 63,000 km^2 (Claus et al. 2014). Mayotte became an overseas department of France in 2011 and an outermost region of the EU in 2014. While the United Nations and African Union recognize Mayotte as part of Comoros, Mayotte remains governed as a Department of France. Mayotte reports catch data to the FAO under France, not Comoros, and is therefore presented in this section together with La Réunion, as French Indian Ocean Territories.

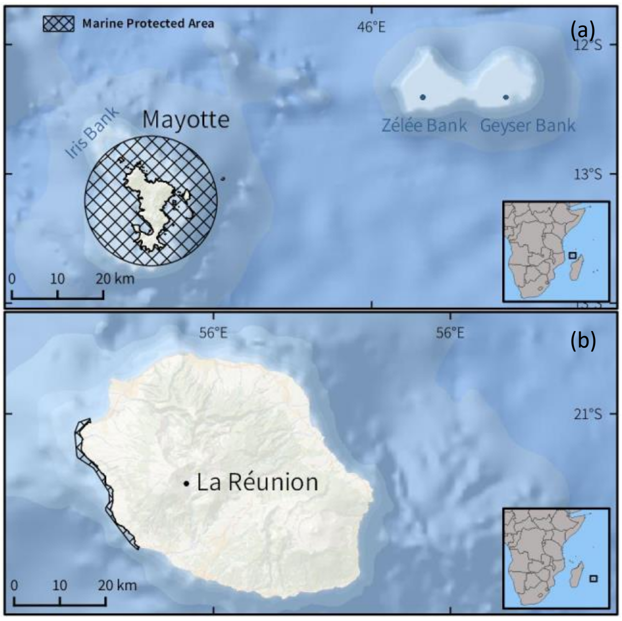


Figure 6.6.1 Maps of a) Mayotte Island group and b) La Réunion, showing their positions in the Western Indian Ocean and place names mentioned in text.

La Réunion is an overseas department of France and an island of volcanic origin. The island lies east of Madagascar and about 175 km southwest of Mauritius (Figure 6.6.1b), and forms part of the Mascarenes Archipelago (together with Mauritius and Rodrigues). It has an EEZ of about 315,070 km^2 and a coastline of 210 km, with a narrow continental shelf encompassing 595 km^2 (Claus et al. 2014).

La Réunion and Mayotte are part of a biodiversity hotspot that has recently been identified as a priority location for marine conservation due to its high species richness and levels of endemism (Myers et al. 2000). In La Réunion, fringing reef on the western coast has been protected, but the rest of the coral reefs have suffered visible degradation as human pressures increased (Conand 2002). Mayotte is almost entirely surrounded by a 197-km long barrier reef. The lagoon and surrounding reef complexes of Mayotte have an area of 1,500 km^2 with an average depth of 20 m and a maximum depth of 80 m in the western lagoon, while the peri-insular slope off the barrier reef is very steep and contains many submarine canyons and volcanoes, offering a diversity of potential habitats for marine species, including chondrichthyans.

The economy of La Réunion relies on agriculture and, increasingly, tourism; fisheries were insignificant until the 1980s but expanded in the early 2000s (Guyomard et al. 2006). There has been an increased incidence of shark attacks on surfers, divers and bathers on the west coast of La Réunion since 2011, many of which have been fatal (Lemahieu et al. 2017, Lagabrielle et al. 2018). Local authorities have officially recognised this human-shark conflict as a ‘shark crisis’. The conflict has had negative economic, social, ecological and political impacts on the island, generating negative local attitudes towards sharks, particularly bull sharks *Carcharhinus leucas* and tiger sharks *Galeocerdo cuvier* (Fabing 2014, Jaccoud 2014, Taglioni and Guiltat 2015).

[83] While the United Nations and African Union recognize Mayotte as part of Comoros, Mayotte remains governed as a Department of France, and reports catch data under France, rather than Comoros. For consistency in the data reporting and governance frameworks, we here present Mayotte with the French Department of La Réunion.

Mayotte is the second most densely populated group of islands in the SWIO, and the population depends on small-scale fishing for food security (IEDOM 2006). Tourism has increased in recent years (Guézel et al. 2009) and the entire EEZ is managed as a Marine Natural Park (Houssoyni 2021).

Longlining and trolled handlining are the two main fisheries in La Réunion (Kiszka and van der Elst 2015, Temple et al. 2019). Approximately 30 vessels conduct longlining operations throughout the year, inside La Réunion's EEZ, where they target tuna and swordfish, although sharks comprise a major bycatch component for this fishery, particularly blue sharks *Prionace glauca* (Poisson 2010). Due to increased human-shark conflict in La Réunion, since 2011, measures have been implemented to target and reduce the abundance of *C. leucas* and *G. cuvier*, such as the SMART drumlines developed in La Réunion specifically for this shark control program (Guyomard et al. 2019).

In Mayotte, fisheries are poorly developed and mostly artisanal, with fishers primarily using handlines to target reef and pelagic fish species (Kiszka and van der Elst 2015). Fishers have traditionally exploited the species-rich lagoon surrounding the island (Temple et al. 2018). Small seine nets are also used to target small reef fish on the barrier reef, and two small longline vessels based in Mayotte were known to operate within the EEZ, targeting billfish and tuna (Kiszka and van der Elst 2015). There is also a history of foreign and EU fleets operating in Mayotte's EEZ.

6.6.2 Chondrichthyan biodiversity and status of knowledge, La Réunion and Mayotte

Biodiversity

La Réunion and Mayotte have the second and third lowest chondrichthyan species richness in the WIO, respectively. La Réunion has 48 chondrichthyan species present in its waters, comprising 36 shark and 12 batoid species, representing 14 shark and 7 batoid families, respectively, and an additional 6 shark and 4 batoid species which possibly occur there, but have not been confirmed (Table 3.3). No chimaera species have been recorded from La Réunion. The requiem sharks (Carcharhinidae) represent the most common shark family, with 14 species recorded from La Réunion. All other shark families in La Réunion comprise three or fewer species. The most common batoid family is Dasyatidae (whiptail stingrays), with three species in La Réunion, while all other batoid families comprise two or fewer species.

Mayotte has 50 chondrichthyan species present in its waters, comprising 33 shark and 17 batoid species, representing 13 shark and 5 batoid families, respectively, and an additional 2 shark and 2 batoid species which possibly occur there, but have not been confirmed (Table 3.3). No chimaera species have been recorded from Mayotte. Carcharhinidae again represent the most common shark family, with 12 species recorded from Mayotte. All other shark families in Mayotte comprise three or fewer species. The most common batoid family in Mayotte is again Dasyatidae, with nine species, while all other batoid families comprise four or fewer species.

There are no chondrichthyan species endemic to La Réunion or Mayotte, and no species that are regionally endemic that occur in these two territories (Table 3.3). Of the 26 chondrichthyan species described from the WIO since 2011, only one of these (Human's whaler shark *Carcharhinus humani*) is present in La Réunion while only the bluespotted maskray *Neotrygon caeruleopunctata* is present in Mayotte (Table 3.3).

There is much uncertainty as to the historical status of sawfish in La Réunion. Although largetooth sawfish *Pristis pristis* and green sawfish *P. zijsron* have been reported from La Réunion (Wallace 1967b, Letourneur et al. 2004), these records are uncorroborated and were possibly traded from Madagascar (Pierce 2014, Dulvy et al. 2016). No sawfish species have been recorded from Mayotte.

Status of biological and ecological knowledge

<u>La Réunion</u>

Although no dedicated studies have been undertaken to assess the diversity and status of chondrichthyans around La Réunion, several species checklists for marine fish fauna have been published over the years for this territory, all of which have included chondrichthyan species. Fricke (1999) listed 24 shark and 12 batoid species, Letourneur et al. (2004) listed 29 shark and 12 batoids and Fricke et al. (2009) listed 24 shark and 11 batoid species as occurring in La Réunion. The batoid species richness presented in these three species lists matches (or closely matches) the current species count (12 batoids), however many more shark species are currently known from La Réunion (36 shark species; Table 3.1).

Chondrichthyan research in La Réunion has primarily focused on *C. leucas* and *G. cuvier*, both of which have been the cause of human-shark conflict on the island since at least 1980 (van Grevelynghe 1999), but which has increased dramatically since 2011 (Kiszka and van der Elst 2015, Lemahieu et al. 2017, Taglioni et al. 2018). As this conflict increased, a dedicated research project on these two species has been implemented by IRD (Kiszka and van der Elst 2015). Some of this research has entailed movement studies relating to these two species (e.g., Blaison et al. 2015, Mourier et al. 2021, Soria et al. 2021), while others have focused on human-shark mitigation methods (e.g., Butcher et al. 2019, Gauthier et al. 2020, Guyomard et al. 2020) and forensic methods to determine the species responsible for shark attacks on humans (Oury et al. 2021). Projects CHARC[84] and ECORECO have both focused on the biology and the trophic and behavioural ecology of *C. leucas* and *G. cuvier* around La Réunion, in response to the human-shark conflict.

Research on *C. leucas* and *G. cuvier* in La Réunion also includes studies on their trophic ecology (Trystram et al. 2016), reproductive studies (Pirog et al. 2015, 2019b), age and growth studies (Hoarau et al. 2021), levels of organic pollutants (Chynel et al. 2021) and mercury concentration (le Bourg et al. 2019) in these two species, and presence around aquaculture facilities on the Island (Loiseau et al. 2016). The genetic population structures of these two species within the WIO have also been assessed, using samples obtained from La Réunion. There was a high degree of genetic connectivity of *C. leucas* within the WIO (Pirog et al. 2019c), whereas there appeared to be some genetic differentiation for *G. cuvier* within the WIO – notably individuals from La Réunion and South Africa were significantly different from individuals from Seychelles (Pirog et al. 2019a).

Little is known about areas of importance for chondrichthyan reproduction in La Réunion, although *G. cuvier* parturition season in La Réunion is thought to be between December and January (Pirog et al. 2020), and although *G. cuvier* parturition locality is unknown in the WIO, a pregnant female thought to be a few weeks from birth was caught in La Réunion, and thus a parturition locality may occur in the vicinity of the island (Jaquemet et al. 2012). There are also important aggregation sites in La Réunion for hammerhead sharks *Sphyrna* spp., especially the scalloped hammerhead shark *Sphyrna lewini* which aggregate during September and October on the west of the island near the large drop off of Pointe au Sel (Kiszka et al. 2009). The sharks are thought to migrate past the west of the island, staying only for days at a time (Kiszka et al. 2009). The high seasonal abundance of *S. lewini* was also observed in a recent eDNA study (Mariani et al. 2021). Aggregation sites for other species such as grey reef sharks *Carcharhinus amblyrhynchos* and silvertip sharks *C. albimarginatus* existed in the past, but directed take has reduced their numbers and these species are now rarely seen (Kiszka et al. 2009, Kiszka and van der Elst 2015).

Chondrichthyan research in La Réunion includes ecological risk assessments for shark species caught by La Réunion longliners (Murua et al. 2009), self-reporting data collection in the pelagic longline fishery (Bach et al. 2013), depredation levels in the pelagic longline fishery (Romanov et al. 2013), assessments of population structure for the crocodile shark *Pseudocarcharias kamoharai* in the Atlantic and Indian Oceans, using samples obtained from individuals off the coast of La Réunion (da Silva Ferrette et al. 2015), and diversity and abundance studies using eDNA to determine chondrichthyan species present off the coast of La Réunion (Mariani et al. 2021).

The University of La Réunion is currently conducting research on dogfish (*Squalus* cf. *megalops*), comparing its trophic ecology with that of other deepwater fishes in order to better understand whether the population is increasing and to identify the underlying causes for increases in artisanal catch rates. In 2012, two chimaeras of the genus *Hydrolagus* were caught for the first time in La Réunion waters, as well as two species of little-known, deepwater dogfishes of the genus *Deania* (Mulochau and Quod 2013), but these have not yet been formally described as the taxonomy of this genus is still uncertain and under revision (pers. comm., Dave Ebert, Pacific Shark Research Centre,

[84] Connaissances de l'ecologie et de l'habitat de deux especes de Requins Cotiers sur la cote ouest de La Réunion: Knowledge of the ecology and habitats of two species of coastal sharks on the western coast of Réunion Island.

September 2021). The NGO Shark Citizen established a program to study the risk of ciguatera poisoning associated with the consumption of *C. leucas* and *G. cuvier*, after numerous poisoning incidents on the island (Anon 2017b).

The most commonly caught chondrichthyan species in pelagic longline surveys within the EEZ of La Réunion were silky sharks *Carcharhinus falciformis, Prionace glauca* and pelagic stingrays *Pteroplatytrygon violacea*. Species caught less commonly included the oceanic whitetip shark *Carcharhinus longimanus*, shortfin mako shark *Isurus oxyrinchus*, *Sphyrna lewini* and smooth hammerhead shark *S. zygaena* (Kiszka et al. 2010, Poisson et al. 2011, Romanov et al. 2011).

Mayotte

The only marine fish species checklist for Mayotte listed 15 batoid species around the island (Wickel et al. 2014), corresponding closely with the currently recognized 17 batoid species, but considerably fewer (24) shark species than the 33 shark species currently known from Mayotte (Table 3.1). The Marine Management Plan of the Mayotte Marine National Park suggests there are 39 chondrichthyan species present in the waters off Mayotte, but does not list them by species (Anon 2012).

There is very little published chondrichthyan research from Mayotte, although several small-scale initiatives have been undertaken to assess the diversity and occurrence of chondrichthyans around Mayotte and surrounding reef banks (Iris, Geyser and Zélée). Most diversity records are from a sighting network implemented in 2007 (Jamon et al. 2010).

There are also some important aggregations sites around Mayotte for sharks and batoids. In the austral winter, reef manta rays *Mobula alfredi* are commonly observed on shallow reefs (Kiszka et al. 2008, Wickel et al. 2009a), giant manta rays *Mobula birostris* are also present, with a peak in sightings in May (Anon. 2012), and *Sphyrna lewini* gather in schools sometimes exceeding 20 individuals, mainly along the barrier reef in the west and at Iris Bank (Wickel et al. 2009a, Anon 2012). In front of Papani Beach in the northeast of the Mayotte, an unidentified species of shark was observed aggregating in the area from 2004 to 2007 in the wet season. The etymology of the name of Papani Beach, meaning "the place where there are sharks" in Shimaoré, presumably refers to the historical occurrence of this phenomenon (Anon 2012). Whale sharks *Rhincodon typus* tagged in northwest Madagascar travelled in close proximity to Mayotte (Diamant et al. 2018), however there are no records of any aggregation sites for this species around the island. Similarly, *G. cuvier* tagged in Kenya were recorded moving among the EEZs of eight WIO countries within a year, including the EEZ of Mayotte (Barkley et al. 2019). These movement studies demonstrate the importance of regional collaboration for improved management of shared chondrichthyan stocks. On reefs, *Carcharhinus amblyrhynchos* and whitetip reef sharks *Triaenodon obesus* are the most common species (Jamon et al. 2010). *Carcharhinus leucas* are also regularly observed by ecotourism tour boats in shallow reefs, particularly in the north of the island. Great white sharks *Carcharodon carcharias* have also been recorded around Mayotte (Jamon et al. 2010), including a juvenile captured by a SMART drumline close inshore. Pelagic longline data from slope areas indicates that *C. falciformis*, *P. glauca* and *S. lewini* are the most common species captured in pelagic longlines (Kiszka et al. 2009).

No information regarding important areas or seasons for reproduction is available for Mayotte, other than a pregnant *G. cuvier* with at least 30 embryos of approximately 70 cm TL which was caught off the island in the month of October (Jaquemet et al. 2012), suggesting that parturition could occur close to the island. Surveys undertaken on Iris, Geyser and Zélée banks indicate lower chondrichthyan diversity (Wickel et al. 2009b), although Geyser and Zélée banks could be nursery areas for tawny nurse sharks *Nebrius ferrugineus* and *C. amblyrhynchos*, respectively (Jamon et al. 2010, Wickel et al. 2010).

The University of Montepellier MARBEC research unit – which includes staff from IRD, IFREMER and CNRS – is exploring ways to reduce incidental catches of chondrichthyans by industrial and artisanal fisheries in the WIO, through gear, bait and fishing technique modification; and exploring practices to increase the survival rate of this catch (e.g., Poisson et al. 2011, 2012, 2014, Escalle et al. 2016). Much of this work is funded by the EU. MARBEC also conducts research on the biology and ecology of chondrichthyans (e.g., Filmalter et al. 2017).

Knowledge gaps and research priorities

Considering the limited research focused on chondrichthyans in La Réunion and Mayotte, there are many knowledge gaps for the majority of chondrichthyan species within the EEZs of these two territories. There should, therefore, be a focus on prioritizing research relating to chondrichthyans in La Réunion and Mayotte, particularly for threatened species. All of the data gaps identified for these species should be prioritized for future research (as outlined in Table 3.7).

Of the 42 data-poor[85], threatened chondrichthyan species identified in Chapter 3, seven are present in La Réunion and 12 are present in Mayotte. The seven species in La Réunion comprise five batoids (representing four families) and two shark species (representing two families), while the 12 species in Mayotte comprise eight batoid species (representing three families) and four shark species (representing three families). As the majority of data-poor species that occur in La Réunion and Mayotte are the same, these are discussed together below.

There are six data-poor, threatened species in the family Dasyatidae that occur in La Réunion and/or Mayotte, comprising the Endangered honeycomb stingray *Himantura uarnak*, and Vulnerable broad cowtail ray *Pastinachus ater,* pink whipray *Pateobatis fai*, blotched stingray *Taeniurops meyeni,* porcupine ray *Urogymnus asperrimus* and mangrove whipray *U. granulatus*. Research priorities for this family and these species include most aspects of their movement and reproduction, age at maturity and maximum age for all six species, female size at maturity for all species other than *U. asperrimus,* male size at maturity for *P. ater* and size at birth for *U. asperrimus*, as outlined in Table 3.7.

The family Mobulidae comprises two data-poor, Endangered species – the shortfin devil ray *Mobula kuhlii* and sicklefin devil ray *M. tarapacana*. Other than litter size and migratory status, which is known for both species, and gestation period, which is known for *M. kuhlii*, other aspects of movement and reproduction remain poorly known for both species, in addition to age at maturity and maximum age for both species (Table 3.7).

There are two data-poor, Critically Endangered species belonging to the family Rhinidae, which occur in the two territories, the bowmouth guitarfish *Rhina ancylostomus* (which occurs in both territories) and the bottlenose wedgefish *Rhynchobatus australiae* (confirmed only in La Réunion). Other than litter size, all other aspects relating to movement and reproduction for these species should be prioritized in these two territories, in addition to age at maturity and maximum age (Table 3.7).

The Critically Endangered common eagle ray *Myliobatis aquila* is considered present in La Réunion, and, other than migratory status, gestation period and litter size, information remains limited in the majority of movement and reproduction categories for this species, in addition to age at maturity and maximum age, which should be priority areas of future research for this species (Table 3.7).

The four data-poor, threatened shark species in La Réunion and Mayotte comprise the Endangered little gulper shark *Centrophorus uyato* and Vulnerable smallfin gulper shark *C. moluccensis*, roughskin dogfish *Centroscymnus owstoni* and *Nebrius ferrugineus*. Research priorities for these four species include the majority of movement and reproduction categories, in addition to age at maturity and maximum age (Table 3.7).

There are three other shark species that are Critically Endangered and which occur in La Réunion and Mayotte, *Carcharhinus longimanus*, *Sphyrna lewini* and the great hammerhead shark *Sphyrna mokarran*. Although not data-poor, these species should be considered priorities for research due to their conservation status, particularly areas important for their reproduction.

There are also four Data Deficient (as defined by IUCN) chondrichthyan species in the two territories, comprising two shark species (which occur only in La Réunion) and two batoid species (which occur in both

[85] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

territories) (Table 3.3, Chapter 3). At least one of these, the roughskin spurdog *Cirrhigaleus asper*, is a deepwater species and is therefore infrequently encountered, limiting available information. The remaining three species, *Carcharhinus humani*, the blackspotted electric ray *Torpedo fuscomaculata* and marbled electric ray *T. sinuspersici* have coastal distributions and are exposed to coastal fisheries, and therefore warrant further research to determine their conservation status.

6.6.3 Chondrichthyan fisheries, catch and trade

Fisheries La Réunion

Fisheries in La Réunion are dominated by pelagic species including tuna, swordfish and incidentally caught chondrichthyans (Le Manach et al. 2015b). The fishing fleet can be divided into three major sectors: small artisanal inshore fishing vessels, longliners targeting large pelagic species, and large distant water vessels operating in the Southern Ocean (the latter is not discussed here). *Prionace glauca* made up approximately 6% of the catch (including discards) from 1950 to 2010, however the mortality of sharks has declined in recent years with the ban on finning, a shift in gear use, and the phasing out of coastal fisheries targeting sharks (Le Manach et al. 2015b).

Artisanal and recreational fisheries

The artisanal fishing fleet in La Réunion comprises mainly small fishing vessels (<12m in length) with engines. In 2010, approximately 240 small-scale vessels were registered in La Réunion, of which some 170 to 190 were active (Ojamaa and Martí 2015). A wide variety of demersal and pelagic species is targeted (Le Manach et al. 2015b), including large sharks, which are caught using drumlines, handlines, drop lines, bottom longlines and vertical drifting lines. Chondrichthyan species, including stingrays and *Rhynchobatus australiae*, are also incidentally caught. Shark meat is consumed locally.

Historically, the artisanal fleet focused very little on the pelagic resources, until the anchored fish aggregating device (a-FAD) was introduced by IFREMER (Le Manach et al. 2015b). In 1988, the Regional Committee for Maritime Fishing and Fish farming (Comité régional pour la pêche maritime et la pisciculture, CRPMEM) placed numerous a-FADs around the island to increase the artisanal fleets' efficiency and to reduce the fishing pressure on the coastal reefs (Biais and Taquet 1992). After a production peak and subsequent price collapse, several a-FADs were abandoned, but approximately 34 active a-FADs remained around the island, and it is estimated that almost 50% of artisanal fishing effort is exerted around these a-FADs, mostly using handlines (Tessier et al. 2000, Guyomard et al. 2012). Around 300 boats in La Réunion target reef fish using handlines (Kiszka and van der Elst 2015).

The drift longline fishery for swordfish is a source of incidental shark catch (Nadeau et al. 2014). Artisanal deepwater demersal fisheries appear to be catching increasing numbers of small dogfish (*Squalus* spp.) as incidental catch. No information is available on the chondrichthyan species caught by recreational fisheries. However, it appears that recreational fishers have been recorded fishing in close proximity to the a-FAD network (Biais and Taquet 1992).

Industrial fisheries

There is one large purse seiner registered to La Réunion (Ojamaa and Martí 2015). However, a domestic longline fleet targeting swordfish was created in 1991, when only two boats were active, and numbers quickly rose following an agreement signed between La Réunion and Mauritius, and implementation of a tax-exemption regime (Poisson and Taquet 2000). The vessels were first active in La Réunion's EEZ, Tromelin and Mauritius. More recently, a fleet of about 30 industrial pelagic longliners has operated throughout the WIO, although most catches occur in the waters east of Madagascar and southwest of La Réunion (Poisson and Taquet 2001; Le Manach et al. 2015). As well as swordfish, the drifting longlines now target tuna, particularly bigeye tuna (Poisson and Taquet 2000). Operating bases have been installed in southern Madagascar and catches are transhipped to La Réunion (Ojamaa and Martí 2015). Most of the incidental catch consists of unwanted shark and *Pteroplatytrygon violacea* (Poisson 2010, Sabarros et al. 2013), and the scale of this incidental catch is relatively well known in La Réunion. Data from voluntary logbooks (5,884 longline sets) collected between 1997 and 2000 were analysed to assess the potential impact of the La Réunion longline swordfish fishery on sharks (Poisson 2010). Total shark catch (retained and discarded individuals) was estimated to make up 7–9% of the total catch of all species. *Prionace glauca* represented between 75% and 88% of shark catches, and its CPUE declined from 1998 to 2000, from 2.2 to 1.03 sharks per 1,000 hooks. The economic interest in sharks has changed over time: at the beginning of the pelagic longline fishery in the 1990s, most *C. longimanus* and *I. oxyrinchus* were regularly kept onboard, whereas *P. glauca* were kept occasionally (Poisson 2010). More recently, *P. glauca* are reportedly discarded, while *C. longimanus* and *I. oxyrinchus* are sold in some instances (Sabarros et al. 2013).

Shark control program

A shark control program was implemented around La Réunion, in 2014, in response to a rapid increase in shark-human interactions that resulted in numerous fatalities (Lemahieu et al. 2017). The program consists of measures to capture large-bodied sharks using SMART drum lines (Guyomard et al. 2020); from 2017, any specimens caught of *C. leucas* larger than 1.5 m and *G. cuvier* larger than 2.5 m in length were culled, and since March 2018 all specimens of these species have been culled, regardless of their size (pers. comm., Michaël Hoarau, Le Centre Sécurité Requin, October 2021). The program has, however, recorded at least 10 chondrichthyan species in the waters of La Réunion (Guyomard et al. 2020).

Fisheries monitoring and reporting

Data are collected on targeted and incidental chondrichthyan catches by CRPMEM. Data collected include species, number, size, sex, weight (occasionally), biological samples (sometimes), geographic location of fishing operations, and the products taken. Data are collected via landing sites, fisheries observers, logbook reports, and a self-reporting program. Most of the official fishing data are only available with the authorization of the French authorities as they are collected within the EU data collection framework. However, underreporting is a concern for La Réunion. A reconstruction of total domestic catches (including landings and discards of artisanal, recreational, and industrial sectors) from 1950 to 2010 indicated that La Réunion has caught 1.6 times the figure reported to the FAO, excluding foreign and illegal fishery catches (Le Manach et al. 2015b). Artisanal fishers have also been known to underreport their catches to pay lower revenue taxes, while overreporting the number of trips to increase fuel tax reduction benefits (Roos et al. 1998). Furthermore, landing surveys do not cover fishing activities occurring at night, even though the pelagic longline fleet operates largely at night (Le Manach et al. 2015b).

Fisheries Mayotte

Small-scale fisheries

Fisheries around Mayotte are mainly small-scale, conducted on small, non-motorized boats and, increasingly, larger motorized boats, each with one to three fishers (Doherty et al. 2015b). The most common gear is handline (71% of effort in 2005) – used to target reef and pelagic fish – but nets are also used, and the catch derived from trolling has increased dramatically with the motorization of vessels (Herfaut 2006). Since the late 1990s fishing for demersal species on offshore banks, such as Geyser Bank, has increased (Herfaut 2005a). In a 2010 interview survey, data were collected on the bycatch, exploitation and use of elasmobranchs by small-scale coastal fisheries around Mayotte (Hamada 2010). Up to 97% of respondents confirmed taking sharks as retained bycatch and consuming the meat but not using the fins. The most commonly caught species were *C. amblyrhynchos, G. cuvier, N. ferrugineus* and *S. lewini*.

Small artisanal longliners also operate in Mayotte's territorial waters, targeting billfish and tuna. This fishery is growing rapidly; Mayotte had two longliners in 2010 and four by 2012 (Kiszka et al. 2010, Ojamaa and Martí 2015), with sharks comprising up to 20.3% of catches – usually as discarded incidental catch (Kiszka et al. 2010). The most commonly caught species in the 2000s were, in order of occurrence, *C. falciformis*, *P. glauca*, *S. lewini*, and *C. longimanus* (Kiszka et al. 2010). Based on data collected during an observer program (2009–2010), 127 (76.5%) of the total 166 sharks caught were discarded. Most of them were released alive (88.2%), others were discarded dead. The capture mortality of the sharks was recorded for 137 individuals: 16.1% were observed dead and 83.9% were alive (Kiszka et al. 2010). Based on this information, it is estimated that landed chondrichthyans contributed 4% and discarded chondrichthyans contributed 6% to total artisanal longline catch from 2004 to 2010 (Doherty et al. 2015b).

The recreational fishery has expanded with growth in tourism; in 2008 two boats were offering sports fishing trips, and sharks are targeted (Guézel et al. 2009).

Industrial fisheries

Until 2014, five large purse seiners flagged to Mayotte were operated by the French in EU and international waters (Ojamaa and Martí 2015). These vessels are now French-flagged (IOTC Secretariat 2015b), target tuna and the catch is mostly landed or transhipped in Seychelles. Subsequent to this, a new EU Sustainable Fisheries Partnership Agreement (SFPA) was established from 2014 to 2020, which permitted up to eight Seychelles-flagged tuna purse-seiners and two supply vessels to operate in EU waters, including the EEZ of Mayotte (EU 2014b). Up to 42 Spanish and French purse seiners, and about 20 EU surface longliners (Ojamaa and Martí 2015) also operated in Mayotte's EEZ over this period. This SFPA between the EU and Seychelles was renewed in 2020 and is valid for the period 2020 to 2026, although there is no specific mention of Mayotte, but rather the agreement permits 16 tuna purse seine vessels and surface longline vessels from France to fish within the EEZ of Seychelles (EU 2020).

Fisheries monitoring and reporting

The first extensive survey of the small-scale boat fisheries was completed in 1989 by Mayotte's Service des Pêches (Direction de l'Agriculture et de la Forêt). Catch data from subsequent surveys are available for 1992 (Maggiorani and Maggiorani 1990) and 1997–2005 (Herfaut 2004, 2005b, 2006). However, these surveys did not record catches by the numerous Anjouan fishers operating illegally (Doherty et al. 2015b).

Domestic longline catches are reported to the IOTC, although these did not appear to be realistic in some years (Doherty et al. 2015b). The national fishing cooperative, COPEMAY, also records catch data, but the longline data contained no chondrichthyan catches from 2006–2009, when chondrichthyan catches were known to be made (Kiszka et al. 2010). Total reconstructed domestic catches from 1950 to 2010 were 1.4 times the official figure reported to the FAO, largely due to the underreporting of small-scale catches before 1989 (Doherty et al. 2015b).

Reported chondrichthyan catches from La Réunion and Mayotte

Chondrichthyan catches in Mayotte and La Réunion are reported to the FAO in aggregate as 'Sharks, rays, skates, etc. nei' (FAO 2021). Of all the Nairobi Convention Member States, La Réunion landed the second lowest chondrichthyan catch from 2012 to 2019, accounting for less than 0.5% of the total Nairobi Convention Member State catch in all oceans and in FAO Major Fishing Area 51 (FAO 2021). During this period, La Réunion landed an average of 24.5 t of chondrichthyans exclusively from FAO Major Fishing Area 51 (Figure 6.6.2a).

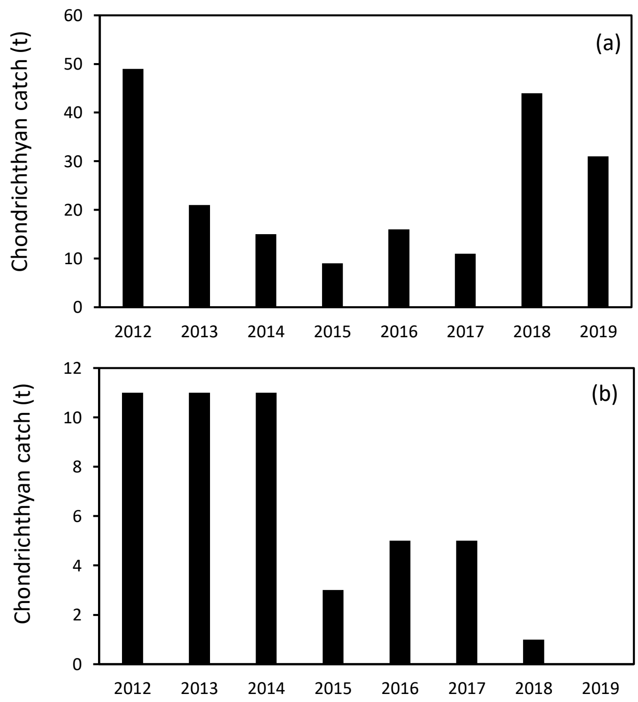


Figure 6.6.2: Total chondrichthyan catch from FAO Major Fishing Area 51 reported by La Réunion (a) and Mayotte (b), 2012–2019 (FAO 2021).

Mayotte landed the lowest chondrichthyan catch reported for FAO Major Fishing Area 51 from 2012 to 2019, with an average of 5.9 t per year (Figure 6.6.2b). The annual catch by Mayotte showed a general decline over the 2012–2019 period, and no chondrichthyan catch was reported during 2019 (Figure 6.6.2b). In comparison, chondrichthyan catch peaked in La Réunion at 49 t in 2012, then tended to decrease from 2013 to 2017, with a second peak of 44 t in 2018 and a decrease to 31 t in 2019 (Figure 6.6.2a). Given the unreliable nature of national catch statistics, these chondrichthyan catches are likely to be very conservative.

Trade in chondrichthyan products

The French Customs Department collects data on marketing of sharks and their products at the national level, and statistics on quantities exported are suggested to be available from Direction de la Mer Sud Océan Indien (DMSOI) and Customs. However, trade statistics from French Overseas Territories and from France itself have been merged and reported jointly since 1996. There is no formal fish processing in Mayotte, nor exports from Mayotte (Ojamaa and Martí 2015). Finning is illegal on EU vessels and there is no known fin trade.

Official chondrichthyan trade data

No chondrichthyan exports or imports were reported by La Réunion or Mayotte to UN Comtrade (2021) from 2012 to 2019, however there are records of imports of shark fins into Hong Kong from France (Hong Kong Census and Statistics Department 2021). From 2012 to 2019, an average of 28.3 t of shark fin was imported into Hong Kong from France, with a peak of 45.2 t in 2014 (Figure 6.6.3). However, it was not possible to search individually for the territories of La Réunion and Mayotte, therefore such imports to Hong Kong could have originated from any area under French jurisdiction.

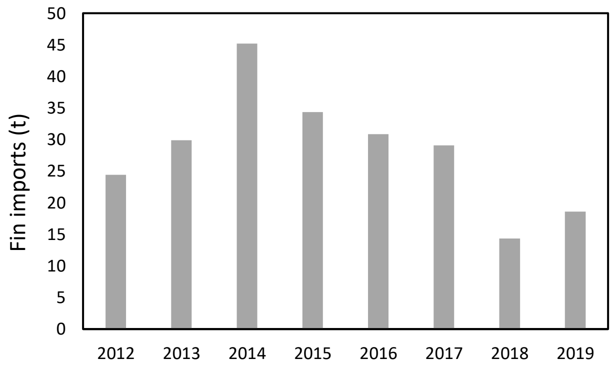


Figure 6.6.3: Hong Kong (SAR of China) imports of shark fin (HS 3057111) from France (2012–2019; Hong Kong Census and Statistics Department 2021).

Trade in CITES-listed chondrichthyan species

According to the CITES Trade Database[86], there are no official records of any CITES-listed chondrichthyan species being exported from La Réunion or Mayotte.

6.6.4 Conservation status

As a result of this heavy exploitation, 29 (60%) of the 48 confirmed chondrichthyan species in La Réunion are currently considered threatened with extinction according to the IUCN Red List of Threatened Species (IUCN 2021), the third highest proportion of threatened chondrichthyan species in any Nairobi Convention Member State or area therein. These include 15 Vulnerable, 8 Endangered and 6 Critically Endangered species (IUCN 2021, see Table 3.4).

In Mayotte, 36 (72%) of the 50 chondrichthyan species present are threatened with extinction, the highest proportion of threatened chondrichthyan species of any Nairobi Convention Member State or area therein, comprising 18 Vulnerable, 14 Endangered and 4 Critically Endangered species (IUCN 2021, Table 3.4).

Considering the high proportions of threatened chondrichthyan species in these two territories, there is strong evidence indicating that fisheries in these territories and within the WIO in general have negatively impacted chondrichthyan species present in these territories, and that improved conservation and management are needed.

[86] https://trade.cites.org

6.6.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

As La Réunion and Mayotte are both overseas departments of France, much of the institutional governance structure is the same for both islands. Fisheries are managed under the EU's Common Fisheries Policy[87] which, among other things, aims to conserve marine biological resources and ensure the effective management of fisheries targeting these resources (EU 2013b). The Common Fisheries Policy also allows for regionalisation, whereby EU countries can propose management measures for adoption into EU law (Lado 2016).

One of the few governance frameworks that differs between the two islands is for fisheries management and research. In La Réunion, this portfolio is managed by DMSOI, Institut Français de Recherche pour l'Exploitation de la Mer Réunion (IFREMER), and CRPMEM. In Mayotte, fisheries management and research were previously the joint responsibility of Parc Naturel Marin de Mayotte (part of Agence des Aires Marines Protégées) and Service des Pêches, but the latter no longer exists (Table 6.6.1).

The remaining applicable governance structures discussed herein are the same for both islands. Customs are responsible for export and import trade controls in La Réunion and Mayotte, including permitting and enforcement, but CITES permits are handled through the Direction de l'Environnement, de l'Aménagement et du Logement (DEAL; Table 6.6.1). DEAL is also responsible for species conservation, environmental protection and coastal zone management for the French overseas territories (Table 6.6.1). The Agence des Aires Marines Protégées, established in 2006, is the national public entity responsible for the creation and management of MPAs in France, including its overseas territories; however, enforcement of fisheries legislation in La Réunion and Mayotte is the responsibility of the maritime police, who are also responsible for policing the MPAs in Mayotte (Table 6.6.1).

Table 6.6.1: Designated local authorities for chondrichthyan management on La Réunion and Mayotte.

Area of management	Designated authorities La Réunion	Designated authorities Mayotte
Fisheries management and research	Direction de la mer sud Océan Indien (DMSOI); Institut Français de Recherche pour l'Exploitation de la Mer Réunion (IFREMER); Comité régional pour la pêche maritime et la pisciculture (CRPMEM)	Parc Naturel Marin de Mayotte (Agence des Aires Marines Protégées)
Export and import trade controls (including permitting)	Customs; Direction de l'Environnement, de l'Aménagement et du Logement (DEAL), as the CITES authority	Customs; Direction de l'Environnement, de l'Aménagement et du Logement (DEAL), as the CITES authority
Permitting of fisheries	DMSOI	DMSOI
Enforcement of fisheries legislation	Gendarmerie Maritime (Maritime Police)	Gendarmerie Maritime (Maritime Police)
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	Customs	Customs
Species conservation and environmental protection	DEAL	DEAL
Coastal zone management	DEAL	DEAL
MPA management and enforcement	DEAL, Agence des Aires Marines Protégées	Agence des Aires Marines Protégées; Maritime Police

National legislation and regulations

Article 5 of EU Regulation 1380/2013 (EU 2013b), which sets out rules on access to waters, allows Member States to restrict fishing, up to 12 nm from shore, to fishing vessels that have traditionally fished those waters, as long as the vessels originate from ports on the adjacent coast (EU 2013b). Article 5 also allows France to reserve the waters up to 100 nm from the baselines of La Réunion and Mayotte for vessels registered in the ports of those territories and the EU

[87] EU CFP only applies to Mayotte since it became a French Overseas Department in 2011.

vessels that traditionally fish in those waters. These regulations remain in force until 31 December 2022, after which new measures will be adopted. EC Regulation 1185/2003 prohibits finning (EU 2003), and was amended in 2013 to allow for fins to be partially sliced and folded against the carcass to facilitate onboard storage, but 'not be removed from the carcass before landing' (EU 2013c). Article 6 of EC Regulation 1185/2003 (EU 2003) requires that where vessels catch, retain on-board, tranship or land sharks, the flag State must send annually a comprehensive report on its implementation (monitoring of compliance and enforcement measures taken in the case of non-compliance) of this Regulation during the previous year. Information that must be provided includes the number of sharks landed; the number, date and place of the inspections that have been carried out; the number and nature of cases of non-compliance detected, including a full identification of the vessel(s) involved and the penalty applied for each non-compliance case; and the total landings by species (weight/number) and by port.

A Sustainable Fisheries Partnership Agreement (SPFA) between the EU and Seychelles allowed Seychelles-registered vessels to fish in the Mayotte EEZ from 2014–2020 (EU 2014b); however, the agreement permitted the capture of only highly migratory species listed in Annex 1 of the UN Convention on the Law of the Sea (UN 1982), with the exclusion of basking sharks *Cetorhinus maximus*, *Rhincodon typus*, *Carcharodon carcharias*, *Carcharhinus falciformis* and *C. longimanus*, and the families Alopiidae (thresher sharks) and Sphyrnidae (hammerhead sharks) (EU 2014b). A new SFPA between Seychelles and the EU was signed in 2020 (EU Regulation 2020/271) and is valid until 2026, although there is no specific mention of Mayotte, but rather 16 French tuna purse seine and surface longline vessels are permitted to fish within Seychelles EEZ (EU 2020).

An SFPA was established in 2014 between the EU and Madagascar which allowed La Réunion-registered vessels to fish in the Madagascar EEZ (EU 2014a), although this agreement expired in 2018. Another SFPA was signed between the EU and Mauritius for the period 2017–2021 (EU Regulation 2018/76), allowing 29 surface longliners and 16 tuna purse seiners from France to target tuna in the Mauritian EEZ (EU 2018).

There are several legal texts in La Réunion which are relevant to chondrichthyans. Arrêtés préfectoral No. 3416 legislates traditional fisheries exercised as a leisure activity inside the La Réunion Marine National Nature Reserve (Anon 2019):

- Article 1. Recreational shore fishing is prohibited on the reef platforms (lagoons) of the La Réunion Marine Nature Reserve, from the beach to the coral reef.
- For traditional fishers, the total catch (i.e., all species combined), is limited to 5 kg per day per fisher holding a fishing permit.
- Article 5 prohibits the sale of recreational catch.

Arrêtés préfectoral No. 2412-2006 regulates the species of marine fishes that can be marketed within La Réunion, with prohibitions largely based on the risk of ciguatera toxins (Anon 2006). This decree prohibits the marketing of several chondrichthyan taxa:

- Article 2 – The marketing of certain shark species in La Réunion is prohibited, including all members of the families Sphyrnidae (hammerhead sharks), Hexanchidae (cow sharks) and Carcharhinidae (requiem sharks) with the exception of two Carcharhinid species: *C. longimanus* and *Prionace glauca* that may be marketed. *Carcharhinus falciformis* may be marketed only if caught within the EEZ of La Réunion.

Arrêtés préfectoral No. 000954 (Anon 2013a):

- Article 4 – All fish must be landed whole, to ensure that they can be measured accurately.

Arrêtés préfectoral No. 1742-2008 regulates the exercise of commercial maritime fishing in the waters of La Réunion (Anon 2021b):

- Article 4 – professional underwater fishing and the use of a breathing apparatus are prohibited;
- Article 6 – limits the use of vertical longlines to two, for fishing around a FAD;
- Article 8 – prohibits the use of explosive and electrical fishing, and the use intoxicating substances (such as poisons) for catching or killing fish, crustaceans or shellfish;

- Article 9 – prohibited gears include trawls and dredges, all nets, driftnets, seines, traps or any other fishing gear made of vines, herbs, or leaves;
- Article 18a – fishing, keeping on board, transhipment, landing, storage and sale of all or part of the following shark species is prohibited: *Carcharhinus albimarginatus*, *C. amblyrhynchos*, blacktip reef sharks *C. melanopterus*, *Nebrius ferrugineus* and *Triaenodon obesus*. Any of these species caught accidentally must be released immediately and must be handled with as much care as possible. Fishers are required to record and report incidental captures and releases of live individuals of these shark species.

Arrêtés préfectoral No. 1743-2008 regulates the exercise of recreational sea fishing in the waters of La Réunion (Anon 2021c):

- Article 3 – recreationally caught fish may not be sold or traded; underwater fishing using SCUBA gear is prohibited;
- Article 5 – boats conducting recreational line fishing can use a maximum of twelve hooks;
- Article 15 – prohibits the same shark species from recreational capture, transporting, transhipment, landing, storage and sale as for commercial capture (i.e., *Carcharhinus albimarginatus*, *C. amblyrhynchos*, *C. melanopterus*, *N. ferrugineus* and *T. obesus*). Any of these species caught accidentally must be released immediately and must be handled with as much care as possible.

Other than these regulations, there are no minimum size or bag limits for chondrichthyans in the La Réunion recreational and commercial fisheries. Since 1999, it has also been illegal to sell the meat of *C. leucas* and *G. cuvier* because of the risk of ciguatera poisoning (Quod et al. 2000).

In Mayotte, relevant fisheries regulations for chondrichthyan species include the following.

- Purse seiners are excluded from fishing within the 24-nautical mile zone from the coastline (Decree No. 0291, Article No. 37; Anon 2009);
- Professional or recreational fishing of any species in the family Mobulidae (manta/devil rays) is prohibited (Arrete No. 37/UTM; Anon 2013b);
- The marketing of certain shark species in Mayotte is prohibited, as in La Réunion, comprising all members of the families Hexanchidae (cow sharks), Sphyrnidae (hammerhead sharks) and Carcharhinidae (requiem sharks) with the exception of *C. longimanus* and *P. glauca* that may be marketed. *Carcharhinus falciformis* may be marketed provided they are caught within the EEZ of Mayotte (Arrete No. 08/UTM; Anon 2015).

Finally, under the EU Fishing Opportunities Regulation 2016/72 (EU 2016), which governs EU fishing vessels and non-EU vessels fishing in EU waters, a total of 13 chondrichthyan species applicable to the WIO are prohibited from capture, retaining on board, transhipment or landing in all waters/territories, comprising *Carcharodon carcharias*, *Cetorhinus maximus*, porbeagle shark *Lamna nasus*, *Mobula alfredi*, *M. birostris*, longhorned pygmy devil ray *M. eregoodoo, M. kuhlii*, spinetail devil ray *M. mobular*, *M. tarapacana,* bentfin devil ray *M. thurstoni,* narrow sawfish *Anoxypristis cuspidata*, *Pristis pristis* and *P. zijsron.* If accidentally caught, these species must be promptly released (EU 2016).

Status of NPOA-sharks

The conservation of sharks and rays in France and its Overseas Territories of La Réunion and Mayotte is addressed within the framework of the EU Plan of Action (EUPOA-Sharks) adopted by the European Commission in February 2009 (COM 2009). The EUPOA-Sharks identifies measures deemed necessary both at the EU level (TACs, technical measures, effort and capacity limits) and under international management regimes (measures taken in the framework of RFMOs, CITES, CMS and the Barcelona Convention; Fischer et al. 2012). However, considering the geographically isolated nature of these French Departments, and the varying chondrichthyan-related issues between the waters of La Réunion and Mayotte (and between these Departments and France and the EU), conservation and management plans specific to each Department may be advisable.

Marine protected areas

There are two MPAs in Mayotte and one in La Réunion. Although not discussed in detail in this country/area profile, the îles Éparses at the local level are all classified as natural reserves with various regulations, but only Europa and Glorieuses have been proclaimed as MPAs at the national level (Pothin 2021).

Mayotte adopted its management plan in 2012, aiming to protect sensitive areas within the lagoon system, whilst improving the monitoring of inshore artisanal fisheries and domestic and foreign offshore pelagic fisheries. In Mayotte, the Marine Nature Park of Mayotte covers 63,176 km^2, encompassing the entirety of Mayotte's EEZ. Within this Nature Park is the marine section of the Nature Reserve of M'bouzi (spanning just 0.6 km^2), within which traditional and recreational longline fishing from nonmotorized boats is permitted (Pothin 2021). As the Marine Nature Park of Mayotte covers 100% of the EEZ, it includes coastal and pelagic habitats such as sandy, mangrove, seagrass, salt marsh, coral and rocky reef, deep-sea benthic habitats, and seamounts and ridges (Pothin 2021), which provide various habitats of importance for chondrichthyan species. Considering that 50 chondrichthyan species have been recorded from Mayotte (Table 3.3), these species should all receive some degree of protection within the EEZ. However, the Marine National Park is managed based on the ecosystem approach, whereby human activities compatible with the integrity of the natural habitats and biodiversity conservation are permitted (Anon 2012), therefore the degree of protection that is afforded chondrichthyans within the EEZ of Mayotte is largely dependent on effective management and enforcement of fishing gears and relevant catch restrictions.

The National Marine Reserve of La Réunion covers an area of 35 km^2, representing just 0.01% of the EEZ of La Réunion (Pothin 2021). The Reserve is coastal and includes sandy nearshore, seagrass and coral and rocky reef habitats (Pothin 2021), which are also important for various coastal chondrichthyan species. This reserve is split into different management zones, with only 6% of the reserve being declared a no-take area within which all fishing activities are forbidden (Pothin 2021). Commercial fishing inside the Reserve is prohibited in the lagoon, while giraffe crab fishing, dwarf capucin (goatfish) fishing and trolling for pelagic fish are permitted, subject to compliance with the conditions of the Reserve. Furthermore, recreational and commercial fishing are prohibited in the reinforced protection zones and in the integral protection zones of the Reserve, and it is prohibited to use (or even to have on board a vessel) any form of nets, fixed or drifting, or any underwater fishing weapon (Anon 2021b). Recreational fishing inside the Reserve is prohibited at night, but fishing on foot or by snorkelling during the day can be undertaken inside the lagoon, and recreational fishing from a registered boat less than 20 m can be conducted outside the lagoon (Anon 2021c). The reef platforms or "lagoon" waters from the beach to the coral reef, including rear reef channels and the coral reefs, constitute a fishing reserve, within which only dwarf capucin (goatfish) fishing and line fishing without a reel (gaulette fishing) are authorized, during the day and only on sandy bottoms, within the limit of 25 meters of the highest water mark. Fishing from a boat is prohibited in the lagoons. Although chondrichthyan species receive some protection inside these lagoon areas, the small size of the National Marine Reserve likely does not afford sufficient protection for chondrichthyan species present in La Réunion.

In the context of the human-shark conflict situation in La Réunion, the Marine Reserve has also received some condemnation from the Réunionese for supposedly being a source of food that attracts sharks closer to shore and also for excluding recreational fishers from the reserve, which in turn supposedly enables increased shark presence in this area (Pothin 2021). However, improved communication and awareness around the purpose of the MPA and the role it plays in shark management has improved its perception with the Réunionese. Although the relaxation of regulations inside the Reserve to allow the deployment of SMART drumlines has been proposed as a potential role the Reserve could play in terms of being part of the human-shark conflict solution (Pothin 2021), this negates the little positive benefit this reserve might have on the few chondrichthyan species that may reside or spend time in the reserve, and does not seem to be a justifiable option in terms of chondrichthyan management and conservation in La Réunion.

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Multilateral agreements and RFBs are applicable to La Réunion and Mayotte, through France and the European Union (EU), which are signatory to several MEAs and RFBs (see Table 5.2). France and the EU ratified CMS in 1990 and 2003, respectively, and are thereby bound by CMS commitments (see section 5.2.1). There are seven chondrichthyan species listed on Appendix I and 13 listed on Appendix II of CMS (six of which are listed on Appendices I and II), which are known to occur in the waters of Mayotte, while there are five chondrichthyan species on Appendix I and ten on Appendix II in La Réunion (four of which are listed on both; Table 5.1). These territories (or France) are thus obliged to protect these Appendix I species, and to implement the CMS concerted actions for whale sharks and mobulid rays. As a Party State, France is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. Many of the CMS Appendix II species present in La Réunion and Mayotte are shared with other Nairobi Convention Member States (Table 5.1), therefore these territories should participate in the development of regional management plans, where appropriate, for these species. France (2019) and the EU (2011) have also signed the CMS Sharks MOU (Table 5.2) and should thus implement measures to effectively manage the species listed in Annex I of the MOU (Table 5.1).

France approved CITES in 1978 and the EU acceded in 2015 (Table 5.2), and both are thereby required to regulate the international trade in chondrichthyan species listed on CITES Appendices I and II (see section 5.2.2). There are at least 14 chondrichthyan species listed on CITES Appendix II that occur in the waters of Mayotte and 10 in the waters of La Réunion, with no Appendix I species confirmed in either (Table 5.2). France and the EU are therefore bound by the listings of these Appendix II species. French national legislation is generally believed to meet the requirements for implementation of CITES (category 1[88] of 3; CITES 2021). However, no NDFs, as required for international export of CITES Appendix II species to confirm that such trade is not detrimental the survival of the species in the wild, could be found for the export of chondrichthyan species from the WIO French Territories. No NDFs would be required if there is no trade (as is reported) in chondrichthyan products from these territories, but that seems unlikely.

France (and the EU) are members of three relevant RFBs: IOTC, SIOFA and SWIOFC (Table 5.2). The State should therefore work with SWIOFC, and is bound by the commitments under SIOFA, which include *inter alia* a prohibition on the use of gillnets, as well as several measures specific to deep-sea chondrichthyan species, such as research on and setting of bycatch limits for these species, and prevention of targeting of the deep-sea chondrichthyans listed in Annex I of SIOFA's Shark CMM (SIOFA 2019, see section 5.4.2). Since 2015, La Réunion has headquartered SIOFA and is thus expected to play an important role in governing high seas fishing and in promoting the EU's CFP (Ojamaa and Martí 2015). Under the IOTC, French and EU shark, tuna and swordfish fisheries must report their catches and follow the IOTC regulations concerning chondrichthyan species, retention bans, finning and reporting (see section 5.4.1). These measures include the need for retention bans in IOTC-managed fisheries for eight species of chondrichthyans confirmed in Mayotte waters and five in the waters of La Réunion (Table 3.3). The 2021 IOTC compliance report for the French Overseas Territories, however, indicates that there are no vessels on the IOTC record of authorized vessels and that measures relating to the prohibition on large-scale drift nets and of shark finning, prohibition on the capture of thresher sharks *Alopias* spp. and *Carcharhinus longimanus*, as well as measures prohibiting capture and hooking of mobula rays (Mobulidae) and intentional setting of nets around *Rhincodon typus* are not applicable in the French Overseas Territories (IOTC Secretariat 2021f); although the 2020 report cited legal prohibition on any targeting, bycatch or incidental catch of mobulid rays, and that the capture of *Alopias* spp. and *C. longimanus* was banned in 2010 and 2013, respectively (IOTC Secretariat 2021f). Similarly, the requirements to report on nominal catch data, catch and effort data, and size frequency data for chondrichthyans are also listed as not applicable. Compliance for France falls under the EU compliance report, which indicates that

[88] https://cites.org/eng/res/08/08-04R15.php

measures have been taken for the prohibition on large-scale drift nets and of shark finning, prohibition on the capture of *Alopias* spp. and *C. longimanus*, as well as measures to prohibit the capture of mobulid rays and intentional setting of nets around whale sharks (IOTC Secretariat 2020b, 2021g). However, a separate report identifies the EU and certain nations specifically as being only partly compliant with reporting requirements on nominal catch data (France, Mayotte particularly), catch and effort data (France and Spain), and size frequency data (France) on sharks (IOTC Secretariat 2021g).

France is also a Member of the Nairobi Convention and both France (2016) and the EU (2011) have ratified the PSMA (Table 5.2). While neither of these instruments specifies management measures or commitments for chondrichthyan species, the Nairobi Convention lists species-specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future. Membership of the EU to the PSMA means that port officials in French overseas territories can prohibit foreign vessels that are suspected of illegal activity from receiving port services and access, and alert other ports to the situation, blocking illegally caught chondrichthyans from entering the global marketplace. This agreement is only relevant for La Réunion, since foreign vessels do not visit Mayotte. Both instruments are binding on Member States, and France and the EU are thus obliged to implement the required measures.

France is also a Party to the Ramsar Convention, which it signed in 1986 (Table 5.2). There are no Wetlands of International Importance in La Réunion, but La Vasière des Badamiers in Mayotte provides important habitats for fish (Anon 2017b), and *Sphyrna* spp. are relatively abundant off Île d'Europa (Clarke et al. 2012). France is also one of the five Members of the IOC and, while the IOC does not impose management commitments on Members, it promotes regional cooperation among the WIO island States (including the French Territories of La Réunion and Mayotte).

France (1996) and the EU (1998) are also Party to UNCLOS and the UN Fish Stocks Agreement (both 2013) and, by virtue of membership to the UN, France is a Member of the UN General Assembly (Table 5.2). France and the EU are thus bound by commitments to these measures and the UN General Assembly Resolution on sustainable fisheries (as these measures relate to La Réunion and Mayotte). While the UN Fish Stocks Agreement does not carry specific measures for chondrichthyan species, UNCLOS and the UN General Assembly Resolution on sustainable fisheries do impose specific chondrichthyan measures, such as reduced chondrichthyan mortality, strengthened management and conservation and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). All three instruments impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks, for sustainable fisheries. As a Member of the FAO since 1945, France is also encouraged to follow and implement the measures presented in the guiding documents published by the FAO, including several specific to chondrichthyans (see section 5.3).

6.6.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in La Réunion and Mayotte

Although fisheries in La Réunion and Mayotte are poorly developed relative to other countries in the WIO, there is evidence that chondrichthyans in these territories are being impacted. From 1998 to 2000, catch rates of *Prionace glauca* in the La Réunion longline fishery declined from 2.2 to 1.03 sharks per 1,000 hooks (Poisson 2010). In addition, the small shelf system around the island is considered to be overfished, although catch reconstructions of domestic and distant-water fisheries for the territory from 1950–2010 suggest that the mortality of shark species is decreasing, attributable to the increased use of circle hooks, the prohibition of shark finning from 2006 and a ban on the domestic marketing of coastal shark species (Le Manach et al. 2015b). However, elasmobranch landings in La Réunion's small-scale fisheries are currently not recorded (Temple et al. 2018), therefore no official estimates of the current exploitation of this group exist.

A 2010 interview study in Mayotte on small-scale coastal fishers revealed that 97% of respondents retained sharks as bycatch and, although fins were not collected, the meat was consumed locally (Hamada 2010). The most commonly caught species were

Carcharhinus amblyrhynchos, Galeocerdo cuvier, Nebrius ferrugineus and *Sphyrna lewini* (Hamada 2010). In the domestic pelagic longline fishery, sharks comprised 20% of catches, but were generally discarded (Kiszka and van der Elst 2015). The most commonly caught species by occurrence were *C. falciformis, Prionace glauca, S. lewini* and *C. longimanus* (Kiszka et al. 2010). Although fishing is not permitted around the Îles Éparses, illegal fishing takes place, particularly around the Glorieuses Islands, with vessels from Madagascar, Sri Lanka and possibly other countries targeting sharks in this area (Kiszka and van der Elst 2015). Key threats are detailed below.

Fisheries, trade and reporting

- Up to 97% of respondents surveyed from small-scale fisheries in Mayotte confirmed taking sharks as retained bycatch.
- Sharks comprised up to 20.3% of catches in small artisanal longliners in Mayotte, but were typically discarded, representing unnecessary mortality and lost opportunities for protein and income.
- The shark control program in La Réunion results in non-fishery mortality of chondrichthyans.
- Although the scale of incidental catch is relatively well known in the swordfish longline fishery in La Réunion, most of the official catch data are not publicly available.
- No information is available on chondrichthyan species caught by recreational fisheries in La Réunion or Mayotte.
- Of all States/areas in the Nairobi Convention area, Mayotte reported the lowest and La Réunion the second lowest chondrichthyan catches from 2012 to 2019, in FAO Major Fishing Area 51, with annual averages of 5.9 t and 24.5 t, respectively (FAO 2021), although these catch reports are likely to be underestimates.
- Underreporting is a concern for La Réunion, as a reconstruction of total domestic catches from 1950 to 2010 indicated that La Réunion caught 1.6 times the figure reported to the FAO, excluding foreign and illegal exploitation (Doherty et al. 2015b). Also, landing surveys do not occur at night, when pelagic longline fleets primarily operate (Le Manach et al. 2015b).
- Artisanal fishers in La Réunion sometimes underreport their catches to pay lower taxes, and overreport the trip numbers to benefit more from fuel incentives (Roos et al. 1998).
- Domestic longline catches in Mayotte reported to the IOTC appear to be unrealistic in some years (Doherty et al. 2015b). National longline catch data contained no chondrichthyan catches from 2006 to 2009, when chondrichthyan catches were occurring (Kiszka et al. 2010), and total reconstructed domestic catches from 1950 to 2010 were 1.4 times the official figure reported to the FAO (Doherty et al. 2015b).
- In La Réunion and Mayotte chondrichthyan catches are not reported to the FAO at the species or family level, but are aggregated in a broader group called 'Sharks, rays, skates, etc. nei', while France reports at species level for *P. glauca* and shortfin mako shark *Isurus oxyrinchus* (FAO 2021).
- Trade statistics from French Overseas Territories and from France itself have been merged and have been reported jointly since 1996.
- No chondrichthyan exports or reported imports by La Réunion or Mayotte were reported (UN Comtrade 2021) from 2010 to 2020, yet there are records of imports of shark fins into Hong Kong from France (Hong Kong Census and Statistics Department 2021), although it was not possible to search individually for the territories of La Réunion and Mayotte, therefore these imports could have originated from any area under French jurisdiction.

Governance

- The conservation of sharks and batoids in France and its Overseas Territories of La Réunion and Mayotte is addressed within the framework of the EU Plan of Action (EUPOA-Sharks), which identifies the measures deemed necessary both at the EU level and under international management regimes (Fischer et al. 2012). But no management plans are in place within each territory. The delay is reportedly due to limited political will and shortcomings in the legal/regulatory framework, limited knowledge of chondrichthyans, limited manpower, and insufficient funding.

- Although some shark species are prohibited from capture and retention in La Réunion, there are some chondrichthyan species listed on CMS Appendix I, or that are subject to IOTC retention bans, that remain unprotected in La Réunion.
- There are no minimum size or bag limits for chondrichthyans caught in the La Réunion.
- MPAs in La Réunion and Mayotte are generally too small to offer effective protection to the majority of chondrichthyan species.
- The lack of political will and public support are key constraints to developing better understanding of chondrichthyan resources and thus more effective management (Jaquemet et al. 2015).
- Chondrichthyans have not been a primary interest in La Réunion, therefore local skills and expertise for research and management have been limited (Jaquemet et al. 2015).

Information

- Historically there has been limited research on chondrichthyans in La Réunion and Mayotte, and thus there is limited biological and ecological information to inform their management at national level, aside from information gained through several recent projects linked to the shark-human conflict in La Réunion.
- No population assessments or stock assessments have been conducted on chondrichthyans in La Réunion or Mayotte.

Required and recommended actions

Governance, policy, legislation, enforcement and capacity needs

- Implementation of the French NPOA-Sharks would assist local management efforts in La Réunion. But, considering the geographically isolated nature of these French Departments, and the varying chondrichthyan-related issues between the waters of La Réunion, Mayotte and France (or the EU), conservation and management plans specific to each Department are advisable.
- As France is Party to CMS, CITES and IOTC, all of which are legally binding on Member States, the binding provisions regarding chondrichthyans must be incorporated into the management and conservation of chondrichthyan stocks in La Réunion and Mayotte. Regional management plans should also be developed for relevant CMS Appendix II-listed species.
- National legislation must incorporate CITES trade controls, to regulate international trade in CITES-listed chondrichthyan species, and systems to implement CITES trade controls and to record and report on CITES shipments must be established. Furthermore, increased capacity, increased funding and trained personnel will help to improve CITES implementation and enforcement.
- NDFs must be completed for all CITES Appendix II-listed chondrichthyan species that are exported from La Réunion and Mayotte, or imported from ABNJ.
- A ban on chondrichthyan discards should be enforced.
- Fuel tax incentives and subsidies for all fisheries should be eliminated.
- MPAs in La Réunion and Mayotte need to consider chondrichthyan conservation goals. This needs to be assessed and incorporated into the development of new MPAs, while the potential protective benefits of existing MPAs should be assessed where relevant, to identify how their contribution to chondrichthyan conservation could be improved, such as expanding the geographical coverage of no-take zones.
- The shark control program in La Réunion results in non-fishery mortality of chondrichthyans and should, therefore, be carefully weighed against conservation threats, particularly for threatened species and species that have not been implicated in the human-shark conflict.
- Culling is not thought to be a realistic solution to the human-shark conflict, particularly for *Galeocerdo cuvier* that are transient in La Réunion (Blaison et al. 2015; pers. comm., John Nevill, independent fisheries consultant, April 2017; pers. comm., David Ardill, independent fisheries consultant, May 2017; pers. comm., Marc Soria, IRD, May 2017). Rather, the results of recent and current efforts to understand behaviour and habitat use should inform shark risk management.

- Local skills and expertise for chondrichthyan research and management require improvement (Jaquemet et al. 2015).
- Attitudes have worsened in the context of the shark bites that occurred in La Réunion from 2011 to 2013, and community education programs are required (Jaquemet et al. 2015).
- Improved political will and public support are necessary to develop a better understanding of chondrichthyan resources, and thus more effective management, particularly considering the negative connotations of the human-shark conflict (Jaquemet et al. 2015).

Data collection and research priorities

Data collection priorities include:

- Recording and reporting of chondrichthyan catches should be improved in existing national fishery monitoring programs (in all fisheries), with particular emphasis on species-specific recording and reporting, and including incidental catch wherever it occurs.
- Reporting of catch and trade data to the FAO should occur at the department level (i.e., separately for La Réunion and Mayotte), and not aggregated with mainland France.
- Official catch data should be made publicly available.

Research priorities include:

- Stock assessments for chondrichthyan species known to be caught in fisheries;
- Studies regarding chondrichthyan movement behaviour, including migratory patterns, temporal movement patterns, fine-scale movements, habitat use and identification of critical chondrichthyan habitats (e.g., mating areas, breeding grounds, parturition/pupping grounds, nursery areas, aggregation sites and migration corridors);
- Genetic connectivity studies;
- Studies regarding reproductive biology and ecology, making particular use of specimens caught in La Réunion's shark control program;
- Studies investigating the age and growth (age at maturity and maximum age in particular) of chondrichthyan species present in La Réunion and Mayotte. Again, specimens can be obtained through the shark control program if live release is not possible.
- There is an urgent need for more dedicated research on species taken as incidental catch in commercial longline fisheries (including *Alopias* spp., *C. falciformis*, *C. longimanus, I. oxyrinchus*, *Sphyrna* spp. and pelagic stingrays; Jaquemet et al. 2015). While some of these species are protected by current IOTC regulations, the status of stocks, many aspects of their biology, and their conservation needs are largely unknown, as is the efficacy of current conservation measures.
- A coherent overarching research program should be developed among the different research institutions, to allow improved collaboration (Jaquemet et al. 2015).

Such information will help to elucidate critical habitats and hotspot areas for the most threatened chondrichthyan species, inform spatial and temporal protection measures such as closed areas and closed seasons, and provide the necessary information to determine reliable generation lengths which are used in assessments of conservation status.

6.6.7 Priority chondrichthyan species for protection

There are five chondrichthyan species confirmed and a further four reported from the waters of La Réunion (Table 6.6.2), as well as seven confirmed and one additional reported species from Mayotte (Table 6.6.3) that are listed on CMS Appendix I, and thereby require national level protection. As France and the EU are signatory to CMS, these species should be fully protected either through regulations pertaining specifically to these Indian Ocean territories or under French or EU regulations. These include *Carcharodon carcharias, Carcharhinus longimanus* and *Rhincodon typus,* which are present in both territories, and several mobulid rays present in one or both territories (Tables 6.6.2, 6.6.3). *Pristis pristis* and *P. zijsron* are also listed in CMS Appendix I, but these are not known from Mayotte and have not been confirmed in La Réunion (see Table 3.3, chapter 3). Under EU regulation 2016/72 (EU 2016), *Carcharodon carcharias*, all mobulid species and all sawfish species are prohibited from capture, however there does not appear to be legislation prohibiting the capture of *R. typus* or *Carcharhinus longimanus* in the French territories.

There are also five chondrichthyan species confirmed and a further four reported from the waters of La Réunion (of which six are also CMS Appendix I) (Table 6.6.2), as well as eight confirmed and two reported species from Mayotte (of which seven are also listed on CMS Appendix I) (Table 6.6.3) that require retention bans in tuna and tuna-like fisheries through IOTC resolutions. As France and the EU are signatory to IOTC, retention of these species in the relevant fisheries under IOTC management should be banned in France and its overseas departments. The 2020 IOTC compliance report for the French Overseas Territories indicated that legal prohibitions were in place for any targeting, bycatch or incidental catch of mobulid rays, *Alopias* spp. and *C. longimanus*, and on intentional setting of purse seine nets around *R. typus* (IOTC Secretariat 2020c), suggesting that France was adhering to these requirements, yet the 2021 report indicated that there are no vessels on the IOTC record of authorized vessels and that measures relating to the prohibition of the capture of these species are therefore not required (IOTC Secretariat 2021f).

There are also five (possibly) six Critically Endangered chondrichthyans in La Réunion and three in Mayotte, as well as five Endangered chondrichthyan species in La Réunion and nine in Mayotte, other than those listed in CMS Appendix I or prohibited by IOTC resolutions (Table 6.6.2), which should be considered for prohibition (at least from commercial harvesting and trade) by virtue of their poor conservation status. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1999); therefore, as a Member State of both Organizations, France should implement the precautionary principle and prohibit the take of Endangered and Critically Endangered species (Tables 6.6.2, 6.6.3). However, none of these species are currently protected under French or European Law, and the only one of these species protected by local regulations is the Endangered grey reef shark *Carcharhinus amblyrhynchos*, which is protected in La Réunion by Arrêtés préfectoral No. 1743-2008 (Anon 2021c). This law also protects four Vulnerable chondrichthyan species in the waters of La Réunion, including *Carcharhinus albimarginatus*, *C. melanopterus*, *Nebrius ferrugineus* and *Triaenodon obesus* (Table 6.6.2).

Arrêtés No. 08/UTM (Anon 2015) in Mayotte and Arrêtés préfectoral No. 2412-2006 (Anon 2006) in La Réunion prohibit the marketing of all species of hammerhead (family Sphyrnidae) and requiem (family Carcharhinidae) sharks; however, these regulations do not prohibit capture. There remain several Critically Endangered and Endangered hammerhead and requiem shark species in Mayotte's and La Réunion's waters, which should be considered for full protection, beyond the current prohibition of marketing. Furthermore, despite *C. longimanus* being Critically Endangered and listed on CMS Appendix I, these two regulations provide an exemption allowing the sale of this species, in contravention of the binding requirements of CMS. This should be addressed, and the species should be prohibited. Similarly, these regulations allow for the marketing of *Isurus oxyrinchus*, which are Endangered and should thus be considered for protection.

Table 6.6.2. Chondrichthyan species confirmed or reported (* i.e., not confirmed) from the waters of La Réunion, for which national protection (under France or the European Union) or certain fishery prohibitions are binding, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Species already under some level of regulation at Departmental level or under European Union legislation are shaded in green, those prohibited from marketing are shaded in yellow (see National legislation section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Critically Endangered and Endangered Species not already protected are also presented and are recommended to be considered for protection.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus**	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	*Alopias vulpinus**	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula birostris*	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	*Mobula eregoodoo**	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	*Mobula kuhlii**	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula tarapacana	Sicklefin devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Pristis pristis**	Largetooth sawfish	I, II		I	CR	CMS I
	*Pristis zijsron**	Green sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Other species that are protected or prohibited from marketing in La Réunion							
Carcharhinidae	*Carcharhinus albimarginatus*	Silvertip shark				VU	
	Carcharhinus amblyrhynchos	Grey Reef shark				EN	EN
	Carcharhinus melanopterus	Blacktip reef shark				VU	
	Triaenodon obesus	Whitetip reef shark				VU	
Ginglymostomatidae	*Nebrius ferrugineus*	Tawny nurse shark				VU	
Carcharhinidae	Family Carcharhinidae	All requiem sharks [a]					
Hexanchidae	Family Hexanchidae	All cow shark species					
Sphyrnidae	Family Sphyrnidae	All hammerhead sharks [b]					
Critically Endangered and Endangered species for which prohibition is recommended							
Myliobatidae	*Myliobatis aquila*	Common eagle ray				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
	Rhynchobatus australiae	Bottlenose wedgefish	II		II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR [b]
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR [b]
Carcharhinidae	*Carcharhinus plumbeus*	Sandbar shark				EN	EN [b]
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN

[a] All Carcharhinid species are prohibited from marketing/sale in La Réunion, except oceanic whitetip sharks *Carcharhinus longimanus* and blue sharks *Prionace glauca*, as well as silky sharks *Carcharhinus falciformis* caught within the EEZ of La Réunion (Arrêtés préfectoral No. 2412-2006; Anon 2006).

[b] Hammerhead (Sphyrnidae) and Requiem (Carcharhinidae) sharks that are Critically Endangered or Endangered should be considered for full protection (i.e., beyond the existing prohibition on marketing).

Table 6.6.3. Chondrichthyan species confirmed or reported (* i.e., not confirmed) from the waters of Mayotte, for which national protection (under France or the European Union) or certain fishery prohibitions are binding, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Species already under some level of regulation at Departmental level or under European Union legislation are shaded in green, those prohibited from marketing are shaded in yellow (see National legislation section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Critically Endangered and Endangered Species not already protected are also presented and are recommended to be considered for protection.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus *	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula alfredi*	Reef manta ray	I, II	Yes	II	VU	CMS I; IOTC
	Mobula birostris	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula eregoodoo *	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Pristis zijsron *	Green sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Other species that are prohibited from marketing in Mayotte							
Carcharhinidae	Family Carcharhinidae	All requiem sharks [a]					
Hexanchidae	Family Hexanchidae	All cow shark species *					
Sphyrnidae	Family Sphyrnidae	All hammerhead sharks [b]					
Critically Endangered and Endangered species for which prohibition is recommended							
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR [b]
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR [b]
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN [b]
	Carcharhinus plumbeus	Sandbar shark				EN	EN [b]
	Negaprion acutidens	Sicklefin lemon shark				EN	EN [b]
Centrophoridae	*Centrophorus granulosus*	Gulper shark				EN	EN
	Centrophorus uyato	Little gulper shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN

[a] All Carcharhinid species are prohibited from marketing/sale in Mayotte, except oceanic whitetip sharks *Carcharhinus longimanus* and blue sharks *Prionace glauca*, as well as silky sharks *Carcharhinus falciformis* caught within the EEZ of Mayotte (Arrete No. 08/UTM; Anon 2015).

[b] Hammerhead (Sphyrnidae) and Requiem (Carcharhinidae) sharks that are Critically Endangered or Endangered should be considered for full protection (i.e., beyond the existing prohibition on marketing).

6.7 Republic of Seychelles

6.7.1 Introduction

The Republic of Seychelles (hereinafter Seychelles) is an archipelagic country lying to the northeast of Madagascar (Figure 6.7.1) and comprising 115 islands. The main archipelago consists of 41 islands – 39 granitic islands of continental origin and two coralline islands; the rest are coralline and comprise three major groups: the Amirantes Islands, the Aldabra Group and the Farquhar Group. The Seychelles is the least populated country in Africa – with most of the population living on the largest island Mahé – and with relatively high social and economic indices for the region (Le Manach et al. 2015c). With just 453 km^2 of land area and the largest EEZ in the WIO (1,331,964 km^2; Claus et al. 2014), marine biodiversity is Seychelles' most important resource.

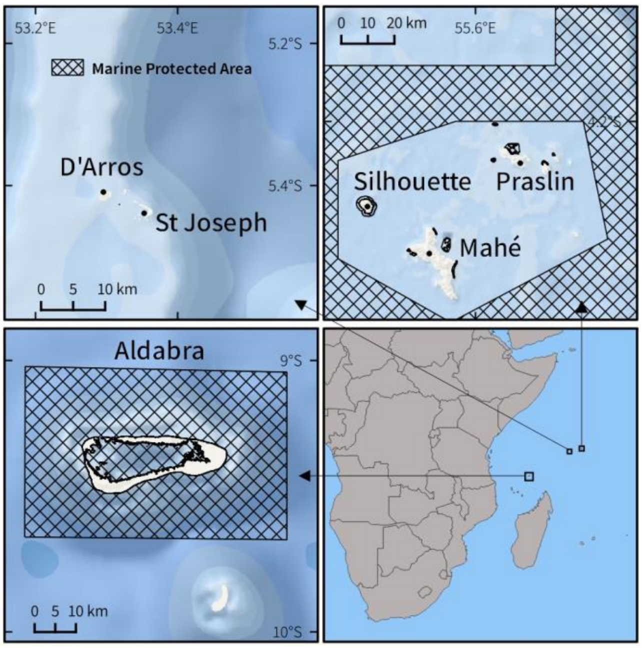


Figure 6.7.1 Map of The Republic of Seychelles, showing its position in the Western Indian Ocean, and place names mentioned in text.

The islands are part of a biodiversity hotspot that has recently been identified as a priority location for marine conservation due to its high species richness and relatively low levels of human impact (Myers et al. 2000, Selig et al. 2014). However, due to the concentration of activity on the main granitic islands, their surrounding coral reefs are under high pressure (Spalding et al. 2001). Outer islands face less fishing pressure, but shark populations have been depleted throughout the archipelago (SFA 2016).

Seychelles is one of only three Nairobi Convention Member States (the others being France and Mauritius) classified as a high-income country (World Bank 2021), and is among the countries with the highest GDP in Africa (Breuil and Grima 2014b). Fishing and tourism are key pillars of the economy (Le Manach et al. 2015c). Mahé hosts the largest tuna hub in the Indian Ocean and one of the largest tuna canneries in the world (Martin 2011).

Shark watching (particularly supported by whale sharks *Rhincodon typus*) has become an important component of the tourism industry – an importance heightened by the mass coral bleaching event of 1997/98 (SFA 2007a). *Rhincodon typus* tourism revenue for Seychelles has been valued at between USD2.02 million per year (Rowat and Engelhardt 2007) and USD4.99 million for a 14-week season (Norman and Catlin 2007), although a decline in whale shark abundance in inshore waters in recent years has reduced this economic potential (pers. comm., John Nevill, independent fisheries consultant, July 2021).

Shark fishing has occurred in Seychelles for several centuries, with dried shark meat being favoured historically due to its rich source of protein, low cost on local markets and ease of transportation (Marshall 1997b). Sharks are both targeted and caught as incidental catch in Seychelles. The Seychellois shark fishery comprises three sectors: industrial fisheries (consisting of foreign purse seiners and longline vessels), semi-industrial fisheries (consisting of a domestic longline fleet) and an artisanal fishery (multiple vessel types and varied fishing methods; SFA 2016).

The strategic vision for the fishery sector is to "Develop fisheries to its full potential whilst safeguarding the marine environment and resource base for sustainability" (SFA 2019). Effective fisheries management must therefore be seen as a significant priority.

6.7.2 Chondrichthyan biodiversity and status of knowledge, Seychelles

Biodiversity

Seychelles has the fifth lowest chondrichthyan species richness in the WIO, excluding areas beyond national jurisdiction, with 69 chondrichthyan species documented to date, comprising 51 shark and 18 batoid species, representing 20 and 7 families, respectively, and an additional 6 shark and 4 batoid species which possibly occur, but have not been confirmed (Table 3.3). No chimaera species have been recorded from Seychelles. The requiem sharks (Carcharhinidae) represent the most common shark family, with 19 species recorded from Seychelles. All other shark families in Seychelles comprise four or fewer species. The most common batoid family is Dasyatidae (whiptail stingrays), with seven species in Seychelles, while all other batoid families comprise three or fewer species.

Two chondrichthyan species are endemic to the Seychelles, the Seychelles gulper shark *Centrophorus seychellorum* and the Seychelles spurdog *Squalus lalannei* (Table 3.3), both of which are known from specimens only off Alphonse Island. There are no additional chondrichthyan species which occur in Seychelles that are regionally endemic (Table 3.3). Of the 26 chondrichthyan species described from the WIO since 2011, only one has a distribution which is believed to include Seychelles, Human's whaler shark *Carcharhinus humani* (Table 3.3), which is confirmed in Seychelles by an unregistered Seychelles specimen (White and Weigmann 2014).

There are key aggregation sites and/or nursery sites in Seychelles for reef manta rays *Mobula alfredi*, silvertip sharks *Carcharhinus albimarginatus*, grey reef sharks *C. amblyrhynchos*, bull sharks *C. leucas*, blacktip reef sharks *C. melanopterus*, tawny nurse sharks *Nebrius ferrugineus,* sicklefin lemon sharks *Negaprion acutidens* and scalloped hammerhead sharks *Sphyrna lewini* (Stevens 1984, Kiszka et al. 2009, Rowat et al. 2009, Brooks et al. 2010, Peel et al. 2020).

There is much uncertainty as to the historical status of sawfish (family Pristidae) in Seychelles. Two species of sawfish were historically recorded as occurring in the Seychelles (SFA 2016), although the species are not confirmed. While recent reports suggest that it is possible that these records refer to specimens traded from Madagascar (Pierce 2014, Dulvy et al. 2016), at least two earlier publications report sawfish in Seychelles waters, listing *Pristis antiquorum* (a synonym for *Pristis pristis*) in fisher catches on the Mahe Plateau and the outer islands (Pike 1873) as well as through visual observation at Aldabra (Smith 1955). However, recent and historical information indicate that any and all species of sawfish have now been extirpated from Seychelles' waters.

Status of biological and ecological knowledge

A national list of chondrichthyan species was compiled in 2007, and then updated in 2016 to list 52 shark and 22 ray species, not including unnamed species (SFA 2007a, 2016), however there are now 69 chondrichthyan species confirmed from Seychelles (Table 3.3). The ecology of chondrichthyans is not well understood in Seychelles, but stakeholder surveys conducted in 2005 indicated that shark biodiversity in Seychelles has declined, relative to historical accounts (Nevill 2005). However, shark numbers in the Amirantes are markedly higher than in the central Seychelles, where there is a long-standing fishing operation (pers. comm., Rupert Ormond, Heriot-Watt University, May 2017).

Data on the behavioural ecology of sharks in Seychelles is generally limited (Filmalter et al. 2013a), although better than many other countries in the WIO. Since 1996, the Marine Conservation Society Seychelles (MCSS) has been monitoring *R. typus* in Seychelles. Marine Conservation International (an NGO based in the United Kingdom) has also been involved, first working in Aldabra and now in the Amirantes. In 2010, MCSS began a multi-species acoustic tracking program in northwest Mahé, with the aim of improving knowledge of threatened and indicator species (including chondrichthyans) in this biodiversity hotspot and involving the local community. It continues with the cooperation of Seychelles National Parks Authority (SNPA), Seychelles Fishing Authority (SFA) and local businesses and organizations.

SOSF D'Arros Research Centre in the Amirantes Group runs a project that aims to conduct an initial assessment of populations of *C. melanopterus* and *N. acutidens* in the Seychelles, and to investigate how natural resources are partitioned between and within these species (Anon 2017c). These findings will be crucial for general management and conservation strategies of juvenile predators in this and other nursery habitats. The French Institut de Recherche pour le Développement (IRD) is also conducting research on the inshore nursery grounds and home ranges of *N. acutidens*.

There have been several movement studies on chondrichthyan species in Seychelles. Distributions and migrations of coastal sharks around the inner granitic islands have been investigated by the SFA through acoustic telemetry (SFA 2015a, 2015b). The study revealed high fidelity of juvenile *N. acutidens* to the Bay Ternay MPA. This species also exhibited restricted area use and high site fidelity to St. Joseph Atoll in the Amirantes Islands, highlighting the vulnerability of *N. acutidens* to localised overexploitation and the importance of remote habitats like St. Joseph and Aldabra Atolls for their conservation (Filmalter et al. 2013a). Aldabra Atoll is also an important area for *C. albimarginatus* and *C. melanopterus* (Stevens 1984, Clarke et al. 2012). *Rhincodon typus*, mainly juveniles, were known to aggregate around Mahé (Rowat 2007, Kiszka et al. 2009, Rowat et al. 2009, 2011, Brooks et al. 2010), but this apparently no longer occurs (pers. comm., John Nevill, independent fisheries consultant, October 2021). Dive operators have reported that 20 years ago, a *C. amblyrhynchos* aggregation around Marianne Island commonly hosted 70 sharks or more, whereas now no more than five are typically seen at one time (SFA 2016). Annual aggregations of *S. lewini* persist at some sites in Seychelles (pers. comm., John Nevill, independent fisheries consultant, April 2017). A high abundance of *C. leucas* was described in Port Victoria in 2013, although this was an artefact of anthropogenic influences rather than natural behaviour, as the high numbers were attributed to dumping of fish waste in the port area and off the east coast of Mahé (SFA 2016).

A large, pregnant *C. leucas*, which was tagged in Seychelles with a pop-up satellite-linked archival transmitter (PAT) and an acoustic transmitter, travelled to southeast Madagascar and back over a period of approximately three months (Lea et al. 2015), travelling a distance of at least 4,000 km during that time. Acoustic and archival pop-up satellite tracking and photo-identification of *M. alfredi* around D'Arros Island and St Joseph Atoll showed that individuals are detected year round, with a peak between November and April, with all five satellite-tagged individuals remaining within the Seychelles EEZ (Peel et al. 2019b, 2020). Silky sharks *Carcharhinus falciformis* tagged with PAT tags after being caught in a tuna purse seine near Seychelles were documented travelling west to Somalia, while other individuals swam east in close proximity to Indonesia (Onandia et al. 2021). Similarly, tiger sharks *Galeocerdo cuvier* tagged in Kenya were recorded moving among the EEZs of eight countries, within one year, including that of Seychelles (Barkley et al. 2019). These movement studies demonstrate the importance of regional collaboration for improved management of shared chondrichthyan stocks, and the need for regional management measures.

Acoustic tracking of *C. albimarginatus, C. amblyrhynchos*, *C. melanopterus*, *Negaprion acutidens* and *Nebrius ferrugineus* around D'Arros Island and St Joseph Atoll provide information on fine-scale habitat use to inform the expansion of a proposed MPA, to ensure that the MPA would incorporate important habitat for these shark species (Lea et al. 2016). Photo identification of 724 *R. typus* from key aggregation sites in Djibouti, Madagascar, Mozambique, Seychelles and Tanzania showed no matches between populations, suggesting that individuals do not move between these aggregation sites (Brooks et al. 2010, Diamant et al. 2018), although one male *R. typus* recorded in Mozambique in 2010 was observed in Seychelles eight months later, showing some connectivity at least between these two known aggregation areas (Andrzejaczek et al. 2016).

There have been several genetic studies conducted in Seychelles or at least using genetic samples collected in Seychelles. A study investigating the global population structure of *C. leucas* revealed genetic differences between sharks from the Western Atlantic and those from the Western Pacific and Western Indian oceans, with no evidence of contemporary gene flow (Pirog et al. 2019c). However, genetic connectivity was high within the WIO, with samples taken from Madagascar, Mozambique, La Réunion, Rodrigues, Seychelles, South Africa and Zanzibar. The results suggest that gene flow occurs along coastlines and highlights the need for management of this species at the regional level (Pirog et al. 2019c). There was weak genetic differentiation for *G. cuvier* observed between the WIO and Western Pacific Ocean, suggesting a high degree of connectivity, although variations in mitochondrial DNA suggested some level of differentiation, notably individuals from La Réunion and South Africa were significantly different from individuals from Seychelles (Pirog et al. 2019a). Population genetics has also suggested that there is significant genetic differentiation, and thus little genetic connectivity, between *M. alfredi* in Seychelles and those in Maldives and Chagos (Hosegood 2020).

There are several known areas of importance for chondrichthyan reproduction in the Seychelles. The broad cowtail ray *Pastinachus ater*, porcupine ray *Urogymnus asperrimus* and mangrove whipray *U. granulatus* have nursery areas around St Joseph Atoll (Elston et al. 2017, 2019, 2021). The Aldabra Atoll is an important breeding, parturition and nursery area for various chondrichthyan species. *Carcharhinus amblyrhynchos* uses Aldabra Atoll as a parturition and nursery area, with peak parturition occurring around October (Stevens 1984). *Carcharhinus melanopterus* and *N. acutidens* both mate between October and November at Aldabra Atoll, and also use the area as a nursery ground, with parturition of *N. acutidens* neonates occurring during October (Stevens 1984). There is also a nursery for *N. acutidens* around Curieuse Island. Catches from artisanal fisheries in Seychelles also provide insight into the reproductive biology and ecology of several shark species landed in the fishery. *Carcharhinus albimarginatus* pup off the continental shelf and have nursery grounds on the outer banks of Seychelles; spinner sharks *C. brevipinna* are thought to have a nursery area on the Seychelles plateau; *C. falciformis* may use the outer banks as a nursery habitat and the spottail shark *C. sorrah* uses inshore areas as nurseries (SFA 2016). In addition, *C. leucas* seem to pup between October and November in nearshore waters in Seychelles and appear to use the east coast of Mahé as nursery grounds (SFA 2016), while the blacktip shark *C. limbatus* has a distinct pupping season from April to June, with *S. lewini* and great hammerhead sharks *S. mokarran* pupping in Seychelles' waters from July to August, and around December, respectively (SFA 2016).

There are some historical accounts of sightings of great white sharks *Carcharodon carcharias*, hammerheads sharks (unknown species) and *G. cuvier* on the coasts of the inner granitic islands in the 1940s, which indicate that there may have been a decline in abundance of these species – a possibility that has been corroborated by interviews with people involved in the shark fishery in the 1950s (see SFA 2007a).

Knowledge gaps and research priorities

Although there has been much research on chondrichthyans in Seychelles relative to other countries in the WIO, particularly research relating to movement and important areas for reproduction, which have been highlighted as key research priorities for the region (see Chapter 3), research is still lacking for many species, resulting in numerous knowledge gaps for the majority of chondrichthyan species within the Seychelles' EEZ; therefore, there should be a focus on prioritizing research relating to chondrichthyans in Seychelles, particularly for threatened species. All of the data gaps identified for these species should thus be prioritized for future research (as outlined in Table 3.7, in Chapter 3). Of the 42 data-poor[89], threatened chondrichthyan species identified, 12 are present in Seychelles, comprising nine batoid species (representing four families) and three shark species (representing three families).

There are five data-poor, threatened species in the family Dasyatidae that occur in Seychelles, comprising the Endangered honeycomb stingray *Himantura uarnak*, and Vulnerable *Pastinachus ater*, blotched stingray *Taeniurops meyeni, Urogymnus asperrimus* and *U. granulatus*. Other than litter size, which is known for *H. uarnak, P. ater* and *T. meyeni*, most aspects of movement and reproduction remain poorly known for these five species. In addition, age at maturity and maximum age are unknown for all five species, female size at maturity is unknown for all species except *U. asperrimus*, and male size at maturity and size at birth are unknown for *P. ater* and *U. asperrimus*, respectively (Table 3.7).

[89] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

There are two data-poor, Critically Endangered species belonging to the family Rhinidae which occur in Seychelles, the bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*. Other than litter size, all other aspects relating to movement and reproduction for these species should be prioritized in Seychelles, in addition to age at maturity and maximum age (see Table 3.7).

The families Mobulidae and Myliobatidae each comprise one data-poor, threatened species that occurs in Seychelles, the Endangered shortfin devil ray *Mobula kuhlii* and ornate eagle ray *Aetomylaeus vespertilio*, respectively. Litter size and migratory status are known for both species, and gestation period is known for *M. kuhlii*, however all other aspects of movement and reproduction remain poorly known for both species. Age at maturity and maximum age are also unknown for both species, in addition to female size at maturity and size at birth for *A. vespertilio* (Table 3.7), therefore future research should focus on these aspects for these two Endangered species.

The three data-poor, threatened shark species in Seychelles comprise the smallfin gulper shark *Centrophorus moluccensis* (family Centrophoridae), roughskin dogfish *Centroscymnus owstoni* (Somniosidae) and *Nebrius ferrugineus* (Ginglymostomatidae), all of which are classified as Vulnerable. Other than migratory status, which is known only for *N. ferrugineus*, all other aspects of movement are poorly known for these three species. Age at maturity, maximum age, gestation period and parturition season are also unknown for all three species, therefore future research should focus on these aspects as outlined in Table 3.7.

Although not data-poor, there are also three Critically Endangered shark species that occur or have been recorded in Seychelles, the oceanic whitetip shark *Carcharhinus longimanus*, *S. lewini* and *S. mokarran*. All three species are caught in Seychelles, with *S. lewini* comprising one of the main species caught in the artisanal catch (SFA 2016). Therefore, future research should prioritize these species, particularly areas important for their reproduction.

There are also four Data Deficient chondrichthyan species in Seychelles (as defined by the IUCN (2019)), comprising two shark and two batoid species (Table 3.3). One of these, the roughskin spurdog *Cirrhigaleus asper*, is a deepwater species from the family Squalidae (dogfish sharks), and is thus infrequently encountered, limiting available information. The remaining three species, *Carcharhinus humani* (family Carcharhinidae, requiem sharks), the blackspotted electric ray *Torpedo fuscomaculata* and marbled electric ray *T. sinuspersici* (family Torpedinidae, torpedo rays) have coastal distributions and are exposed to coastal fisheries, and therefore further research is needed to establish their conservation status to help inform their effective management.

6.7.3 Chondrichthyan fisheries, catch and trade

Fisheries

Shark fisheries have a long history in Seychelles, dating back to the 1920s when sharks were primarily caught for their meat (Marshall 1997b). However, there was evidence of a decline in the importance of sharks within the artisanal sector in the early 2000s (SFA 2007a). Before the Second World War, sharks were caught as incidental catch and retained, dried and used locally for consumption. An intensive shark fishery developed in the 1940s and operated through the 1960s, and was responsible for dramatic declines in shark abundance (SFA 2016). As fishing effort increased, a decline in large sharks around the central islands was noted and by the end of the 1960s they were almost absent off Mahé (Smith and Smith 1969).

Industrial tuna fisheries (purse seine and longline) have existed around Seychelles since the mid-1950s, and expanded with the development of Port Victoria in the early 1980s. A semi-industrial longline fishery targeting swordfish and tuna was initiated in the mid-1990s and resulted in considerable incidental catch of sharks. By the late 1990s, the high export value of shark fins likely prompted increased targeting of sharks by longliners (Bargain 2001). A ban on exports of swordfish to the EU by Seychelles (imposed to address the cadmium levels in swordfish meat (2003–2005)), also increased the targeting of sharks by swordfish vessels (Breuil and Grima 2014b, SFA 2016).

Exploitation of Seychelles' shark stocks has continued in recent years and concerns have been raised regarding the sustainability of catch levels and the practice of finning in certain fisheries (Kiszka and van der Elst 2015).

Three main fisheries operate in Seychelles (Le Manach et al. 2015c, SFA 2019):

- The artisanal fishery comprises fishers who use traps, nets, harpoons and handlines and a fleet of small and large boats targeting demersal and semi-pelagic species on or near shallow waters (typically 0–60m) of the banks and reefs. The artisanal fishery is concentrated predominantly around the inner islands of Mahé, Praslin and La Digue. The majority of domestic catch in Seychelles is artisanal (Breuil and Grima 2014b, Le Manach et al. 2015c).
- The semi-industrial fleet consists of small (14 m to 22 m) Seychellois-owned and operated longline vessels, that target large pelagic species (mostly swordfish and tuna) offshore of the continental shelf (Breuil and Grima 2014b).
- The industrial fleet comprises vessels that are foreign-owned and foreign- or Seychelles-flagged, with purse-seiners targeting predominantly pelagic tuna species and longliners targeting deeper-swimming tuna species throughout the region (Breuil and Grima 2014b).

Artisanal and recreational fisheries

From 2007 to 2016, there were on average 416 artisanal boats operating in Seychelles at any time (SFA 2019). Fishing effort during this period was highest for fishing traps, although handlines were responsible for the highest catch each year (SFA 2019). Artisanal fishers target mainly demersal teleost species, although shark species are among the targets (Kiszka and van der Elst 2015). Artisanal fisheries are open access, and subject to limited management control (Breuil and Grima 2014b).

An estimated eight to ten artisanal operators target sharks specifically, operating year-round from Mahé and Praslin (SFA 2016). They use anchored and buoyed longlines (known locally as 'drag'), which typically range from 150–400 m in length, set with 50–150 baited hooks – a largely non-selective method (SFA 2016). A small boat harpoon fishery also targets rays, selling the catch at local markets (Everett et al. 2017). Artisanal fishers tend to land and use the entire shark, primarily for local consumption (SFA 2016, Everett et al. 2017).

Numbers of recreational fishing boats in Seychelles increased sharply in the 1990s, but estimates are not reliable (SFA 2014), although it is estimated that they are responsible for approximately 3.5% of total marine catches (Le Manach et al. 2015c). Information on chondrichthyan catches is unavailable in this fishery.

Semi-industrial fisheries

From 2004 to 2014, four to nine semi-industrial longliners were operating in Seychelles, increasing to 11 vessels in 2015 and 29 vessels in 2016, targeting tuna and swordfish (SFA 2014, 2019). From 2005, four to five semi-industrial longliners have targeted sharks full-time, primarily for their fins; however, in July and August when swordfish are scarce, it is usual for all boats to target sharks (SFA 2016). Buoyed monofilament longlines with metal traces are used to target sharks, with an average of 350–400 baited hooks set over some 12–15 miles of line.

This fishery historically targeted primarily swordfish and tuna; however, the 2003 EU ban on swordfish exports resulted in many of these vessels shifting their focus towards catching sharks, predominantly for their fins (Breuil and Grima 2014b). Shark fins were retained while the carcasses were often discarded at sea (Compagno et al. 2005), although this practice has presumably declined following the prohibition of shark finning. The SFA has discouraged the targeting of sharks by semi-industrial fishers by introducing a Fisheries Incentive Regulation, which specified that fishers whose catch exceeded 15% of sharks per trip did not quality for fuel concessions (tax rebates), which prompted several vessels to return to targeting swordfish (Breuil and Grima 2014b); however, such a measure probably incentivized underreporting of shark catches, and when vessels were caught exceeding this catch limit, they were ultimately not penalised (pers. comm., John Nevill, independent fisheries consultant, October 2021).

Industrial fisheries

In 2016, 47 industrial purse seiners operated out of the Seychelles, 14 of which were flagged to Spain, 13 to Seychelles and 12 to France (SFA 2019). During this time, Port Victoria remained a hub for the landing and transhipment of tuna caught by purse seiners in the WIO (SFA 2019). In the longline fishery, 183 vessels were active in Seychelles in 2016, with 105 vessels flagged to Taiwan and 47 to Seychelles, and with bigeye tuna being the dominant species caught (SFA 2019). Decreasing trends in the number of licensed vessels operating in Seychelles over the last two decades have been linked to Somali piracy threat levels (SFA 2016). There is a high level of incidental catch of *C. falciformis* in the WIO tuna purse seine fishery associated with FADs, leading to extremely high mortality (Filmalter et al. 2013b), which is considered higher in Seychelles than other areas (Amandè et al. 2008, 2011). Of concern is that these mortalities are likely not recorded and not represented in discard figures (SFA 2016).

Longline vessels also catch sharks as incidental catch – mainly pelagic species and particularly blue sharks *Prionace glauca* and mako sharks *Isurus* spp., whereas the carcasses of most other species are discarded at sea due to their lower value (SFA 2007b, 2016). Although EU vessels have been banned from finning sharks since 2003 and finning by foreign vessels has been banned in Seychellois waters since 2006, the effectiveness of these bans has not been determined (SFA 2007a) and finning apparently still occurs (SFA 2016). The IOTC implemented a ban on the removal of fins from carcasses at sea, in 2017 (Resolution 17/05), which may have subsequently helped to reduce the incidence of this practice.

Fisheries monitoring and reporting

WIOFish reported 47% of Seychelles fisheries to be monitored for catch and effort (creel surveys, onboard observers and required submission of catch returns) and 16% to have some biological monitoring in place (data on species composition, sex, reproductive state, lengths and weights, and samples of otoliths and vertebrae of some species; Everett et al. 2017). Landings are recorded at 54 landing sites throughout the main Islands (Mahé, Praslin and La Digue; SFA 2015b). Weight of catch is reported by fishing gear and boat type, and, for the semi-industrial and industrial fisheries, individual species are disaggregated for reporting as required by the logbook regulations.

Monitoring is much better in the artisanal shark fisheries than in the industrial and semi-industrial fisheries. Intensive surveys have been conducted through the monitoring of artisanal catch, including cooperation with the Artisanal Shark Fishers Association (2012–2015 and 2017–2019), collecting data on seasonality, size range, and size-at-maturity for at least 25 shark and 10 batoid species (J. Nevill, unpublished data). All these data remain private, except for those for the year 2013 (SFA 2016). Through these surveys, a national monitoring protocol was developed, technicians were trained, a species identification guide was produced, and a national database established (SFA 2016). This protocol addressed the issue of not being able to record length-frequencies for dressed carcasses, by generating morphological models from intact specimens of the 10 most commonly landed species (98% of landed catch). There is no monitoring in the recreational fishery.

The SFA reports official catch statistics to the FAO and foreign fleets fishing in Seychellois waters are required to report catches to the IOTC. However, these official catch statistics do not include the artisanal fishery data collected by the Artisanal Shark Fishers Association. A reconstruction of total domestic catches (including landings and discards of artisanal, recreational and industrial sectors) from 1950 to 2010 suggested that the Seychelles' domestic fishers alone have caught 1.3 times the figure reported to the FAO, and that does not include foreign and illegal exploitation in Seychelles' waters (Le Manach et al. 2015c). The recent introduction of fuel tax incentives has likely further reduced the reliability of reporting by the semi-industrial fishery. There are also discrepancies in official industrial longline data; for instance, there are records of porbeagle sharks *Lamna nasus*, a species not present in the Seychelles, but there are no records of *Sphyrna* spp., and remarkably few records of *C. longimanus* (SFA 2016), which are confirmed from Seychelles' waters and appear in high proportions in similar fisheries of other WIO countries, and would therefore be expected to be present in the Seychelles catches.

In the WIOFish database, only the hook-and-line, longline, swordfish and tuna fisheries have chondrichthyan bycatch recorded, and this is all recorded as '*Carcharhiniformes*'. There is very little species-level catch reporting of chondrichthyans in Seychelles, with the majority of chondrichthyan catch aggregated as "sharks and rays" (SFA 2019). This means that CITES Appendix II shark species are generally not specified as such, but rather grouped in catch statistics under "sharks" or "sharks and rays". A workshop run by the SmartFish 'Sharks and Rays

Initiative' in November 2014 provided training on the identification of sharks and rays to fishers, observers and inspectors in Seychelles (Bodiguel et al. 2017). The training was intended to build capacity of participants to use the identification keys to identify pelagic sharks and rays, collect samples and biological data from sharks and rays and to have a greater awareness of CITES and IOTC requirements. The observers monitor the purse seine fishery, with 93 observers deployed in 2015. In 2016, observer coverage decreased due to the implementation of Electronic Monitoring Systems being installed on some vessels, which was seen as a substitute to replace observer coverage (SFA 2019).

Reported chondrichthyan catches

On average, shark and ray species contributed only 1% of artisanal catches between 2007 and 2014, which reportedly averaged 29.9 t per year during this time (SFA 2016), although between 2015 and 2016 elasmobranch catch increased by 16% (SFA 2016, 2019). In a one-year survey of artisanal catch in 2013, 20 shark species and two batoid species were recorded, with the most common species being *C. amblyrhynchos, C. limbatus, C. sorrah* and *S. lewini* (Table 6.7.1).

Table 6.7.1: Chondrichthyan species caught during a one-year survey of the Seychellois artisanal fishery (ordered by relative contribution to total chondrichthyan catch), including IUCN Red List Status (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened). Adapted from SFA (2016).

Family name	Species name	Common name	% of total chondrichthyan catch	IUCN Red List Status
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey reef shark	31.7	EN
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	18.3	CR
Carcharhinidae	*Carcharhinus limbatus*	Blacktip shark	14.2	VU
Carcharhinidae	*Carcharhinus sorrah*	Spottail shark	11.5	NT
Carcharhinidae	*Carcharhinus brevipinna*	Spinner shark	8.8	VU
Carcharhinidae	*Carcharhinus albimarginatus*	Silvertip shark	5.2	VU
Rhinidae	*Rhynchobatus australiae*	Bottlenose wedgefish	3.0	CR
Carcharhinidae	*Carcharhinus falciformis*	Silky shark	2.5	VU
Sphyrnidae	*Sphyrna mokarran*	Great hammerhead shark	2.0	CR
Carcharhinidae	*Carcharhinus leucas*	Bull shark	1.1	VU
Carcharhinidae	*Carcharhinus plumbeus*	Sandbar shark	0.5	EN
Galeocerdidae	*Galeocerdo cuvier*	Tiger shark	0.5	NT
Carcharhinidae	*Loxodon macrorhinus*	Sliteye shark	0.2	NT
Carcharhinidae	*Negaprion acutidens*	Sicklefin lemon shark	0.2	EN
Carcharhinidae	*Triaenodon obesus*	Whitetip reef shark	0.1	VU
Carcharhinidae	*Carcharhinus melanopterus*	Blacktip reef shark	< 0.1	VU
Hemigaleidae	*Hemipristis elongata*	Snaggletooth shark	< 0.1	VU
Ginglymostomatidae	*Nebrius ferrugineus*	Tawny nurse shark	< 0.1	VU
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish	< 0.1	CR
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead shark	< 0.1	VU

From 2007 to 2014, incidental chondrichthyan catch in the semi-industrial longline fishery comprised approximately 2–9% of total catch, with an average of 244.9 t per year (SFA 2016). However, during this time vessels were found with large quantities of fins onboard, suggesting that the figures reported to SFA are substantially lower than actual shark catch by semi-industrial vessels (SFA 2016). From 2009 to 2014, shark bycatch in the semi-industrial longline fishery was reported to species level for *C. longimanus,* shortfin mako sharks *Isurus oxyrinchus,* longfin mako sharks *I. paucus, P. glauca* and to family level for hammerhead sharks (SFA 2016).

Chondrichthyan catch reported to the FAO indicates that Seychelles landed the eighth largest chondrichthyan catch of all Nairobi Convention Member States between 2012 and 2019, accounting for 1.7% of the total Nairobi Convention Member State catch in all oceans and 3.2% in FAO Fishing Area 51 alone (FAO 2021). Most catches reported to the FAO were in the category 'Sharks, rays, skates, etc. nei', although species-level catch records were reported for *I. oxyrinchus* and *P. glauca*. However, official records from the industrial shark longline fishery in Seychelles reported shark bycatch to species level for *C. longimanus, I. oxyrinchus, Lamna nasus* and *P. glauca* (SFA 2016). Therefore, there appear to be reporting inconsistencies to the FAO.

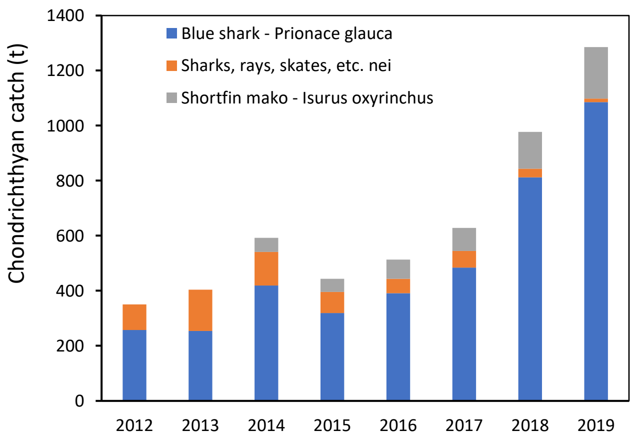


Figure 6.7.2: Seychelles chondrichthyan catches by species and category, from FAO Major Fishing Area 51, for 2012–2019 (FAO 2021).

From 2007 to 2014, chondrichthyans were reported to constitute 0.02–0.25% of the purse seine catch, averaging 40 t per year, while in the industrial longline fishery chondrichthyans comprised between 1 and 6% of total catch, averaging 224.5 t per year (SFA 2016). From 2012 to 2019, Seychelles landed an annual average of 659 t from all oceans (FAO 2021). The majority (99%) of the catches were from FAO Fishing Area 51 (averaging 649 t per year; Figure 6.7.2) and the remaining 1% was from the Eastern Indian Ocean (9.4 t per year).

Of the chondrichthyan catch reported to the FAO by Seychelles, *P. glauca* comprised the majority across all years from 2012 to 2019, peaking at 1.1 t in 2019 (Figure 6.7.2). However, given the unreliable nature of national catch statistics, these figures are probably quite conservative.

Trade in chondrichthyan products

Historically, artisanal shark fishing was conducted for dried or salted shark meat, and for the local use of liver oil for maintenance of traditional vessels (Marshall 1997b). However, there is evidence of a trade in shark fins going as far back as 1840 (J. Nevill, unpublished data). Commercial shark fishing expanded after 1950 to meet demand from Asia (Marchand 1956, 1957). Exports of chondrichthyan products are recorded by the SFA and some statistics are available (SFA 2014, 2016), but the recent statistics for dried shark fins have been combined with sea cucumbers in annual reports (SFA 2015c), making it impossible to discern the exact quantities of chondrichthyan products exported.

No detailed data are being collected on the market chain for chondrichthyan products; therefore, the exact chondrichthyan products (and their respective quantities) exported from Seychelles, or the means of transport used, remain unknown, although some NGOs and private consultants may be trying to address this gap (MCSS 2015). It was reported that chondrichthyan products are generally sold directly to the public at local markets or on the roadside (MCSS 2015).

Shark fins saw a dramatic (~90%) decline in their value in local markets in 2014, following a ban on the freighting of dried shark fins by key airlines servicing Seychelles. This, in turn, is thought to have reduced the targeting and landing of sharks in the semi-industrial longline fleet, which had until then been responsible for targeting of sharks for the fin trade, as well as within the artisanal fishery (SFA 2016).

Official chondrichthyan trade data

Seychelles imports of shark products

Seychelles reported no imports of chondrichthyan products to UN Comtrade (2021) over the period 2012–2019, and there were no reports of countries exporting chondrichthyan products to Seychelles in this period (UN Comtrade 2021). However, it is likely that some introductions from the sea are taking place, which would constitute import and the requirement to report such an import.

Seychelles exports of shark products

Seychelles reported few exports of chondrichthyan products to UN Comtrade (2021) over the period 2012–2019, including 24.26 t of frozen shark meat in 2017, 3.07 t of shark fins in 2018 and 26.52 t of frozen shark meat and shark fins in 2019 (Table 6.7.2). However, national data were available on shark fin exports, as presented in the NPOA-Sharks (SFA 2016), for the period 2006–2014, reporting shark fin exports every year during this period. The peak in fin exports in 2012 (13.2 t; Table 6.7.3) can be linked to a privately sponsored unscientific cull following two deaths from shark bites in 2011 (SFA 2016).

Table 6.7.2: Total chondrichthyan catch (t) reported by Seychelles from FAO Major Fishing Area 51; chondrichthyan exports (t) to the world as reported by Seychelles; chondrichthyan imports (t) from Seychelles as reported by the world; and shark fin imports from Seychelles by Hong Kong (t) as reported by Hong Kong.

Year	Total Catch [a]	Seychelles exports, all codes [b]	World imports from Seychelles, all codes [b]	Fin imports by Hong Kong [c]
2012	351	0	28.36	6.13
2013	404	0	20.52	5.40
2014	592	0	68.28	1.46
2015	443	0	382.58	1.79
2016	513	0	25.93	1.83
2017	628	24.26	189.24	1.50
2018	977	3.07	157.46	4.95
2019	1,286	26.52	544.15	3.82
Total	**5,194**	**53.85**	**1,416.52**	**26.88**
Average	**649.25**	**6.73**	**177.06**	**3.36**

[a] FishStatJ (FAO 2021)
[b] UN Comtrade (2021)
[c] Hong Kong Bureau of Statistics (2021)

Table 6.7.3. Reported shark fin export quantities from Seychelles, 2006–2014, as reported at national level (SFA 2016).

Year	Shark fin export volumes (t)
2006	9.3
2007	10.7
2008	3.7
2009	3.7
2010	4.6
2011	2.4
2012	13.2
2013	1.9
2014	1.3
Total	50.8

On average, the total reported import of all chondrichthyan products originating from Seychelles was 177.06 t per year, from 2012 to 2019 (UN Comtrade 2021; Figure 6.7.3a). Over this period, frozen shark meat accounted for most (88%) of the exports and shark fins accounted for 12%.

The imports of shark fin from Seychelles dropped in the period 2017–2019 (3%), during which time the majority of imports reported were of frozen shark meat (95% from 2017–2019). From 2012 to 2019, there are large discrepancies between chondrichthyan exports as reported by Seychelles (average of 6.73 t) and chondrichthyan imports from Seychelles reported by other countries (average of 177.06 t; Table 6.7.2). Data sourced from the Hong Kong Census and Statistics Department (2021) show that shark fins were imported from Seychelles by Hong Kong through 2012–2019, at an average 3.36 t per year (Figure 6.7.3b; Table 6.7.2).

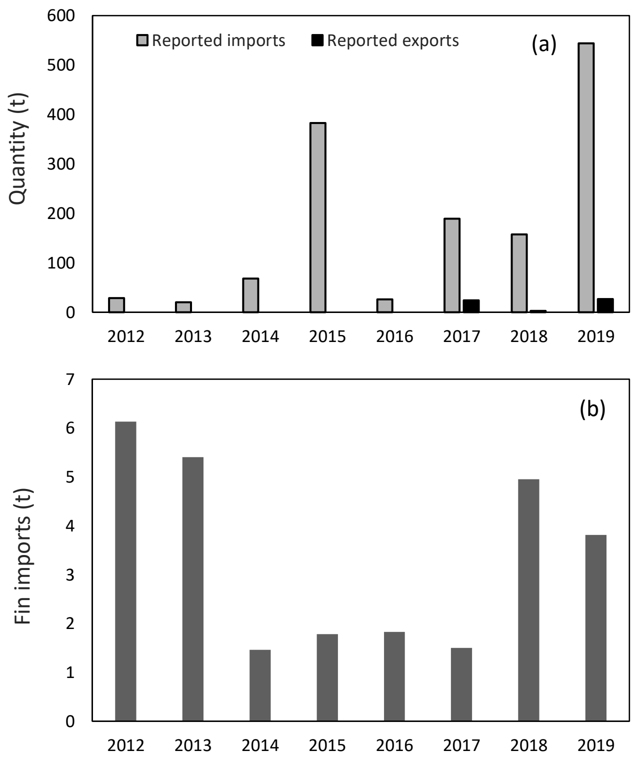


Figure 6.7.3: (a) World imports of chondrichthyan products from Seychelles (reported by the world) and chondrichthyan exports by Seychelles to the world (as reported by Seychelles) for the period 2012–2019 (UN Comtrade 2021); and (b) imports of shark fin from the Seychelles as reported by Hong Kong from 2012–2019 (Hong Kong Census and Statistics Department 2021).

Trade in CITES-listed chondrichthyan species

There were 13 records of CITES-listed chondrichthyan species being exported from Seychelles in the last 10 years (i.e., since 2011), comprising six different species, all of which are listed on CITES Appendix II, being exported to five different countries/areas (Table 6.7.4). The main species exported during this time were *Mobula alfredi* and *Sphyrna lewini.* Of these 13 occurrences, there was only one occasion where the reported quantity from the exporter (i.e., 44 specimens (tissue samples) of *M. alfredi* from Seychelles) matched the import quantity as reported by the importing country (i.e., Australia; Table 6.7.4).

In comparison to other Nairobi Convention Member States, Seychelles has the second-highest documented trade in CITES-listed chondrichthyan species, although it is possible that this is an artifact of better reporting standards in Seychelles in comparison to other WIO countries. Nevertheless, like other countries in the WIO, there are major discrepancies between Seychelles' reported export trade volumes and those from importing countries (Table 6.7.3), making it difficult to determine the exact quantities that are traded.

Table 6.7.4. CITES-listed elasmobranch species exported from Seychelles and imported into various importer countries, as determined from the CITES Trade Database[90], for the period 2011–2019. Importer country, importer reported quantity and exporter (i.e., Seychelles) reported quantity, export purpose and source of the export specimen are given. App. refers to CITES Appendices. Rows highlighted in grey reflect instances in which reported export quantities from Seychelles match the import quantity as reported by the importing country. Where no units are given, the quantity represents the total number of specimens/products traded.

Year	App.	Taxon	Importer	Importer reported quantity	Exporter reported quantity	Term	Unit	Purpose	Source
2013	II	*Carcharhinus longimanus*	Hong Kong		100.14	Fins		Commercial	Wild
2013	II	*Rhincodon typus*	Australia		61	Specimens		Scientific	Wild
2013	II	*Sphyrna* spp.	Hong Kong		98.6	Fins		Commercial	Wild
2015	II	*Sphyrna lewini*	USA		151	Specimens		Scientific	Wild
2015	II	*Sphyrna mokarran*	USA		20	Specimens		Scientific	Wild
2016	II	*Mobula alfredi*	Australia	44	44	Specimens		Scientific	Wild
2016	II	*Mobula alfredi*	Great Britain		16	Specimens		Scientific	Wild
2016	II	*Sphyrna lewini*	Australia		20	Specimens	kg	Scientific	Wild
2017	II	*Carcharhinus longimanus*	Hong Kong	11.3		Fins	kg	Commercial	Wild
2017	II	*Mobula alfredi*	Australia	170		Specimens		Scientific	Wild
2017	II	*Sphyrna lewini*	Hong Kong	5.55		Fins	kg	Commercial	Wild
2017	II	*Sphyrna mokarran*	Hong Kong	6.25		Fins	kg	Commercial	Wild
2019	II	*Isurus oxyrinchus*	Taiwan		458	Derivatives	kg	Commercial	Wild

6.7.4 Conservation status

As a consequence of these high levels of legal and illegal fishing pressure, chondrichthyans in Seychelles are heavily overexploited, with a significant decline in abundance over the last 70 years, leading the SFA to classify the shark fishery as "over exploited or depleted" (SFA 2016). As a result of this heavy exploitation, 46 (67%) of the 69 confirmed chondrichthyan species in Seychelles are currently considered threatened with extinction (IUCN 2021), the second highest proportion of threatened species of any WIO country/area (Table 3.4). These include 24 Vulnerable, 17 Endangered and 5 Critically Endangered species, according to the IUCN Red List of Threatened Species (IUCN 2021; Table 3.4). The only species endemic to Seychelles, *Centrophorus seychellorum* and *Squalus lalannei,* are both classified as Least Concern by the IUCN Red List (IUCN 2021).

[90] https://trade.cites.org/en/cites_trade

In the 1990s, it was observed that the number of sharks landed was almost seven times less than the number caught for their fins, and that there was a need for improved monitoring of shark catches (Marshall 1997b). Considering that two-thirds of chondrichthyans in Seychelles face a high to extremely high risk of extinction in the wild (IUCN 2021), there is strong evidence indicating that fisheries and the shark fin trade have negatively impacted chondrichthyan populations in Seychelles, and that improved conservation and management are needed.

6.7.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework,

The government department responsible for fisheries in Seychelles and the implementation of the national Fisheries Sector Policy and Strategy is the Ministry of Fisheries and Agriculture (MF&A) (Seychelles 2019). However, the designated authority for fisheries management and research, permitting of fisheries and enforcement of fisheries legislation in Seychelles is the Seychelles Fishing Authority (SFA), a parastatal organization[91] that functions as the executive and technical arm of Government for fisheries and related matters (Table 6.7.5).

SFA's Fisheries Monitoring Centre (FMC) handles the compliance of all fishing vessels with reporting requirements, VMS, and the validation of statistical documents for IOTC, EU and Non-EU catch certificates. The Fisheries Control Unit is responsible for the processing of fishing licences.

Export and import trade controls, including permitting, are handled by the Ministry of Agriculture, Climate Change and Environment (MACCE), through the Wildlife Trade and Conservation section, which is also the CITES Scientific Authority for Seychelles, within the Biodiversity Conservation and Management Division, which is also the CITES Management Authority for Seychelles. Enforcement relating to trade is the responsibility of SFA in collaboration with the Ministry of Environment and Energy (MEE) (Table 6.7.5).

Species conservation and environmental protection are the responsibility of MACCE, while coastal zone management is jointly overseen by MACCE and the Ministry of Lands and Housing (Table 6.7.5).

The Enforcement Unit is responsible for MCS and carries out all inspectorate duties with regards to Port State inspection, land inspection, and sea and air surveillance duties pertaining to national and regional requirements. Seychelles has seen continual gradual improvement of its MCS of industrial and semi-industrial fisheries (SFA 2014), and is believed to have adequate infrastructure and resources for effective MCS (Breuil and Grima 2014b).

Table 6.7.5: Designated national authorities for chondrichthyan management in Seychelles.

Area of management	Designated national authorities
Fisheries management and research	Seychelles Fishing Authority (SFA); Fisheries Monitoring Centre (under SFA, for reporting, VMS data and catch data)
Export and import trade controls (including permitting)	Ministry of Agriculture, Climate Change and Environment (MACCE), as national CITES scientific authority
Permitting of fisheries and processing of fishing licences	SFA; Fisheries Control Unit (under SFA)
Enforcement of fisheries legislation	SFA Enforcement Unit
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	SFA; MACCE
Species conservation and environmental protection	MACCE;
Coastal zone management	Ministry of Environment and Energy (MEE); Ministry of Land Use and Habitat
MPA management and enforcement	MEE (through the SNPA); SFA; Seychelles Islands Foundation (SIF)

[91] https://www.sfa.sc/index.php/about-us1/about-sfa

National legislation and regulations

The Fisheries Act 2014 (which repealed the Fisheries Act 1986) and supporting regulations provide for the management, conservation and development of fisheries within Seychelles waters and related matters (Seychelles 2014a). Licenses are required for hook-and-line, longline and semi-industrial fisheries, but no licensing is required specifically for shark fishing (Everett et al. 2017). SFA licenses foreign fleets to fish within the Seychelles EEZ (SFA 2015c). There are also vessels flying flags of convenience, including foreign-owned vessels registered to Seychelles (Ojamaa and Martí 2015). Industrial longliners licensed to operate inside of the Seychelles EEZ in 2014 were operating under two main fishing agreements: the Taiwan Deepsea Tuna Longline Boat Owners and Exporters Association (TTA) and Top Fortune Agreement (TFI). An existing FPA with the EU allows Seychelles access to Mayotte's EEZ (EU 2014b).

There are no quotas or restrictions on the areas that can be fished, except for in Marine Parks and Protected Areas, but fishing by foreign vessels is prohibited within 3 km of the 200-m isobath, which in effect reserves the fishing of banks and inshore areas to local operators. There are also well-defined gear restrictions in certain fisheries. Compliance and enforcement are believed to be high in the industrial fisheries in Seychelles; however, there is believed to be generally poor compliance with existing regulations and poor enforcement by authorities in the artisanal sector, with infringements including fishing during the closed seasons, fishing within MPAs and the use of unlicenced gears (Breuil and Grima 2014b). Furthermore, IUU by foreign unlicensed vessels is suspected, as well as transhipment at sea, under-reporting by licensed fishing vessels, and non-compliance by Seychelles flagged foreign vessels (Breuil and Grima 2014b).

The Seychelles legal framework makes provision for SFA to develop specific fisheries management plans, which can impose measures such as closed seasons, closed areas, gear restrictions, species restrictions and entry limitation (Breuil and Grima 2014b), and this may be a useful option for more effective management of Seychelles' chondrichthyan fisheries (and those catching chondrichthyans as bycatch).

Legislative measures that pertain directly or indirectly to chondrichthyans is as follows:

- The Wild Animals and Birds Protection Act 1961 (Seychelles 2012a), establishes the legal framework for the protection of species of wild animals and birds. Under this act, the Wild Animals (Whale Shark) Protection Regulation 2003 (Seychelles 2003) declared *Rhincodon typus* protected throughout Seychelles at all times. However, this remains the only chondrichthyan species fully protected in Seychelles.
- According to the 2021 annual report by the IOTC Secretariat (IOTC Secretariat 2021h), all thresher shark species (Alopiidae), all manta and devil rays (Mobulidae) and *Carcharhinus longimanus* are banned from retention in tuna fisheries in Seychelles, through permit conditions. These measures were implemented to adhere with IOTC conservation and management measures; although they are applicable only in tuna-focused fisheries.
- The Fisheries (Amendment) Regulations of 1998 (Seychelles 1998), prohibit the fishing of sharks using nets[92]. This measure was apparently not implemented to reduce shark mortality, but rather mortality of bycatch species, including turtles, marine mammals and non-target *R. typus*, in gillnets. SFA subsequently developed the local 'drag' (anchored longlines) system of fishing, as an alternative to net fishing, and such longline gears were distributed to former net fishers. The switch to this equipment was initially believed to have increased shark catches, and this gear appears to have higher impact on selected species of sharks, although gillnets generally catch more sharks overall than the anchored longlines (pers. comm., John Nevill, independent fisheries consultant, April 2017).
- The Fisheries Act of 2014 (Seychelles 2014a) prohibits chumming[93] in Seychelles waters, which is defined as the act of attracting a shark "by placing in the water fish, part of fish, blood, or such matter upon which shark feed, lured to, for the purpose of making use of shark for any sport, game, or any activity", with the provision that this did not relate to scientific research or activities.

[92] Regulation 16C

[93] Part II Management of Fisheries, Sub-Part 6 Control of fishing activities

- The Fisheries (Shark Finning) Regulations (Seychelles 2006) apply to local vessels of 24 m or more and to foreign vessels licensed to operate in the Seychelles' EEZ. The Regulations prohibit the removal of shark fins from carcasses on board a vessel unless authorization is granted. In such cases, the Regulations define a standard maximum fin-to-carcass ratio of 5% (after evisceration, or 7% after evisceration and beheading) of the total mass of dressed shark carcasses, with the intention of preventing finning (and associated discarding of carcasses) at sea. Applicants applying for the exemption are required to produce evidence that they have the capacity to utilize all parts of the shark.
- All catches of sharks must be recorded in a logbook issued by SFA. The Regulations also prohibit the transhipment of fins. Many of these measures thus align with the shark fin measures imposed by the IOTC; however, the effectiveness of this measure has not been evaluated (SFA 2016).
- Zones[94] where fishing by foreign vessels is prohibited cover all islands and related banks through prohibiting fishing activity within 3 km of the 200-m isobath (Seychelles 2014a), which is likely to have a significant protective benefit for coastal chondrichthyan species, if the measure is adhered to.
- Demersal trawling is prohibited in Seychelles' waters (Breuil and Grima 2014b), which likely reduces potential mortality on benthic chondrichthyan populations.
- Logbooks specifically designed for the semi-industrial fishing fleet were introduced in 2003, and could contribute to improved chondrichthyan catch data recording and reporting, if enforced and implemented effectively.

Fisheries Regulations (Seychelles 1987) dictate that logbooks should be maintained on the nature, time, and position of all fishing operations, and on the quantity of catch by species, including all fish caught (i.e., including discards). The FMC has installed VMS on increasing numbers of local vessels and inspects VMS mobiles of foreign-flagged vessels (SFA 2014). Regional surveillance patrols are carried out to monitor and deter IUU activities, but there are no specific efforts being made to reduce IUU exploitation of chondrichthyans (SFA 2015b).

Export of all fishery products is regulated under the Export of Fishery Products Act 2012 (Seychelles 2012b). The main legislation governing the trade of chondrichthyans is the Customs Management Act 2011 (Seychelles 2011) with accompanying Customs Management (Export Permit) Regulations 2014 (Seychelles 2014b) and Customs Management (Prohibited and Restricted Goods) Regulations (Seychelles 2014c).

Seychelles has had a long history of Fishery Partnership Agreements (FPAs) with the EU. The current FPA and associated implementing protocol were singed in February 2020, for a six-year period. This agreement allows vessels from Spain, France, Italy and Portugal to fish in the Seychelles' fishing zone, the majority of which comprises tuna purse seine vessels (European Commission 2020).

Status of NPOA-sharks

Seychelles finalised its first NPOA-Sharks in 2007 (SFA 2007a). It was compiled based on a national shark status survey, as recommended by the IPOA-Sharks, and had as its ultimate vision 'that shark stocks in the Seychelles EEZ are effectively conserved and managed to enable their optimal long-term sustainable use'. The NPOA set out a four-year action plan with 11 work programs, which sought to address the ten goals of the IPOA-Sharks as they relate to local circumstances in the Seychelles. The first four-year phase of this National Plan of Action (2007–2010) aimed to establish the necessary capacity, systems and databases to enable the informed adaptive management of shark stocks in Seychelles, and to implement an active and progressive precautionary approach to the management of targeted and non-targeted shark fishing effort that took into account the transitional needs of stakeholders.

[94] Reg. 5a, Schedule 1 carried over from the 1986 Fisheries Act as per Fisheries Act 2014 Para 79: Savings and Transitional provisions

The strategic objectives were to:

1. Ensure that shark catches from directed and non-directed fisheries are sustainable.
2. Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use.
3. Identify and provide special attention, in particular, to vulnerable or threatened shark stocks.
4. Improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between States.
5. Minimize unutilized incidental catches of sharks.
6. Contribute to the protection of biodiversity and ecosystem structure and function.
7. Minimize waste and discards from shark catches in accordance with article 7.2.2.(g) of the Code of Conduct for Responsible Fisheries.
8. Encourage full use of dead sharks.
9. Facilitate improved species-specific catch and landings data and monitoring of shark catches.
10. Facilitate the identification and reporting of species-specific biological and trade data.

Stakeholder support for the management of shark fisheries through the NPOA-Sharks was reported to be low in 2010 (FAO 2011). An independent review at the end of the first phase (IOTC 2015b) was largely positive, finding that the NPOA has 'so far engendered considerable progress in laying the foundations for viable conservation and sustainable use of sharks through the development of capacity and understanding amongst stakeholders'. Notable outcomes so far (IOTC 2015b) are the publication of a Shark Identification Guide and cartoon book, co-sponsored by SmartFish, to highlight the importance of sharks in the marine ecosystem and educate on shark finning. A database has also been designed to capture data for morphological modelling of shark species, which will be used in identification. Work program assessments found strategic objectives 9 (improved data on landings) and 10 (improved identification and reporting) to be substantially realized, but described implementation of the NPOA to be patchy and in some cases absent (SFA 2016).

A second NPOA (2016–2020) has since been developed through a process of iterative stakeholder consultation, which should build on these achievements (SFA 2016). It sets out nine work programs: co-management of the NPOA, fishery data gathering and management, research, managing effort in line with the precautionary approach, optimising use of capped shark catch, non-consumptive sustainable use, conservation and management measures, international obligations and cooperation, education and awareness. While this NPOA is comprehensive, it was developed to cover the period 2016 to 2020, and should now be revised.

Marine protected areas

The National Parks and Nature Conservancy Act (1969, consolidated 2014; Seychelles 2014d) established the framework for the declaration of different categories of protected area and prohibits fishing with Marine National Parks and Marine Special Reserves. There are 16 marine protected areas (MPAs) in Seychelles, encompassing an area of 365,663 km^2 (approximately 32% of the EEZ; UNEP-WCMC and IUCN 2021e), thus covering the highest proportion of the EEZ of all the Nairobi Convention Member States. There are four different types of MPA defined in Seychelles, which offer different levels of protection. Strict Nature Reserves do not permit any interaction whatsoever with the natural environment other than those activities deemed essential for the safeguarding of these areas; however, no sites have been afforded this category of protection. Special Reserves afford certain species protection within their boundaries, and currently comprise three sites. National Parks protect and preserve wildlife or places and objects of interest and beauty for the benefit of the public, and currently comprise seven sites in Seychelles, while Areas of Outstanding Natural Beauty are designated for the benefit of the general public, of which there is currently one site (Bijoux 2021).

The rationale for the development of the first MPAs in Seychelles was predominantly tourism, and the protection of coral reefs and nesting marine turtle populations. Conservation of chondrichthyans was not therefore a motivating factor in designating the early MPAs in Seychelles. However, several more recently implemented MPAs in Seychelles afford some degree of protection to various chondrichthyan species, with some having chondrichthyan conservation as one of their purposes.

The Aldabra Special Reserve, which covers a marine area of 2,406 km^2, was designated in 1981 and encompasses a variety of habitat types such as mangrove stands, coral reefs, seagrass beds, intertidal mudflats and deep sea and offshore pelagic habitats, which are utilized by many chondrichthyan species. Silvertip sharks *Carcharhinus albimarginatus*, blacktip reef sharks *C. melanopterus* and sicklefin lemon sharks *Negaprion acutidens* occur in high abundance around the Atoll and use this site as an important breeding, parturition and nursery area (Stevens 1984, Clarke et al. 2012). As most of this MPA is classified as a no-take zone with restricted access (Bijoux 2021), it provides protection for these shark species during crucial life history events. The Aldabra Marine National Park, which was proclaimed in 2018 and encompasses an area of 177,477 km^2 of deep sea, benthic and offshore pelagic habitat, was created, among other reasons, with a specific purpose of protecting whale sharks and other shark species within its boundaries (Bijoux 2021). However, as this National Park is situated offshore, managing and enforcing its regulations is a challenge and it is therefore susceptible to overfishing as a result of IUU fishing activities.

The D' Arros Island and St Joseph Atoll in the Amirantes group of islands are also important areas for various shark and batoid species. They are situated in close proximity to one another and cover a combined marine area of 40 km^2 which has been identified for designation as an MPA (Bijoux 2021). Although these atolls are not officially designated as MPAs (they were designated as a Special Reserve in 2014 but the legislation was revoked approximately two months later), they are privately administered by the Save Our Seas Foundation D'Arros Research Centre and in effect are managed as MPAs, although this is not recognised by fishers and tourism operators (Bijoux 2021). D' Arros Island and St Joseph Atoll primarily comprise seagrass habitats on the reef flats and hard corals on the reef slope. Reef manta rays *Mobula alfredi* are known to aggregate around these two atolls (Peel et al. 2019b, 2020). Five shark species, *C. albimarginatus,* grey reef sharks *C. amblyrhynchos, C. melanopterus, Negaprion acutidens* and tawny nurse sharks *Nebrius ferrugineus*, are known to spend significant amounts of time at these atolls (Filmalter et al. 2013a, Lea et al. 2016). Furthermore, the shallow lagoon at St. Joseph Atoll, at 3.5 km long and with an average depth of 3 m, is a nursery area for broad cowtail rays *Pastinachus ater,* porcupine rays *Urogymnus asperrimus* and mangrove whiprays *U. granulatus* (Elston et al. 2017, 2019, 2021). The identification of this area for future designation as officially sanctioned MPAs is encouraging as this would ensure this important area for these shark and batoid species would be conserved.

The St Anne Marine National Park in Seychelles Inner Islands represents a relatively large complete no-take zone, of nearly 10 km^2 (Bijoux 2021), and is known to harbour a portion of an important shark pupping ground and nursery (SFA 2007a). The Baie Ternay Marine National Park in the Seychelles Inner Islands appears to be an important nursery area for juvenile *N. acutidens,* which have shown high fidelity to the MPA (SFA 2015a, 2015b).

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Seychelles is signatory to several MEAs and RFBs (see Table 5.2). Seychelles ratified CMS in 2005 and is thereby bound by CMS commitments. There are six chondrichthyan species listed on Appendix I and a further 10 listed on Appendix II of CMS (excluding those also listed on Appendix I), which are known to occur in the Seychelles EEZ (Table 3.3, Chapter 3). Seychelles is thus obliged to protect the six species listed on Appendix I (see Table 6.7.6 in section 6.7.7). The State is also obliged to implement the CMS concerted actions for mobula rays *Mobula* spp. and *R. typus*. As a Party State, Seychelles is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. Many of the Appendix II species are shared with other Nairobi Convention Member States, therefore Seychelles should participate in the development of regional management plans, as appropriate, for these species (Table 5.1). Seychelles was actively involved, and took a lead role in the lobbying for the development of, a specific chondrichthyan MOU, that could act as a mechanism to facilitate cooperation among CMS parties to support the implementation of CMS as it relates to chondrichthyan species (SFA 2007a). This initiative led to the CMS Sharks MOU, which entered into effect in 2010. Despite its role in lobbying for this, Seychelles is not signatory to the CMS Sharks MOU (Table 5.2). Having recognized the need for such a mechanism, and because many of the species listed in Annex I of the MOU occur in Seychelles waters, the State should consider signing the MOU, to further support regional management effort for these species.

Seychelles ratified CITES in 1977, but national legislation is generally not believed to meet the requirements for implementation of CITES (CITES 2021). CITES permits are handled through the MACCE Conservation Section, but although the Seychelles' NPOA-Sharks covers trade in CITES-listed sharks and rays, there is currently no enforcement. A permit is required for the trade (import and export) of species listed under CITES, and MACCE officers are required to liaise with local exporters to record the export products of CITES-listed shark and ray species. However, this is done on a voluntary basis and not all exporters collaborate with the MACCE officers (SFA 2015b). There are sixteen CITES Appendix II chondrichthyan species known from Seychelles, for which trade should be carefully controlled (there are no Appendix I chondrichthyan species). At present, all CITES-listed species are listed as restricted goods under the Customs Management (Export Permit) Regulations (Seychelles 2014b) and Customs Management (Prohibited and Restricted Goods) Regulations (Seychelles 2014c). Despite this, CITES permits have been issued for the export of chondrichthyan products, yet no NDFs had been concluded[95] by the time of writing, and so it remains unclear which criteria are used to issue these permits (pers. comm., John Nevill, independent fisheries consultant, April 2017). However, NDFs are expected under the IBRD (SWIOFish3[96]) threatened elasmobranch species project (pers. comm., John Nevill, independent fisheries consultant, April 2017).

Seychelles is a member of three relevant RFBs: IOTC, SIOFA and SWIOFC (Table 5.2). The State should therefore work with SWIOFC, and is bound by the commitments under SIOFA, which include *inter alia* a prohibition on the use of gillnets and several measures specific to deep-sea chondrichthyan species, such as research on and setting of bycatch limits for these species, and prevention of targeting of the deep-sea chondrichthyans listed in Annex I of SIOFA's Sharks CMM (SIOFA 2019, see section 5.4.2). Under the IOTC, shark, tuna and swordfish fisheries in the Seychelles must report their catches and follow IOTC regulations concerning chondrichthyan species, retention bans, finning and reporting (see Section 5.4.1). Foreign pelagic fisheries must report all catches, including incidental catches, to the IOTC, and all foreign vessels licenced under the Seychelles flag are made aware of this resolution in their licence conditions. Provisions are made under the Fisheries Act (Seychelles 2014a) to incorporate IOTC resolutions into the regulations, but this has not yet been undertaken (SFA 2015b). These measures include retention bans in IOTC-managed fisheries for seven species of chondrichthyans that occur in Seychelles waters (Table 3.3, see Table 6.7.6 in section 6.7.7). While just one of these species is legally protected within Seychelles, the 2021 IOTC compliance report found Seychelles to be legally compliant with the prohibitions on large-scale driftnets and shark finning, the prohibition on the capture of *C. longimanus* and thresher sharks *Alopias* spp., and on intentional net-setting around *R. typus* and *Mobula* spp. in the tuna-related fisheries, through permit terms and conditions; but Seychelles remains only partially compliant in terms of reporting nominal catch, catch and effort and size frequency data for chondrichthyan species (IOTC Secretariat 2020d). Although SFA made necessary preparations (training, equipment purchase, etc.) for implementation of a National Scientific Observer Program in 2012 (SFA 2014), there is still non-compliance with observer coverage requirements (IOTC Secretariat 2021h).

Seychelles is also a Member of the Nairobi Convention and SADC (and thus the SADC Protocol on Fisheries) and acceded to the PSMA in 2013 (Table 5.2). While none of these instruments specifies management measures or commitments for chondrichthyan species, the Nairobi Convention does list species-specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future.

[95] An assessment of the *Sphyrna lewini* fishery, undertaken in 2015 through the Artisanal Shark Fishers Association provides the basis for an NDF.

[96] https://swiofish3.sc/

Membership of Seychelles to the PSMA means that port officials in Seychelles can prohibit foreign vessels that are suspected of illegal activity from receiving port services and access and alert other ports to the situation, potentially blocking illegally caught chondrichthyans from entering the global market. This is of particular value in Seychelles, considering the extent of foreign fishing operations that are based in Seychelles. The Nairobi Convention, SADC and the PSMA are binding on Member States, therefore Seychelles is obliged to implement the required measures. All three instruments have the potential to facilitate improved chondrichthyan management and decrease IUU fishing of chondrichthyans in Seychelles.

Seychelles is also one of the five Member States of the IOC and, while the IOC does not impose management commitments on Members, it promotes regional cooperation among the WIO island States. In addition, the Ramsar Convention entered into force in the Seychelles in 2005, and it currently has four sites designated Wetlands of National Importance (UNEP-WCMC and IUCN 2021f), including one coastal wetland and the Aldabra Atoll – both of which are important habitat for chondrichthyans. The marine component of the coastal wetland is a complete no-take zone, but it is only 1.54 km^2 (Bijoux 2021) and thus offers little opportunity for protection of chondrichthyans.

Seychelles is also Party to UNCLOS, the UN Fish Stocks Agreement and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). While the UN Fish Stocks Agreement does not carry specific measures for chondrichthyans, UNCLOS and the UN General Assembly Resolution on sustainable fisheries present specific chondrichthyan measures, such as reduced chondrichthyan mortality and strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). All three instruments impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks, for sustainable fisheries. As a Member of the FAO since 1977, Seychelles is also encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, many of which present specific chondrichthyan measures (see section 5.3).

6.7.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Seychelles

Shark fishing has had an important socioeconomic impact in the Seychelles for a long time (Lea et al. 2016), with legal and illegal fisheries drastically decreasing the abundance of shark populations (SFA 2016), and shark stocks were already considered depleted as far back as the 1950s (Marshall 1997b). Despite several "events" in history where fisheries caused rapid declines in shark abundances in Seychelles, and much evidence of the depletion of the stocks of certain species, intense, unregulated fishing pressure persists. Like much of the world, fishing pressure is the greatest threat to chondrichthyans in Seychelles.

Fisheries and trade

- There is extensive fishing pressure on chondrichthyans in Seychelles, as they are caught and targeted in many fisheries. This is largely unregulated and poorly monitored.
- Threatened species are commonly recorded in catches and are even targets in certain sectors.
- Sharks are regularly targeted for their fins, for the global fin trade, and there is evidence in Seychelles of the finning of sharks and dumping of finned carcasses at sea (although whether this continues is not certain).
- In addition to targeted fisheries, sharks constitute significant bycatch in certain fisheries. For example, silky sharks *C. falciformis* are caught in unknown quantities as bycatch in purse seine fisheries, and through incidental mortality in FADs that are targeted by purse seiners for tuna. The result is underestimated total mortality of this species – which is suspected to be higher in the waters of Seychelles than other WIO States.
- Longline fisheries have a large proportion of sharks in the catches, and while some are retained due to their high value fins and meat, some species are discarded (most likely not reported) due to their lower value meat and fins.
- There is also evidence and perceived threat of IUU fishing activities in Seychelles – the extent of which remains unknown.

- Several reports indicated chondrichthyan stock declines, even prior to the turn of the century, yet these were largely ignored, with no catch controls imposed.
- Reported export volumes of chondrichthyan species do not match reported import volumes into other countries that reportedly originate from Seychelles.
- Similarly, export and import volumes of CITES-listed chondrichthyans show major discrepancies, with major underreporting of CITES exports, which is in breach of CITES trade regulations.

Governance

- There is evidence of poor adherence to fishery regulations, and poor enforcement thereof, particularly in the artisanal fishery.
- While permit conditions in tuna fisheries prohibit the capture of all chondrichthyan species in Seychelles for which there are IOTC retention bans in place, the only chondrichthyan species fully protected in Seychelles is the whale shark *R. typus*. There are many other species that require protection or harvest limitations that need to be considered.
- Seychelles has several MPAs that likely provide some protective benefit to chondrichthyan species, but these were generally not developed for chondrichthyan species and there is evidence of IUU fishing in MPAs and no-take zones.
- Seychelles is signatory to CMS, yet falls short in terms of the binding commitments to this Convention. At least six species listed on CMS Appendix I should be protected in Seychelles, yet the only protected species is *R. typus*.
- Seychelles should consider signing the CMS Sharks-MOU, as Seychelles is a Range State to many of the species governed by the MOU.
- Seychelles is Party to IOTC and has implemented the relevant retention bans in its tuna fisheries, but remains only partially compliant in terms of the required catch data reporting to IOTC, for chondrichthyan species.
- Seychelles is signatory to CITES, yet the 2021 status of legal implementation of CITES indicated that Seychelles' national legislation generally does not meet requirements defined by CITES.
- All commercial exports of CITES-listed species are required by CITES to have a positive NDF assessment, indicating that the trade in that species does not have a significant impact on the wild population. However, no NDFs have been concluded for CITES-listed chondrichthyan species in Seychelles. Therefore, any commercial exports of such species would be in breach of CITES trade controls.
- Limited funding is a constraint to enhancing knowledge and effective management of chondrichthyans (SFA 2015b). Implementation of the NPOA-Sharks has also been constrained primarily by financial and human capacity limitations (MCSS 2015).

Data collection and monitoring

- There are major limitations in terms of the level of species reporting – most chondrichthyan catch data are grouped under "sharks" or "sharks and rays", which makes species-level assessments impossible. Furthermore, the grouping of shark fin and sea cucumber exports totally negates any assessment of impacts in either group.
- There is also underreporting of shark catches to SFA, with evidence of large volumes recorded on vessels that are not reported in the catch data.
- Catch statistics reported to the FAO appear to be lower than those reported nationally to SFA.
- Catch statistics reported to FAO and IOTC do not include artisanal catch volumes. Therefore, reported chondrichthyan catches are considerable underestimates of actual catches.
- There are discrepancies in official catch statistics, which include species not known from Seychelles waters, and suspiciously low or zero catch rates of species known to occur and expected to be present in the catches. This is indicative of inaccurate and poor reporting, misreporting or poor capacity for species identification.
- There is a lack of capacity for chondrichthyan research (i.e., limited staff with relevant experience for monitoring work, archiving and data analysis) and the absence of a marine research institute where this kind of research can be prioritized. Training for government fisheries and conservation staff is required.

Required and recommended actions

The following priority activities were identified, most of which are presented in Seychelles' second NPOA-Sharks (SFA 2016).

Governance, policy, legislation, enforcement

Measures must be identified and implemented to effectively protect threatened chondrichthyan species, including species assessments and the development of species management or recovery plans as appropriate in the Seychelles context. Such measures should include *inter alia*:

- Significant reduction in fishery-related shark mortality through a complete ban on finning (in all fisheries) and implementation of existing regulations.
- Species-specific management and conservation measures for threatened species and heavily depleted populations (pers. comm., John Nevill, independent fisheries consultant, April 2017).
- Enforcement of regulations (along with catch monitoring), which was identified to be of primary and overriding importance, relative to other conservation and management measures.
- Identification and implementation of means to minimize catch and consumption of juvenile chondrichthyans.
- Improvement of measures for mitigation of incidental catch (SFA 2015b).
- Utilisation of the 2014 Fisheries Act to give legal status to the NPOA-Sharks.
- Securing of international assistance and resources to enhance Seychelles' national capacity to implement the NPOA-Sharks.
- The SFA is working closely with relevant stakeholders to develop an operational fishery management plan for the plateau fishery for demersal fish resources in Seychelles. The successful implementation of such a plan could set an example for the development of a management plan for pelagic fish resources in the future (MCSS 2015).
- Reduction in the use of FADs (or stricter regulations therefor), to reduce overall incidental catch of *C. falciformis* (Amandè et al. 2008).
- Improvement and enforcement of regulations on solid waste management in the port areas, to avoid human-shark conflict that could lead to unnecessary and non-consumptive shark mortality.
- A formal assessment of the legal fishery for Critically Endangered scalloped hammerhead sharks *Sphyrna lewini* was conducted and found that this fishery could be sustainable, as there is minimal impact on mature females, if existing fishers were licensed and participation capped at the existing level at the time of the assessment (Nevill 2016). However, impacts of the illegal gillnet fisheries on juveniles of this species would need to be prevented.
- Identification of critical habitats – e.g., nurseries and aggregation sites – and incorporation of these considerations into the Protected Area Network (PAN) and Marine Spatial Planning (MSP) processes.
- Establishment of LMMAs in shark aggregation sites or hotspots (pers. comm. Clay Obota, CORDIO East Africa, June 2017).
- (Re)negotiation of "no shark fishing" areas around various dive sites and formalization of these through regulations.
- Fulfilling of international obligations to protect relevant chondrichthyan species, such as all CMS Appendix I species that require strict protection at national.
- Improved and full identification and addressing of, and adherence to, international obligations, particularly regarding international trade and chondrichthyan species that are threatened or listed in global conventions.
- Improved implementation of CITES and other trade controls, including the development of a specific national policy relating to the trade of CITES-listed species, the development of a robust system and guide for the identification and labelling of products from CITES species (following appropriate global HS codes), and training of customs officers in the identification of such products (SFA 2015b).
- NDFs are needed for CITES Appendix II species that will be traded.

Data collection and research priorities

Monitoring of fishery activities and catches (along with enforcement of regulations) was identified to be of primary importance, relative to other conservation and management measures. The quality of catch and trade data reporting must also be improved. Specific fishery monitoring and reporting actions include the following:

- Improving monitoring of chondrichthyans catches in all fisheries, including the recreational fishery (SFA 2015b; pers. comm., John Nevill, independent fisheries consultant, April 2017).
- Enforcing data gathering and provision requirements of semi-industrial chondrichthyan catch (targeted and untargeted) and monitoring these for accuracy.
- Reviewing and strengthening chondrichthyan catch data gathering in industrial fisheries.
- Recording catches at species level (but at least separately for shark and batoid catches, where species-level recording is not possible).
- Recording and presenting shark (and shark-like ray) fin data separately from other commodities, following appropriate HS codes.
- Identifying to species level the species from which fins are being traded, particularly CITES-listed species, to meet international obligations.
- Recording and reporting all shark (and shark-like ray) fins imported from the high seas.

The research agenda should support the implementation of the NPOA-Sharks and include research required to meet international obligations (such as that called for by the IOTC), to generate science-based recommendations for the conservation and sustainable use of Seychelles chondrichthyan stocks, to inform management measures for the minimisation of impact and rehabilitation of populations of species identified as being at high risk, and to assess efficacy of conservation and management measures.

Capacity needs

- Training is required on biological and ecological data collection and research, for government staff and the staff of other stakeholders.
- Chondrichthyan species and fin identification capacity require improvement, to enable trade management, including for on board fishing vessels (for fishers) and at landing sites and points of trade (inspectors and data collectors) (pers. comm. Clay Obota, CORDIO East Africa, June 2017). This includes development of appropriate species identification guides, and training on how to use them.
- Options for financial and institutional support should be identified, to facilitate the implementation of the research agenda, particularly that laid out in the NPOA-Sharks.
- Securing funding would facilitate the implementation of the NPOA-Sharks. Access to such funding may improve political will to implement such a policy. The recent creation of the Seychelles Conservation and Climate Adaptation Trust (SeyCCAT) will make more funds available for marine conservation into the future, particularly for marine spatial planning, and it should be ensured that chondrichthyans are incorporated into this planning.

Awareness

- Chondrichthyans are a low priority in Seychelles fisheries management and, after several human-shark incidents some years ago, the public are less interested in conserving them than eradicating them (MCSS 2015). Community education programs and more stakeholder engagement are therefore essential (SFA 2015b).

6.7.7 Priority chondrichthyan species for protection

There are eight chondrichthyan species either confirmed or reported from the waters of Seychelles that are listed on CMS Appendix I, and as a signatory to CMS Seychelles is obliged to protect these species nationally (Table 6.7.6). *Rhincodon typus* are fully protected in Seychelles, under the Wild Animals and Birds Protection Act 1961 (Seychelles 2012a); however, no other chondrichthyan species are fully protected in Seychelles. In order to adhere to the binding commitments to CMS, Seychelles should prohibit the capture of the other seven CMS Appendix I species (Table 6.7.6).

There are nine chondrichthyan species in Seychelles that require, through IOTC resolutions, retention bans in tuna-associated fisheries under IOTC management, five of which are also listed on CMS Appendix I (Table 6.7.6). These include all thresher sharks *Alopias* spp., all mobulid rays *Mobula* spp., *C. falciformis* and *R. typus*. All of these species are apparently banned from retention in tuna fisheries in Seychelles, through permit conditions (IOTC Secretariat 2021h).

There are six Critically Endangered and 12 Endangered chondrichthyan species in Seychelles (Table 6.7.6), other than those in CMS Appendix I or prohibited by the IOTC. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1995). Therefore, as a Member State of both Organizations, Seychelles should implement the precautionary principle and consider prohibiting the taking of Endangered and Critically Endangered species (at least from commercial harvesting and trade) by virtue of their poor conservation status.

Table 6.7.6. Chondrichthyan species confirmed or reported (*not confirmed, ** extirpated) from the waters of Seychelles, for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Species already protected at national level are shaded in green, and those prohibited from retention in IOTC-related fisheries are shaded in blue (see National legislation section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Critically Endangered and Endangered species for which prohibition is recommended are also presented.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN RL	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus	Common thresher shark *	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula alfredi*	Reef manta ray	I, II	Yes	II	VU	CMS I; IOTC
	Mobula birostris	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Pristis pristis*	Largetooth sawfish **	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Critically Endangered and Endangered species for which prohibition is recommended							
Carchariidae	*Carcharias taurus*	Ragged-tooth shark				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
	Rhynchobatus australiae	Bottlenose wedgefish	II		II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN
	Carcharhinus plumbeus	Sandbar shark				EN	EN
	Negaprion acutidens	Sicklefin lemon shark				EN	EN
Centrophoridae	*Centrophorus granulosus*	Gulper shark				EN	EN
	Centrophorus squamosus	Leafscale gulper shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Myliobatidae	*Aetomylaeus vespertilio*	Ornate eagle ray				EN	EN
Rajidae	*Rostroraja alba*	Spearnose skate				EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN
Triakidae	*Mustelus manazo*	Starspotted smoothhound				EN	EN

6.8 Federal Republic of Somalia

6.8.1 Introduction

The Federal Republic of Somalia (hereinafter, Somalia) is located on the Horn of Africa, bordered to the north by the Gulf of Aden and to the east by the Indian Ocean (Figure 6.8.1). Somalia has an EEZ that covers approximately 1,165,500 km^2, and a coastline that is 3,330 km long, with 1,200 km facing the Gulf of Aden and 2,000 km bordering the Indian Ocean, making it the longest coastline of any mainland African country (Bihi 1984, Sheik Heile and Glaser 2020).

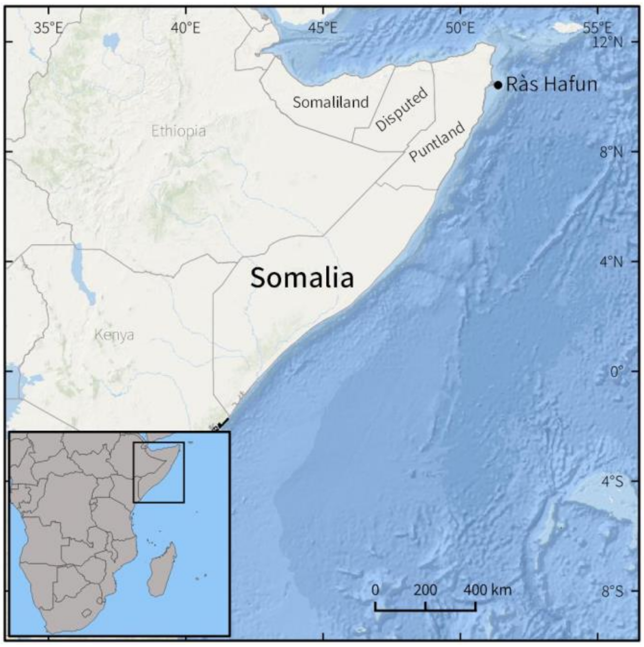


Figure 6.8.1. Map of the Federal Republic of Somalia, showing its position in the Western Indian Ocean, highlighting the regional States of Somaliland and Puntland, and other place names mentioned in text.

Somalia is divided into regional States. Somaliland declared independence from Somalia in 1991, and as this region falls entirely within the Gulf of Aden and thus outside of the Western Indian Ocean (WIO) as defined for this report, it is not addressed specifically in this country profile (the northern boundary of the WIO as defined in Chapter 2 is taken to be the Ràs Hafun peninsula). The State of Puntland borders both the Gulf of Aden and the WIO, and therefore Puntland falls partly within the WIO as defined for this report (Figure 6.8.1). As Puntland remains a semi-autonomous State of Somalia, it is included in the discussion on Somalia, in most sections.

Somalia's coastline spans a long stretch adjacent to the Indian Ocean, as well as a region adjacent to the Gulf of Aden, and is characterized by diverse ecosystems including fringing coral reefs and dense mangrove stands. The Indian Ocean coastal waters span two marine ecoregions: the Northern Monsoon Current Coast, shared with Kenya in the south (part of the Western Indian Ocean marine province), and the Central Somali coast ecoregion (part of the Somali/Arabian marine province) (Spalding et al. 2007, Obura 2012), which extends north to the boundary between the Indian Ocean and the Arabian Seas (IHO 1953). There are many small islands in southern Somalia, just north of the Kenyan border (Marshall 1997c). The extent of coral reefs is limited, compared to more tropical areas to the south, due to cooler waters caused by a major upwelling cell, which drives great productivity off Somalia's Indian Ocean coast (Sumaila and Bawumia 2014). The Indian Ocean waters of the Somali EEZ fall within the highly productive Somali Current Marine Ecosystem, one of the world's Large Marine Ecosystems, which supports many marine species of interest to fisheries, including large pelagic species such as tuna and tuna-like species (Kulmiye 2010, Cashion et al. 2018, Sheik Heile and Glaser 2020). Somalia has a population of approximately 14 million people and has suffered a high degree of political and social instability since the civil war of the 1980s and the collapse in 1991 of its national government. As a result of this continued instability and the rise of piracy in Somali waters since the 1990s, Somalia has been unable to effectively manage its marine resources (Kelleher 1998, Jennings 2001, Trans-Africa 2015), and little formal research has been conducted on fisheries at all.

Although an abundance of pelagic fish (tuna and billfishes) has attracted distant water fleets (Bakun et al. 1998), fishing supports a much smaller relative proportion of the population than in other Nairobi Convention Member States (UNEP 2005), with an estimated 120,000 people depending on fishing to some degree for their livelihood, and the lowest per-household fish consumption in Africa (Mohamed and Simba 2016). Somalia's domestic fisheries are small-scale in nature, with a small domestic industrial fishing fleet. Foreign fleets conduct the majority of industrial fishing in Somali waters; this was historically done through 'joint ventures' between foreign and local operators, although in recent years industrial fishing has been conducted almost entirely by foreign vessels (Cashion et al. 2018). Somalia does not have a recreational or sport fishery (Sheik Heile and Glaser 2020). There is a 12-nautical mile restricted zone reserved only for Somali fishers living on the coast, and a 24-nautical mile protection zone within which no fishing vessels are permitted to enter other than those operated by Somali coastal fishers (Government of Somalia 2016).

6.8.2 Chondrichthyan biodiversity and status of knowledge, Somalia

Biodiversity

Somalia has the sixth highest chondrichthyan species richness in the WIO, with 77 chondrichthyan species documented to date, comprising 51 shark species (representing 12 families), 25 batoid species (7 families) and 1 chimaera species (one family; Table 3.1). There are also seven additional shark and one additional batoid species that possibly occur in Somalia but have not been confirmed (Table 3.3). It should be noted that this species count considers only the WIO waters and coastline of Somalia, not Somali waters that fall within the Arabian Sea to the north of the WIO or the Gulf of Aden (see Figure 2.1, Chapter 2, and Figure 6.8.1). If these areas are considered, Somalia would have a considerably higher chondrichthyan species richness, as there are numerous chondrichthyan species in the Arabian Seas, not present in the WIO (Jabado et al. 2017).

Within the WIO waters of Somalia, requiem sharks (Carcharhinidae) represent the most common shark family with 20 species, followed by the deepwater catsharks (Pentanchidae) which are represented by five species. All other shark families in Somalia comprise three or fewer species. The most common batoid family is Dasyatidae (whiptail stingrays), with 10 species in Somalia, while all other batoid families comprise four or fewer species. The only chimaera species in Somalia belongs to the family Rhinochimaeridae (long-nosed chimaeras).

Only one species, Vivaldi's catshark *Bythaelurus vivaldii*, is endemic to Somalia (Table 3.3), and is known from only two specimens (Weigmann and Kaschner 2017). There are two additional species which occur in Somalia and are regionally endemic, the Mozambique electric ray *Narcine rierai* and grinning spotted izak *Holohalaelurus grennian* (Table 3.3). In addition, the speckled catshark *Halaelurus boesemani* is only known from four confirmed locations, one of which is just south of the Ràs Hafun peninsula in Somalia (Springer and D'Aubrey 1972). A further six chondrichthyan species, although not endemic to the WIO, occur only in Somalia and no other WIO country, comprising Moresby's blind ray *Benthobatis moresbyi*, the soft electric ray *Heteronarce mollis*, dwarf chimaera *Neoharriotta pumila*, smallbelly catshark *Apristurus indicus*, harlequin catshark *Ctenacis fehlmanni* and spined pygmy shark *Squaliolus laticaudus*. Of the 26 chondrichthyan species described from the WIO since 2011, five of these have distributions which occur in Somalia, Baraka's whipray *Maculabatis ambigua*, the bluespotted maskray *Neotrygon caeruleopunctata*, African dwarf sawshark *Pristiophorus nancyae*, Human's whaler shark *Carcharhinus humani* and *Bythaelurus vivaldii* (Table 3.3). In addition, although previously only thought to occur in the Northern Indian Ocean, Persian Gulf and Arabian and Red Seas (Last et al. 2016c), the Critically Endangered Halavi guitarfish *Glaucostegus halavi* was recently documented in Kenya in 2018 but has not been observed in any other WIO countries to date. However, considering this species' presence in the Arabian Sea and in Kenya, it seems highly likely that it would also occur off the coast of Somalia.

The Critically Endangered largetooth sawfish *Pristis pristis* and green sawfish *P. zijsron* are known to have occurred in Somalia, however their current status in the country is uncertain (Pierce 2014), although Dulvy et al. (2016) suggest that *P. pristis* may still be extant in Somalia. In addition, the narrow sawfish *Anoxypristis cuspidata*, may also exist in Somalia, although its presence within the country has not been confirmed (Dulvy et al. 2016).

Status of biological and ecological knowledge

In 1996, the FAO published a guide on the marine living resources in Somalia, which included 44 shark and 26 batoid species that may be present within Somalia's waters, including the Gulf of Aden (Sommer et al. 1996). The ecology of chondrichthyans is poorly understood in Somalia, with very little research having focused on chondrichthyan species in this country.

A German research expedition in the Indian Ocean in 1899 caught two individuals of deepwater shark, which were both recently described as the endemic *Bythaelurus vivaldii*, which is still known only from these two original specimens (Weigmann and Kaschner 2017). Then, in 1964, the International Indian Ocean Expedition collected a shark species off the coast of Somalia which was originally assigned to the family Triakidae (houndsharks) and called *Triakis fehlmanni* (Springer 1968), however it is now valid as *Ctenacis fehlmanni* (family Proscyllidae).

There are few movement studies of chondrichthyans in Somalia, however several silky sharks *Carcharhinus falciformis* caught near Seychelles in the tuna purse seine fishery, and fitted with pop-up archival (PAT) tags, were recorded swimming from Seychelles to the east coast of Somalia (Onandia et al. 2021), while whale sharks *Rhincodon typus* tagged in the Gulf of Aden have also been recorded moving south along the east coast of Somalia (Andrzejaczek et al. 2021).

Knowledge gaps and research priorities

Chondrichthyan research in Somalia is extremely lacking, resulting in many knowledge gaps for the majority of chondrichthyan species within Somalia's EEZ; therefore, there should be a focus on prioritizing research relating to chondrichthyans in Somalia, particularly for threatened species. Data gaps identified for these species should thus be prioritized for future research (as outlined in Table 3.7). Of the 42 data-poor, threatened chondrichthyan species identified in Chapter 3, 16 are present in Somalia, comprising 13 batoid species (representing six families) and three shark species (representing three families).

There are six data-poor[97], threatened species in the family Dasyatidae that occur in Somalia, comprising the Endangered honeycomb stingray *Himantura uarnak* and Vulnerable leopard whipray *Himantura leoparda*, broad cowtail ray *Pastinachus ater*, Jenkins whipray *Pateobatis jenkinsii*, blotched stingray *Taeniurops meyeni* and porcupine ray *Urogymnus asperrimus*. Research priorities for this family and these species primarily relate to the majority of movement and reproduction categories, and the specific age and growth categories of age at maturity and maximum age for all six species, size at birth for *U. asperrimus*, female size at maturity for all species other than *U. asperrimus,* and male size at maturity for *P. ater*, as outlined in Table 3.7.

There are two data-poor, Critically Endangered species belonging to the family Rhinidae which occur in Somalia, the bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*. Other than litter size, all other aspects relating to movement and reproduction for these species should be prioritized in Somalia, in addition to age at maturity and maximum age (see Table 3.7). The Critically Endangered whitespotted wedgefish *R. djiddensis* has also been listed from Somalia's Indian Ocean coast (Sommer et al. 1996, Jabado et al. 2017); however, there is uncertainty regarding the distribution of this species. Therefore, while this species is not considered data-poor here, it should be considered as a priority for research, particularly for improved understanding of its distribution and genetic connectivity.

There are also two data-poor threatened species in the family Mobulidae, the longhorned pygmy devil ray *Mobula eregoodoo* and shortfin devil ray *M. kuhlii*, both of which are Endangered. For both of these species, other than migratory status, gestation period and litter size, all other aspects of movement and reproduction remain poorly known, in addition to age at maturity and maximum age for both species (Table 3.7).

The families Gymnuridae, Pristidae and Rhinopteridae are each comprised of one data-poor, threatened species that occurs in Somalia, the Vulnerable longtail butterfly ray *Gymnura poecilura,* Critically Endangered *Pristis zijsron* and Endangered shorttail cownose ray *Rhinoptera jayakari*, respectively.

[97] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

Other than gestation period, information in most reproduction categories is available for *G. poecilura*, but reproductive information is generally lacking for the other two species, and aspects of movement remain poorly known for all three species. In the age and growth categories, maximum age is unknown for all three species and age at maturity is unknown for all species except *P. zijsron*, although male size at maturity is unknown for *P. zijsron*, and female size at maturity and size at birth are unknown for *R. jayakari* (Table 3.7). *Pristis pristis* is not classified as data-poor (Figure 3.6; Table 3.7), but it is Critically Endangered, and while it is unknown whether both sawfish species persist in Somalia (Pierce 2014), identification of areas still used by these species remain a priority.

The three data-poor, threatened shark species in Somalia comprise the Vulnerable *Halaelurus boesemani*, one of few shallow-water species in the family Pentanchidae, the Vulnerable tawny nurse shark *Nebrius ferrugineus* (Ginglymostomatidae) and Endangered little gulper shark *Centrophorus uyato* (Centrophoridae). Aspects of reproduction and movement, age at maturity and maximum age are unknown for all three species (Table 3.7); therefore, these aspects should be the focus of future research efforts for these species.

There are also four Critically Endangered shark species in Somalia, the oceanic whitetip shark *Carcharhinus longimanus*, ragged-tooth shark *Carcharias taurus*, scalloped hammerhead *Sphyrna lewini* and great hammerhead shark *S. mokarran*. While not considered data-poor here, future research efforts should also focus on these highly threatened species, in particular areas important for their reproduction, to ensure they are effectively managed and conserved in future.

The seven Data Deficient (as defined by IUCN) chondrichthyan species in Somalia comprise four shark and three batoid species (Table 3.3, Chapter 3). At least five of these are deepwater species comprising *Bythaelurus vivaldii*, the whitespotted bullhead shark *Heterodontus ramalheira*, *Heteronarce mollis*, *Holohalaelurus grennian* and *Narcine rierai*, and are therefore infrequently encountered, limiting available information. The remaining two species, *Carcharhinus humani* and the marbled electric ray *Torpedo sinuspersici* have coastal distributions and are exposed to coastal fisheries. In addition, of these seven Data Deficient species, *B. vivaldii* is endemic to Somalia and *N. rierai* and *H. grennian* are regionally endemic. As such, research should also be prioritized for these Data Deficient species.

6.8.3 Chondrichthyan fisheries, catch and trade

Fisheries

Somalia has three main fishery sectors. The small-scale fishery comprises Somali fishers operating in coastal waters, from an estimated 2,500–4,700 small vessels of up to 10 m in length, using longlines, handlines and gillnets (Cashion et al. 2018, Sheik Heile and Glaser 2020). Semi-industrial fisheries comprise Somali fishers operating from vessels up to 23 m, while the industrial sector is comprised entirely of foreign-flagged vessels (Sheik Heile and Glaser 2020). However, the Somali people have traditionally had a nomadic or agro-pastoral culture, with little consumption of seafood, and only a fraction of the population is dependent on fisheries (UNEP 2005). Fisheries have therefore not been a major component in Somalia's economy, accounting for just 1–2% of the country's GDP prior to the civil war (Trans-Africa 2015, Mohamed and Simba 2016).

During the 1970s and 1980s, small-scale fisheries development programs were supported by the former Soviet Union and other countries through foreign aid. At the end of the twentieth century, fisheries resources were still thought to be underexploited, given the lack of infrastructure and capacity in Somalia (Musse and Mahamud 1999, Griffiths 2005). Artisanal fisheries have expanded since the mid-1990s, due to increased private investment, changes in seafood consumption habits, and population displacement to the coast (Gulaid 2004, Sabriye 2005).

Chondrichthyan-targeted fishing, however, has taken place in Somalia for centuries, particularly along the Gulf of Aden coast, but also along the Indian Ocean coast, and predominantly in the artisanal sector for meat protein (Fowler et al. 2005, Ullah and Gadain 2016). Chondrichthyans are caught in domestic small-scale and semi-industrial Somali fisheries along the Gulf of Aden and WIO coasts and make up a substantial proportion of the catch (Glaser et al. 2015, Persson et al. 2015). They are also caught by foreign vessels in Somali waters (Glaser et al. 2015).

Small-scale fisheries

Traditional and artisanal fisheries (part of the small-scale fishery sector) have operated in Somalia for decades, targeting sharks by means of trolling lines, handlines, longlines and gillnets (Kulmiye 2010, Glaser et al. 2015). These fishers traditionally targeted sharks to produce dried shark meat, fins and liver oil for the maintenance of traditional fishing vessels, whereas mobula rays (Mobulidae) and stingrays (Dasyatidae) tended to be caught incidentally and either dried as meat, or used as bait for longlines (Marshall 1997c).

Sharks reportedly dominated catches due to the high value of fins and because meat can be salt dried, thus not requiring freezing facilities (Lovatelli 1996). Rays, guitarfish (Rhinobatidae) and sawfish (Pristidae) form the major component of incidental catch (van der Elst and Salm in ASCLME 2010). Often only the shark fins are harvested, since vessels are small, space and salting facilities are limited, and fins are significantly more valuable than the meat. Discards of shark meat (after finning) came to an estimate of 100,000 t between 1950 and 2010 (Persson et al. 2015). Fishing methods include gillnets and longlines (ASCLME 2010, Glaser et al. 2015). Drift longlines, set longlines and drift gillnets are the gears used to target sharks (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017). Shark drying racks have been observed in Hafun, Bar Madobe, Bander Beyla, Durdura and Bosaso (Kulmiye 2010).

Semi-industrial and industrial fisheries

Somalia has never had a large domestic industrial fishing fleet, thus most of the industrial fishing in Somali and Somaliland waters has been conducted by foreign fleets – both through joint ventures and unlicenced (illegal) (Persson et al. 2015, Glaser et al. 2019). These include Asian and European distant water longline and purse seine vessels, and some smaller gillnet vessels from neighbouring countries, which target tuna and tuna-like species, as well as a mixture of industrial trawlers (illegal) and coastal dhows pursuing coastal and bottom dwelling species (Glaser et al. 2015). Puntland is known to issue licenses to trawlers (Bahadur 2021).

Most foreign fishing has in the past been carried out through joint ventures with countries including the Soviet Union, France, Italy, China, Japan and Greece (Glaser et al. 2015). Since the collapse of the Somali government in 1991, illegal and semi-illegal foreign fishing operations have also been exploiting Somali waters (Persson et al. 2015). Semi-illegal operations involved local warlords selling illegitimate licenses to foreign vessels in exchange for access to their perceived territory and protection against piracy (Sumaila and Bawumia 2014). For example, in 1996 to 1997, 43 longliners, 61 purse seiners and a few Kenyan trawlers were fishing in Somali waters through semi-illegal agreements (Persson et al. 2015). The foreign tuna fleet reduced its reported presence in Somali waters since 2006, when private agreements between the EU purse seiners and Somali authorities expired and the risk of piracy was peaking (IOTC 2013c). Foreign fishing has, however, rebounded with the decline in piracy (Glaser et al. 2015). In the early 2000s, an estimated 700 vessels were fishing unlicensed and unregulated in Somali waters (FAO 2005), and foreign IUU vessels were estimated to catch three times as many fish as the Somali artisanal fishing sector (Glaser et al. 2015). A recent foreign fishing rights agreement has permitted up to 31 Chinese longline vessels to target tuna and tuna-like species in Somali waters (World Bank 2019), and these vessels will almost certainly catch shark species as bycatch, and possibly targeted catch. While there were European vessels operating in Somali waters in the past, there is no fishing partnership agreement in place between the EU and Somalia (European Commission 2020).

Many of the foreign fleets fishing in Somali waters catch sharks, either as target or incidental catch. For example, Sri Lankan longline vessels have targeted sharks off Berbera (Jennings 1998), and the Iranian, Yemeni, and Pakistani gillnet fleets have very large incidental shark catches (MRAG 2012). In Somaliland, the threat to chondrichthyans comes primarily from Egyptian vessels; in 2005, Somaliland had about 36 Egyptian trawlers operating in their waters (Gulaid 2004). There are also increasing numbers of Yemeni boats now fishing under license in Somaliland waters and taking sharks (Berbera Port Authority 2015). The catch is not sold in Somaliland but taken back to Yemen. A proportion of the industrial chondrichthyan catch in Somali waters is taken by IUU vessels, but the magnitude of this catch remains unknown, with estimates between 5% and 50% (Glaser et al. 2015).

Fisheries monitoring and reporting

Knowledge of Somali fisheries is limited, and Somalia is not a member of the WIOFish project (WIOFish 2021). Scientific surveys of Somali waters have not been conducted since the 1980s and fishery data collection has been sporadic (Stromme 1984). The FGS did not collect domestic catch statistics for several decades, nor have they reported catch to the FAO since 1988, while the existing data from the 1970s and 1980s are incomplete (Persson et al. 2015). A catch reconstruction from 1950 to 2015 estimated that true catches were 1.8 times the volumes reported to the FAO (Cashion et al. 2018).

The absence of monitoring and enforcement in Somali waters, coupled with the lack of transparency amongst international monitoring agencies in the WIO, means there is no reliable data collection for foreign fishing activity taking place in Somalia's EEZ (Persson et al. 2015). Although IOTC vessels fishing in the Somali EEZ must report shark catches, there has been widespread underreporting (MRAG 2012), and because many industrial vessels fish without licenses and do not land their catches in Somalia, their catches are not reported at all. Domestic and foreign vessels are required under the Somali Fisheries Law of 2014 to report all catch, but little information is available on the quality of such reporting. There is a clear need for a nationally or regionally coordinated attempt to report, archive and analyse catches from domestic fisheries.

While accurate catch data have been limited for most fisheries in Somalia, over long periods, measures are being implemented to improve the quality of catch data being collected. A monitoring program was developed for Somaliland and Puntland in 1997, and while these States collected fisheries data for a period of time, no formal datasets are available (ASCLME 2010). Such data collection was discontinued. More recently, fishers working for Somali Fair Fishing, an NGO operating in Berbera, have systematically reported their catches (Glaser et al. 2015).

Also, a new data collection program, Project Kalluun (Sheik Heile et al. 2018), was recently piloted through selected universities in the Somali region. The initiative is a partnership among City University, Kismayo University, East Africa University, Berbera Maritime and Fisheries Academy, and Secure Fisheries. Students at the universities collect standardized data on fishing effort, vessel characteristics, gear type, weight of the catch and price per kilogram, with species-level weight and price information for selected species (mainly those identified for species-level reporting by the IOTC) (Sheik Heile and Glaser 2020).

Aspects of this project were expanded and piloted by the Fisheries Data Collection Working Group (FDCWG) of the Federal Government's Ministry of Fisheries and Marine Resources and the UN FAO, initiated in December 2019, intended to collect species-level catch data for all IOTC-managed species, which includes several shark taxa (Sheik Heile and Glaser 2020). The first seven months of data collection revealed that sharks, a large proportion of which were hammerhead sharks *Sphyrna* spp., contributed more than 10% of the small-scale fishery catches (Sheik Heile and Glaser 2020). The data collection process is currently on hold but will continue in due course.

Reported chondrichthyan catches

Somalia did not report any chondrichthyan catch data to FAO from 2012 to 2019; however, several publications report on sporadic data. Chondrichthyan catches in Somalia appear to have risen considerably over the past five to six decades. It was estimated that approximately 21% of total fisher catch in the early 1960s comprised of sharks (Thurow and Kroll 1962). In southern Somalia, Stromme (1987) estimated that sharks comprised 40% of artisanal fisher landings. By the mid-1990s, it was assumed that sharks comprised 55% of small-scale fisher catch in Somalia (Lovatelli 1996, Cashion et al. 2018), and it was this mid-1990 period when Puntland artisanal fishery production peaked, growing exponentially from around 3,000 t per annum in 1991 to 15,000 t in 1995–1997, with little decline thereafter (Sone 2010), suggesting that sharks were under heavy fishing pressure. Extrapolating from these two sources suggests that 7,000 to 8,000 t of sharks were landed annually in the Puntland artisanal fishery in the 1990s, which matches the 2005 reported annual shark catches in Puntland small-scale fisheries, of 8,990 t (Cashion et al. 2018). Including the catches of the South-central Somali region (the coastal waters from Puntland to the Kenya border) gave an estimated total Somali (excluding Somaliland) shark catch in 2005 in excess of 15,200 t (Cashion et al. 2018).

A catch reconstruction suggested that sharks (25%) and rays (8%) together constituted the single greatest species group contribution to domestic fishery catches from 2005 to 2010 (Persson et al. 2015) and from 2005 to 2014 they comprised the second greatest contributor (after tunas) caught by foreign vessels in this period (Glaser et al. 2019). The same assessment estimated that chondrichthyan catches amount to a total of 26,000 t annually, contributing over 33% of total catches in Somali waters – an exploitation level assessed to be unsustainable with no room for increased capture (Glaser et al. 2015). Based on the available literature, Persson et al. (2015) reported the domestic chondrichthyan catch composition to be comprised of rays and manta rays (25%), blacktip reef sharks *Carcharhinus melanopterus* (15%), common thresher sharks *Alopius vulpinus* (15%), mackerel sharks (family Lamnidae, 15%), hammerhead sharks (family Sphyrnidae, 15%), grey reef sharks *Carcharhinus amblyrhynchos* (7.5%), and 'other sharks' (7.5%). Anderson and Simpfendorfer (2005) reported the most commonly caught shark species in Somali waters to be pelagic species such as thresher sharks (family Alopiidae), shortfin mako sharks *Isurus oxyrinchus*, and larger coastal species such as *C. melanopterus, Sphyrna* spp. and sicklefin lemon sharks *Negaprion acutidens*.

There has also been a history of foreign vessels catching chondrichthyan species in Somalia, and the expansion of the industrial fishery (based mainly on foreign vessels or joint ventures) greatly expanded fishery production in Somalia (Sone 2010). Catch reconstructions indicate that sharks constitute significantly to foreign fleet catches in Somali waters, ranging from 4–5% of the Somali catches of Seychelles- and Yemen-flagged vessels, to nearly 70% of the catch by Portuguese-flagged vessels (although the overall catch by Portuguese vessels was considered small, and Portuguese vessels do not currently fish Somali waters), with evidence of shark targeting by some nations, such as Pakistan (Glaser et al. 2015). However, there are also reports that fishing by foreign vessels creates conflict with domestic fishery sectors in Somalia (Glaser et al. 2019). Foreign vessels fishing illegally in Somalia, targeting demersal and pelagic species, were also thought to catch sharks as bycatch (Marshall 1997c), and these illegal fisheries persist today (Glaser et al. 2019).

There has also been a shift in targeting away from the historical capture of sharks for local meat consumption to focus more on the export of shark fins for the Asian fin trade, and along with this has come a considerable level of IUU fishing (Ullah and Gadain 2016). In parts of Somalia, in the early 2000s, artisanal fishers were reported to have focused heavily on shark finning, for the fin trade, whilst discarding thousands of t of unused shark carcasses (Cashion et al. 2018). There are now direct product value chains between Somalia and Asian destinations, such as Hong Kong, for the export of shark fins (Glaser et al. 2015). Declines in shark populations have been ascribed to overfishing for their fins (Pilcher and Alsuhaibany 2000), and several once abundant shark species, including *Sphyrna* spp., mako sharks (Lamnidae) and *Carcharodon carcharias* have completely disappeared in certain areas, while mean sizes of other common species have decreased over the years (UNEP 2005), with local fishers blaming IUU vessels as being responsible for these declines (Kulmiye 2010). Furthermore, there is concern over the targeted capture of *Mobula* spp. in the artisanal fishery and incidental catches thereof in industrial fisheries (Sheik Heile and Glaser 2020). In Somalia, like other WIO States, chondrichthyans are under great threat from fisheries.

Trade in chondrichthyan products

The Somali trade in chondrichthyan products was historically dominated by fins and dried or salted shark meat (Thurow and Kroll 1962, Marshall 1997c). Chondrichthyan meat and fins are major export commodities for Somalia, and the value chain has been assessed by Glaser et al. (2015), largely based on information from Kulmiye (2010). Chondrichthyan fins and meat are generally sold to local collectors, and in turn to traders in Bosaso and Mogadishu, from where they are exported. These traders also often sell fishing gear and finance fishing activities.

Large volumes of chondrichthyan meat are exported to Kenya and Yemen (Glaser et al. 2015). Mombasa, Kenya, is considered the largest market for dried shark meat in East Africa. Marshall (1997c) estimated 300-600 t of shipments containing dried and salted sharks and rays were exported annually from Somalia to Kenya, of which 75% were sharks and the remainder were rays. Shark meat is not generally eaten in Somalia (Berbera Port Authority 2015), although a small proportion of the shark meat from Somali fisheries is believed to be sent to the larger inland cities in Somalia, where it is consumed.

The fins of sharks and shark-like rays are air-freighted to Asian countries such as Hong Kong and Singapore. Fins were exported primarily to Dubai, sometimes via Djibouti, and then on to Asia. However, over the last 10 to 15 years, Somali exporters have largely bypassed intermediary traders (middlemen) in Dubai, as had previously been the case, and established direct business relationships and export channels with buyers, to whom they supply chondrichthyan products under strict contracts, offering the benefits of easier export logistics and greater profit margins. A reported 10,530 kg of shark fins were exported from the port of Bosaso over a six-month period in 1996 (Anon 1996).

Somali fishers operating in the Gulf of Aden have also been recorded selling sharks (whole, including fins) at sea to Yemeni fishing vessels (Glaser et al. 2015). Chondrichthyan products are also exported by boat from Somaliland, via Djibouti, to unknown Asian destinations. Somaliland is not directly addressed in this report, but many of the species of sharks caught in the Gulf of Aden are shared with the Somali Indian Ocean coast and countries further south, therefore such “at sea, unofficial” export of sharks through the Gulf of Aden, which is likely not recorded or reported, may have unknown impacts on WIO populations. As a signatory to CITES, if any of these chondrichthyan species are CITES-listed, which is possible, this may have implications for Somalia’s adherence to CITES.

A recent survey of shark trade was conducted at various landing and processing areas and fish markets. The survey found the price per whole shark to range by species, from USD30 for smooth hammerhead sharks *S. zygaena* to USD350 for *S. lewini*. Shark oil was priced at USD480 per 200-l drum; meat at USD2–3 per kg; whole jaws at USD20; and 1 kg of fin at USD180, depending on the size and species. Jaws were reported to be exported to Italy, fins to China via Dubai, and dried meat and oil to Tanzania, Yemen and Kenya (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017).

Official chondrichthyan trade data

From 2012 to 2019, no data could be found on exports of any chondrichthyan products from Somalia, imports by Somalia, or reported exports to Somalia (UN Comtrade 2021). There were, however, a few countries that reported imports of chondrichthyan product from Somalia: countries reported an average of 5.62 t of shark meat per year; and 10.77 t of shark fin per year. Importing countries included Canada, Hong Kong, Malaysia, Oman, Republic of Korea, Singapore and the United Arab Emirates. Hong Kong reported an average annual import of 7.85 t per year of shark fin from Somalia over this period, with the majority of these imports having occurred in 2017–2019 (average of 16.35 t annually). While these quantities represent relatively low export volumes in comparison to some other WIO country exports, these represent a significant number and biomass of chondrichthyans from which the fins were harvested, highlighting the major underreporting taking place, and the major discrepancies between export and import volumes being reported.

Trade in CITES-listed chondrichthyan species

The only recorded trade in CITES-listed elasmobranch species from Somalia during the last 10 years (i.e., since 2011) was one whole sawfish (*Pristis* spp.) that was confiscated in Norway in 2011[98]. Sawfish populations have declined globally, therefore it is concerning that their illegal trade persists. Considering the high levels of trade in chondrichthyan products from Somalia, as mentioned in earlier sections, it is concerning that this sawfish record was the only official report of a CITES-listed chondrichthyan product being exported from Somalia, as it is highly likely that other CITES-listed species are being exported from Somalia, but not being reported. Furthermore, Somalia has not concluded any Non-Detriment Findings (NDFs) for CITES-listed chondrichthyan species, therefore any current trade in CITES-listed species is in contravention of CITES trade controls. There is thus a strong need for improved monitoring and enforcement of CITES regulations in Somalia.

[98] https://trade.cites.org

6.8.4 Conservation status

As a consequence of these high levels of legal and illegal fishing pressure, chondrichthyans in Somalia are heavily overexploited, with 47 (61%) of the 77 confirmed chondrichthyan species in Somalia (south of Ràs Hafun) currently considered threatened with extinction (IUCN 2021). These include 21 Vulnerable, 18 Endangered, and 8 Critically Endangered species, according to the IUCN Red List of Threatened Species (IUCN 2021, see Table 3.4 in Chapter 3). The only species endemic to Somalia, *Bythaelurus vivaldii*, is currently classified as Data Deficient due to insufficient information being available to assess its risk of extinction based on its distribution and/or population status.

The formally abundant *Pristis pristis* and *P. zijsron* have suffered major population declines globally and are now considered Critically Endangered, and regionally extinct in parts of their range. Historical records confirm the presence of both species in Somalia (Pierce 2014), with both species being caught as bycatch in shark-directed gillnet fisheries in Somalia (Heileman and Scott). Although *P. zijsron* is thought to have been extirpated from the country, the persistence of *P. pristis* remains conflicted (Pierce 2014, Dulvy et al. 2016).

Considering the documented declines in shark catch and mean shark size of common species in artisanal catch in Somalia, there is strong evidence indicating that fisheries, as well as the shark fin trade, have negatively impacted chondrichthyan species in Somalia. This, along with their life-history styles, has had a negative impact on the populations of numerous chondrichthyan species in Somalia, possibly even leading to the extirpation of both sawfish species.

6.8.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

The management of marine resources and implementation of fisheries laws in Somalia falls under the Ministry of Fisheries and Marine Resources (MoFMR). Inshore fisheries in Somalia are subject to the management of federal Member States within Somalia (such as the Ministry of Fisheries, Ports and Marine Transport in Puntland State), while offshore fisheries are under the management of the federal government of Somalia in coordination with the States (Glaser et al. 2019) (Table 6.8.1). However, Somali fisheries have historically been characterized by low levels of governance and enforcement (Hassan 2011). As a result, an estimated 700 foreign flagged trawlers were suspected to be engaged in IUU fishing in or near Somali waters, in the early 2000's (Hassan 2011).

Prior to the civil war in Somalia, fisheries management was centralized with fisheries governed under presidential decrees; however, during the war, there was an absence of central government, which allowed an increase in IUU fishing (Trans-Africa 2015). Following these 20 years without a central government, in 2012 Somalia established the Federal Government of Somalia (FGS). The FGS still has limited control over the Somali regions. Somaliland has had an independent government since 1991, but it is nevertheless recognised as an autonomous State that remains under the governance of FGS. Puntland, like other semi-autonomous States of Somalia, also has its own administration that coordinates with FGS. However, there is inconsistency in these laws, and a more unified fisheries law is needed. Threats to political stability remain (Doboš 2016).

Enforcement of Somalia's fishery laws is the responsibility of the Somali Navy, along with State-level entities, such as the Puntland Maritime Police Force for the enforcement of Puntland's Fisheries Regulations (Hassan 2011) (Table 6.8.1). In 2013, the FGS, Somaliland, and the Somali regions, supported by members of the international community, developed the Somali Maritime Resource and Security Strategy (SMRSS). The SMRSS directs future secure and sustainable development of the Somali maritime sector, including marine resource management.

A Maritime Security Coordination Committee (MSCC) has also been developed to facilitate cooperation and maritime security development between FGS's National Maritime Coordination Committee (NMCC), the Somali Regions Maritime Coordination Committees (MCC; including Puntland, Galmudug, Jubbaland, Hirshabelle and South West States), and with Somaliland's Counter Piracy Program. The MSCC aims to enable implementation of the Somali Maritime Resource and Security Strategy across the full Somali maritime spectrum. Two working groups exist within the MSCC: The Maritime Strategy Working Group and the Fisheries Working Group. The Maritime Strategy Working Group is responsible for overseeing and resolving issues relating to the implementation of the Somali Maritime Resource and Security Strategy, whilst the Fisheries Working Group works on regenerating the Somali Fisheries Industry and preventing the illegal exploitation of Somali natural resources.

The MoFMR is responsible for marine species conservation in Somalia (through its Department of Coastal Biodiversity), and is the focal point for CMS and the CMS Sharks MOU. The MoFMR, the Ministry of Tourism and the Coast Guard share responsibility for MPA and coastal zone management, but no MPAs have yet been designated. The Department of Wildlife in the Directorate of Environment is the designated national CITES management and scientific authority (Table 6.8.1).

Table 6.8.1: Authorities responsible for chondrichthyan management in Somalia (note that in many cases, the named authorities may not have been officially designated as the competent authority for these specified areas of management at present, but as Government develops these are the existing Ministries most likely to deal with the listed management issues).

Area of management	Authority
Fisheries management and research	Ministry of Fisheries and Marine Resources (MoFMR); Ministry of Finance;
Export and import trade controls (including permitting)	Department of Wildlife, as National CITES management and scientific authority (under the Directorate of Environment); MoFMR
Permitting of fisheries	MoFMR
Enforcement of fisheries legislation	Coast Guard and Somali Naval Force (and State Coast Guards)
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	Coast Guard and Somali Naval Force (and State Coast Guards)
Species conservation and environmental protection	Department of Coastal Biodiversity (within MoFMR)
Coastal zone management	Department of Coastal Biodiversity (MoFMR);
MPA management and enforcement	MoFMR; Ministry of Tourism; Coast Guard

National legislation and regulations

Fisheries legislation was first introduced with the 1959 Somaliland Maritime Code (Government of Somalia 1959), which served as the foundation for current Somali maritime regulation and prohibited certain fishing activities, such the use of explosives and fishing in protected areas with prohibited gears (Hassan 2011), and established a vessel concession and licensing system. It empowered the Maritime Authority to conduct fisheries management and oversight. This law was superseded in 1985, by the Somali Democratic Republic Fishery Law No. 23 of 30 (Government of Somalia 1985a), and there were other laws implemented that provided rules relating to fishing by foreign vessels (Hassan 2011).

The Fisheries Law of 1985 placed enforcement authority on the Somali Navy (Table 6.8.1) and developed the licensing framework to include an application process that increased accountability and required fishery data collection. The Fishery Joint Venture Guidelines were also established in 1985 (Government of Somalia 1985b), allowing licenses to be issued for foreign fishing (see Glaser et al. 2015). However, due to the civil war and the absence of a central government between 1991 and 2012, there was no enforcement of fisheries legislation, leaving Somali waters unregulated and unprotected (Samatar 2007). The legal ambiguity of Somalia’s EEZ prior to 2014 also made it difficult to include Somali waters in regional MCS efforts and meant that foreign fishing in these waters was not technically illegal, but greater regional cooperation to combat IUU fishing should now be possible (Persson et al. 2015).

Within the Somali States, State-level fishery regulations were also passed. During the absence of national fisheries governance, regional fisheries legislation was passed by Somaliland. The Somaliland Fisheries Law (Government of Somaliland 1995) is based primarily on the national Fisheries Law

(Government of Somalia 1985a). The law places management authority with Somaliland's Ministry of Fisheries and addresses the Somaliland maritime zone, resource management and licensing. Based on this law, Somaliland passed the Somaliland Fisheries Regulations, which seek to align exploitation levels with resource management principles. All fishing vessels operating in Somaliland waters (regardless of size) must be licensed, but no catch limits are in place and there are no restrictions on gear type or mesh size, and no spatial or temporal restrictions. There are no fisheries regulations for chondrichthyans, and finning is not prohibited. Again, enforcement is a challenge, and much of the 'licensing' is not transparent or legal (Berbera Port Authority 2015). The Puntland administration also established fisheries regulations based on the 1985 national Fisheries Law (Glaser et al. 2015), such as its own licensing scheme for foreign vessels in 1999, but this was short-lived due to political unrest within Puntland in 2001–2002. It also assigned responsibility for controlling coastal resources to foreign private security companies from 2000 to 2006, but with limited success (Hansen 2008).

In 2014, Somalia declared its EEZ (UN General Assembly 2014) and updated the federal fisheries legislation with the Somali Fisheries Law (Government of Somalia 2014), which details numerous fishery actions that are prohibited. The law mandates that catches may not exceed optimum sustainable yield[99], bans bottom trawling, increases requirements for reporting, and reserves the first 12 nm of Somali waters for Somali fishers only. Additionally, the law invalidates all fishing licenses issued between January 1991 and 2014. However, the 2014 Law makes no specific provision for chondrichthyan species, although it prohibits the fishing of endangered aquatic organisms and that any such species caught incidentally shall be released. While the definition of 'aquatic organism' in the law's text includes fish (and thereby also chondrichthyan species), there is no definition of what constitutes an "endangered" species. Article 42 of the Act lists several specific Regulations, addressing aspects such as *Regulation for environmental protection of endangered species.* However, such Regulation texts were never developed, leaving considerable gaps in the legal framework for fisheries management in Somalia (pers. comm., Abdirahim Ibrahim Sheik Heile, Ministry of Fisheries and Marine Resources, September 2021).

In 2016, Somalia published its National Biodiversity Strategy and Action Plan (NBSAP), a strategic action plan for the management of Somalia's biological diversity, for the period 2016–2020 (Ullah and Gadain 2016). The document presents the vision for restored biodiversity by 2050, through five key principles: 1) improving the understanding of the drivers of biodiversity degradation; 2) reduction of direct pressures on Somalia's biodiversity; 3) safeguarding ecosystems, species and genetic diversity; 4) enhancing social benefits from biodiversity; and 5) enhancement of participatory planning, knowledge management and capacity building (Ullah and Gadain 2016). However, while chondrichthyans are included as part of the stated biodiversity, the plan does not provide specific measures for these species.

The adoption of the 2014 Law came a year after Somalia became a member of the Indian Ocean Tuna Commission (IOTC). Thus, the Ministry of Fisheries and Marine Resources has begun reviewing its Fisheries Act to fill these gaps and to reflect the conservation and management measures of regional fishery bodies, the IOTC and multilateral environmental agreements. Accordingly, Somalia has completed a review of its fisheries legislation which addresses such conservation and management measures, including the protection of Endangered species (Sheik Heile, e-mail correspondence, October 2021).

In July 2020, a new federal Fisheries Bill was drafted, on the management, development and sustainable use of fisheries and aquaculture in Somalia. The Fisheries Bill is in the final stages of the consultation process, and it is believed that the Bill will include appropriate management measures for sharks, but it is noted that it is premature to cite any legal reference from the current Fisheries Bill to avoid interrupting this important process (Sheik Heile and S. Glaser, personal communication, September 2021). Somalia is thus making significant improvements in its fisheries legislation, specifically in the protection of sharks.

[99] Significant steps in data collection and analysis are needed before estimates of the status of fish stocks and benchmarks for optimum sustainable yield can be generated.

Status of NPOA-sharks

No NPOA-Sharks has been published for Somalia (IOTC 2020). However, the 2020 annual report to the IOTC (Sheik Heile and Glaser 2020) indicated that the process to develop Somalia's first NPOA-Sharks (SOM-NPOA-Sharks) is underway, with a final consultative meeting held in 2021. The NPOA document has been drafted and is awaiting approval by cabinet, initially intended for publication in 2021; the document will be made available by the Ministry of Fisheries and Marine Resources. The Somali NPOA-Sharks will apparently regulate the intentional targeting of Endangered shark species by the artisanal fishery in Somalia, and implement measures to redirect fishery targeting towards other, more sustainable species (Sheik Heile and Glaser 2020). No further information is available on this document.

Marine protected areas

Somalia has declared no MPAs (UNEP-Nairobi Convention and WIOMSA 2021a, UNEP-WCMC and IUCN 2021g).

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Somalia is signatory to several MEAs and RFBs (see Table 5.2). Somalia ratified CMS in 1986 and is thereby bound by CMS commitments. There are seven chondrichthyan species listed on Appendix I and 14 on Appendix II of CMS (six of which are listed on both), which are known to occur in the Somali EEZ, south of Ras Hafun (as covered in this report) (Table 6.8.2, see also Table 3.3, Chapter 3). Somalia is thus obliged to protect the seven species listed on Appendix I, and to implement the CMS concerted actions for whale sharks and mobulid rays. As a Party State, Somalia is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them; however, the conservation of migratory chondrichthyan species, or any migratory species, does not yet feature in national legislation. Many of the Appendix II species are shared with other Nairobi Convention Member States, and Somalia should participate in the development of regional management plans, where appropriate, for these species (Table 5.1). Somalia also signed the CMS Sharks MOU, in 2016 (Table 5.2). Therefore, the State should support regional management efforts for these species, through the development of regional management plans for threatened chondrichthyan species, where relevant (see section 5.2.1).

Somalia ratified CITES in 1977. There are 13 CITES Appendix II chondrichthyan species known from Somali waters, for which trade should be carefully controlled, as well as two (possibly three) Appendix I species for which commercial international trade should be prohibited, but national legislation is generally not believed to meet the requirements for implementation of CITES and, in fact, Somalia was subject to a recommendation to suspend trade in April 2004 (CITES 2021). While it seems that efforts to improve legislation relating to CITES are underway (CITES 2021), no NDFs or stock assessments have been conducted and no data are currently being collected to ensure that export of CITES-listed shark and ray species is not detrimental to wild populations.

Somalia is a member of two relevant RFBs: the IOTC and SWIOFC (Table 5.2). Somalia has not joined SIOFA. Under the IOTC, shark, tuna and swordfish fisheries in Somalia must report their catches and follow the IOTC regulations on chondrichthyan species, retention bans, finning and reporting (see Section 5.4.1). These measures include retention bans in IOTC-managed fisheries for seven chondrichthyan species confirmed in Somali waters (Table 3.3). However, none of these species is prohibited within Somalia. The State has no vessels on the IOTC record of authorized vessels, therefore many IOTC resolutions and CMMs are not applicable to Somalia, including those relating to chondrichthyans. However, for most measures that are applicable, including reporting on the nominal catch, catch and effort and size frequency of chondrichthyans, and the prohibition on finning, Somalia was found to be non-compliant (IOTC Secretariat 2021i). However, the 2020 Somalia annual report to the IOTC highlights numerous new measures for chondrichthyans (and IOTC-linked fisheries), that have been included in the recently drafted fisheries legislation (Sheik Heile and Glaser 2020), which align closely with the IOTC CMMs and which should have a positive impact on chondrichthyan species, once the law is implemented. These new measures should vastly improve Somalia's compliance with the IOTC.

Somalia is also a Member of the Nairobi Convention and acceded to the PSMA in 2015 (Table 5.2). While neither of these instruments specifies management measures or commitments for chondrichthyan species, the Nairobi Convention does list species-specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future. Membership of Somalia to the PSMA (Table 5.2) means that port officials in Somalia can prohibit foreign vessels that are suspected of illegal activity from receiving port services and access, and alert other ports to the situation, potentially blocking illegally caught chondrichthyans from entering the global marketplace. Both of these instruments are binding on Member States, and Somalia is thus obliged to implement the required measures, and both have the potential to facilitate improved chondrichthyan management and decreased IUU fishing of chondrichthyans in Somalia. Somalia is not a member of the Ramsar Convention.

Somalia is also Party to UNCLOS and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments to these instruments, both of which carry specific measures for chondrichthyan species, and impose strong commitments on Member States to ensure strengthened national fisheries management frameworks, for sustainable fisheries. Somalia is also the oldest Member of the FAO among the Nairobi Convention Member States, having joined in 1960, and is therefore encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, many of which present specific chondrichthyan measures (see section 5.3).

Note on Somaliland: As Somaliland is not a recognised State it cannot become a Signatory of CMS or the CMS Sharks MOU. Somaliland is also unable to become a Party to CITES, so there is no policy on international trade in CITES-listed sharks and rays, nor are there systems in place to implement CITES trade controls or to record and report on CITES shipments. There is no legislation controlling trade in Somaliland, nor are records kept of the nature or quantities of exports of chondrichthyan products (Berbera Port Authority 2015).

6.8.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Somalia

Fisheries

- Chondrichthyans are caught in all fishery sectors in Somalia (including targeting is some fisheries, particularly by foreign vessels) and contribute a substantial proportion of the catch.
- More than half of the chondrichthyan species in Somalia are threatened according to the IUCN Red List; therefore, appropriate management measures must be implemented to ensure that fishing of chondrichthyan species is sustainable.
- Trawling results in significant bycatch of non-target species, including chondrichthyan species, and unwanted bycatch is often discarded, with high mortality rates.
- The threat of conflict driven by the presence of foreign vessels has forced artisanal fishers closer to shore, and this “overcrowding” of artisanal waters was suggested to have caused overexploitation and consequent declines in populations of coastal shark species (Sone 2010).
- The high level of chondrichthyan discards is of great concern; measures are needed to mitigate against this wasteful activity. This is largely driven by the value of fins and the incentive to maximize profits by retaining only the fins.
- The targeted and incidental catches of mobulid rays in Somali waters are also of great concern, as all three confirmed *Mobula* species in Somali waters are Endangered on the IUCN Red List, and the catches of these species may be declining. In line with the CMMs of the IOTC and CMS, the capture of mobulid rays (including incidental capture) should be prohibited.
- There is also a high catch (and bycatch) of threatened species, including hammerhead (Sphyrnidae) and thresher (Alopiidae) sharks, rays (Dasyatidae and other families), guitarfishes (likely Rhinobatidae and Rhinidae) and sawfishes (Pristidae), some of which are Endangered or Critically Endangered, or even locally extirpated, and measures must be implemented to avoid bycatch of such species.

- IUU fishing in Somali waters has a been threat for many decades, particularly from foreign vessels (Glaser et al. 2019). State collapse in 1991 was followed by an exponential increase in IUU fishing in Somali waters, particularly from foreign vessels (Sone 2010). This had major impacts on coastal (mainly artisanal) fisheries, and an unmeasurable impact on fish stocks in Somali waters. This problem was exacerbated by the limited capacity for MCS in Somalia, and enforcement of fishery laws, particularly post 1991 (Sone 2010).
- Owing to the high levels of IUU fishing in Somalia, unknown quantities of fishery resources have been removed, and there is thus a lack of baseline stock information regarding fishery resources in Somalia, against which future trends and indices can be compared.

Governance

- There is no real regulation of fishing activities, no policy for chondrichthyans (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017), and no protection for important habitats, with no MPAs at all in Somalia (UNEP-WCMC and IUCN 2021g).
- Limited fishery regulation and enforcement may have resulted in Somalia (at least at one stage) becoming a refuge for shark fishers displaced from other waters due to declining populations or stricter regulations related to shark fishing, such as bans on shark finning (Glaser et al. 2015).
- There appears to be a significant number of fishing vessels operating in Somalia without appropriate licenses, facilitating underreporting and IUU fishing.
- There are poor trade controls, and there is international trade in CITES-listed species in contravention of CITES trade controls. There are no records of CITES-listed chondrichthyan product exports from Somalia on the CITES trade database, despite volumes of CITES-listed species being confirmed in the trade through several other reports.
- CITES trade data also indicate major discrepancies in export (from Somalia) and import (to other countries) volumes, indicating gross underreporting of exports, and contravention of CITES export requirements.
- Relative to other WIO States, Somalia has limited human capacity and skilled staff for conservation and management (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017).
- There has also been a lack of human capacity and financial resources for fishery data collection and analysis, which have limited the ability of Somalia to collect and report basic fishery statistics (Sheik Heile et al. 2018).

Information

- Limited research has been conducted on chondrichthyans in Somalia, and there remains limited biological and ecological information to inform their management at national level. There is also limited funding for research on chondrichthyans (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017).
- Instability is a major constraint to enhancing the understanding of chondrichthyans for effective management (Berbera Port Authority 2015).
- There is a lack of comprehensive scientific data for Somali fisheries, including fisheries data collection and reporting, which is a significant challenge to management of fishery resources and inhibits efforts to combat IUU fishing (Sheik Heile et al. 2018), as without knowledge of the status of stocks, appropriate management to ensure sustainability is challenging. With the declaration of Somalia's EEZ, this need for scientific data is now more pressing than ever (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017).
- There is limited reporting of catch statistics from Somalia to the FAO, and non-IOTC species caught by foreign vessels operating in Somalia are not reported to Somalia at all - this includes chondrichthyan species caught by the vessels of several other countries, and the lack of catch statistics increases the risk of overfishing (Glaser et al. 2019). However, recently, measures have been implemented to record shark catch data by IOTC-managed vessels, and the 2020 Somali report to the IOTC indicates that shark catch data will become available for the year 2020 in subsequent reports (Sheik Heile and Glaser 2020).

Required and recommended actions

Governance

- Development, finalization and implementation of a robust NPOA-Sharks would provide a useful framework for management of chondrichthyan resources and fisheries, in Somalia.
- The decentralizing of fisheries management to the States, and to regional (within State) fishery management committees (Trans-Africa 2015) and the implementation of Territorial Use Rights for Fisheries (TURF) programs (Glaser et al. 2015) have been proposed for coastal and demersal species in Somalia, particularly in areas with limited government resources, to secure access and benefits for local fishers in each region.
- Somali State fisheries authorities should introduce and enforce the respective State's fisheries regulations in a systematic manner involving all stakeholders in order to mitigate against overfishing (Kulmiye 2010).
- Improved implementation of legal licensing systems will be necessary, to reduce the number of vessels operating illegally.
- Measures are required to diversify livelihoods (at least to reduce fishery impacts on threatened chondrichthyans and other threatened fishery species), and to implement the ecosystem approach to fisheries (Trans-Africa 2015).
- Improved international cooperation in fisheries is necessary, including improved coordination with and adherence to international agreements, and measures to improve MCS activities in Somalia to combat IUU fishing and piracy (Kulmiye 2010).

Policy, legislation and enforcement

- Stricter regulations will need to be implemented legally. A chondrichthyan-specific law (or specific measures in a general Fisheries Law) would provide a legal framework for the protection of threatened and overexploited chondrichthyan stocks. The finalization of the new Fisheries Law that is under development, and which is expected to have revised measures that are pertinent to chondrichthyan species, may partly or adequately cover this need (Sheik Heile and Glaser 2020).
- Legal protections must be implemented for relevant threatened species, and species required to be protected though measures such as CMS Appendix I and IOTC retention bans. Such species requiring protection are defined in detail in section 6.8.7, and in Table 6.8.2.
- Considering the fishery threats to threatened chondrichthyan species, such as *Alopias* spp., *Isurus oxyrinchus* and *Mobula* spp., IOTC CMMs must be adopted in IOTC-managed fisheries, but also smaller vessels operating within the Somali EEZ, to reduce impacts on such species.
- Destructive fishing gears must be banned, such as monofilament nets.
- Regulations already gazetted but that are not yet enforced must be enforced, such as the provision in the Fisheries Law that bans bottom trawling in Somali waters.
- More stringent regulations on finning, including a requirement to keep whole sharks on board until landing, should be introduced.
- There is also a need for the protection of critical habitats, such as mating, pupping and nursery grounds, particularly as Somalia has no MPAs.
- Trade controls will need to be improved, to mitigate against the high level of unreported and illegal exporting of chondrichthyan products (by Somali fishers and foreign fishers operating in Somali waters). This includes improvements in the implementation of (and implementing mechanisms for) CITES trade controls, such as conducting NDFs for CITES-listed species, to assess whether trade can be undertaken without negative impacts on wild populations.
- It is essential that measures are implemented to reduce fishery (particularly chondrichthyan) discards, in order that the potential benefits (protein and income) of the otherwise discarded products may be realized (Kulmiye 2010).
- Measures are drastically needed to reduce the level of IUU fishing in Somalia, including coordinated efforts to update legislation, improve enforcement and judiciary capacity, introduce community-based enforcement, and develop an anti-piracy task force (Trans-Africa 2015).

Data collection and research priorities

- Improved catch data collection is essential and could be achieved through strict and enforced reporting requirements, observer programs and vessel logbooks.
- A national fisheries monitoring program should be implemented, and could be achieved through expansion of existing data collection activities (including catch and effort data for chondrichthyan species), with particular focuses on registering/licensing of all fishing vessels and registration of fishers, training on fisheries monitoring and data collection, and identification of dedicated fish landing sites to facilitate comprehensive data collection (Kulmiye 2010, Berbera Port Authority 2015).
- Catch data collection must be at species-level, in fisheries in which chondrichthyans are targeted and those in which they are incidentally caught, and in all States (Glaser et al. 2015; pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017).
- There is a need to improve data management systems, and to initiate or improve the use and implementation of VMS technology (Trans-Africa 2015).
- There is an urgent need for stock assessments, surveys and other relevant studies in order to establish the status, distribution, abundance and fishery potential of the key target species known to be vulnerable to fishing pressure, including chondrichthyans (Kulmiye 2010).
- Primary research needs (detailed in section 6.8.2) include the collection of baseline data on chondrichthyan biodiversity, chondrichthyan fisheries and trade, and the threats faced by chondrichthyans in this region (Berbera Port Authority 2015). This could guide the authorities in the implementation of appropriate management and conservation measures.

Capacity

- Somalia needs technical support to train national staff on outreach and advocacy (pers. comm., Mohamud Hassan Ali, Ministry of Fisheries and Marine Resources, April 2017).
- By sensitizing fishing communities to the need for sustainable use of resources, fishers may become more actively involved in the conservation of the resources upon which they depend for their livelihoods.
- Those involved in the fish trade should also be sensitized and encouraged to play a role in the conservation efforts.

A note on Somaliland (Berbera Port Authority 2015)

While Somaliland falls outside of the area covered by this report, fishing impacts in Somaliland waters can have negative consequences on populations that are shared with the WIO waters of Puntland and South-Central Somalia. Key issues and needs in Somaliland are thus presented below:

- No real regulatory framework for fisheries management exists and this must be developed.
- Chondrichthyan management is constrained by poor knowledge of chondrichthyan fisheries and trade and necessary management actions, and inadequately trained staff.
- There is a lack of enforcement capacity.
- There is no funding available for research.
- The lack of awareness regarding marine conservation issues may be exacerbated by Somaliland's exclusion from international bodies. Fisheries and trade monitoring and controls may be improved by admittance of Somaliland to international conventions, even if only with observer status (Berbera Port Authority 2015).
- The development of MPAs could also lead to greater awareness of marine conservation issues, and may encourage the government to address chondrichthyan conservation in the near future.
- There is a lack of interest in marine conservation and management, which is unsurprising given the perception of fishing as an undesirable occupation, and the many other challenges facing this impoverished State. There is also a strong cultural aversion to sharks in particular. Community education is required.

6.8.7 Priority chondrichthyan species for protection

There are eight chondrichthyan species either confirmed or reported from Somali waters that are listed on CMS Appendix I, and thereby require national level protection; and nine species (six of which are listed on CMS I) with retention bans under the IOTC (Table 6.8.2). As Somalia is a signatory State to CMS and IOTC, these species should be fully protected or protected within the relevant fisheries, respectively.

There are also six Critically Endangered and 12 Endangered chondrichthyan species in Somalia (Table 6.8.2) other than those listed in CMS Appendix I or with IOTC retention bans. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1995). As a Member State of both Organizations, Somalia should implement the precautionary principle and consider prohibiting the taking of Endangered and Critically Endangered species (at least from commercial harvesting and trade).

Table 6.8.2. Chondrichthyan species confirmed or reported (*not confirmed) from the waters of Somalia (Indian Ocean coast specifically), for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries), respectively. Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Critically Endangered and Endangered species for which prohibition is recommended are also presented.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus *	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Mobulidae	*Mobula birostris*	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula eregoodoo *	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Pristis pristis*	Largetooth sawfish	I, II		I	CR	CMS I
	Pristis zijsron	Green sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Critically Endangered and Endangered species for which prohibition is recommended							
Carchariidae	*Carcharias taurus*	Ragged-tooth shark				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish/shark ray			II	CR	CR
	Rhynchobatus australiae	Bottlenose wedgefish	II		II	CR	CR
	Rhynchobatus djiddensis *	Whitespotted wedgefish			II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN
	Carcharhinus obscurus	Dusky shark	II			EN	EN
	Carcharhinus plumbeus	Sandbar shark				EN	EN
	Negaprion acutidens	Sicklefin lemon shark				EN	EN
Centrophoridae	*Centrophorus granulosus*	Gulper shark				EN	EN
	Centrophorus uyato	Little gulper shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Echinorhinidae	*Echinorhinus brucus*	Bramble shark				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray				EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN

6.9 Republic of South Africa

6.9.1 Introduction

At the southern tip of Africa, the Republic of South Africa (hereinafter South Africa) is bordered by Namibia to the northwest and Mozambique to the northeast, and is bounded by the Indian Ocean to the southeast and south, and the Southeast Atlantic Ocean to the southwest and west (Figure 6.9.1). South Africa has a coastline of more than 3,111 km and a mainland EEZ of about 1,072,716 km^2 (Fielding 2021), however the EEZ of the Indian Ocean coast is about 691,344 km^2 (Claus et al. 2014).

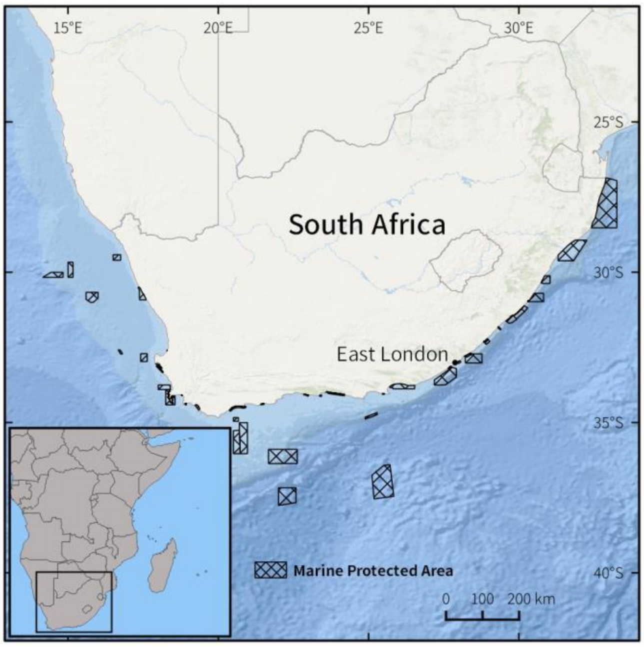


Figure 6.9.1: Map of the Republic of South Africa, showing its position in the Western Indian Ocean and place names mentioned in text.

The warm, fast-flowing Agulhas Current that flows southwest along the east coast of South Africa is a major driver of inshore and offshore marine ecosystems, known as the Agulhas Current Large Marine Ecosystem, while the cool Benguela Current flows northwards along South Africa's west coast (Fielding 2021). Owing to these vastly different large marine ecosystems, South Africa's waters represent great diversity, which can be divided roughly into three main biogeographic regions: the sub-tropical east coast (forming part of the WIO), the cool temperate west coast, and the warm temperate south coast between them that forms a broad transition zone between the warm east coast Agulhas and cool west coast Benguela currents (Turpie et al. 2000).

While the boundaries between these biogeographic regions are themselves broad transition zones, there appears to be a distinct change in the chondrichthyan species assemblage west of East London (Ebert et al. 2021c), including many cooler water species that are not found east of East London, hence the decision to include only species east of East London in this report (see Chapter 2).

South African waters are characterized by high endemism (particularly on the Indian Ocean side) due to their distinct oceanographic conditions and variety of habitats (van der Elst et al. 2005). The northeast coast of South Africa is recognized as forming part of a global hotspot for chondrichthyan species richness, endemism and evolutionary distinctiveness (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020), with South Africa constituting one of 12 countries worldwide that are hotspots for imperilled endemic chondrichthyans, together with Mozambique (Davidson and Dulvy 2017).

The human population of South Africa as of mid-2021 was approximately 60.1 million (Republic of South Africa 2021a). South Africa has traditionally been a net exporter of fish products and has a relatively low fish consumption per capita (6.1 kg in 2016; FAO 2016a), although South Africa's coastal communities have traditionally had diets high in fish (FAO 2018). In 2016, marine capture fisheries produced approximately 611,000 t, with the fishing industry employing an estimated 27,700 individuals in primary and secondary sectors (FAO 2018). Recreational fishers comprise 500,000–900,000 participants (FAO 2016a), the highest of any Nairobi Convention Member State.

Fisheries are considerably more productive on the western coastal shelf due to upwelling, while the east coast has higher species richness, but is considerably less productive (FAO 2018). Overall, fisheries contribute minimally to South Africa's GDP (FAO 2016a). However, chondrichthyans have been exploited in South Africa for nearly a century and continue to be targeted and caught as bycatch in various South African fisheries (da Silva et al. 2015).

6.9.2 Chondrichthyan biodiversity and status of knowledge, South Africa

Biodiversity

South Africa has one of the most diverse chondrichthyan faunas in the world (Compagno 1999, Ebert and van Hees 2015, Ebert et al. 2021c), and the highest chondrichthyan species richness in the WIO (Table 3.1, chapter 3), which is largely influenced by the cold Benguela current on the west coast and the warm Agulhas current on the east coast, with the mixing of these currents creating varied biogeographical zones. Along the Indian Ocean coast of South Africa (i.e., east of East London; Figure 6.9.1), 93 species of shark (representing 29 families), 57 species of batoid (16 families) and five species of chimaera (three families) have been recorded (Table 3.1), with a further four shark and one batoid species reported but not confirmed from these waters. The most common shark families include the Carcharhinidae (requiem sharks), comprising 20 species, followed by Centrophoridae (squaliform sharks), Etmopteridae (lantern sharks) and Pentanchidae (deepwater catsharks), each comprising seven species (Table 3.3). Dasyatidae (whiptail stingrays) and Rajidae (skates) are the most common batoid families, representing 14 and 11 species, respectively. There are three species of Rhinochimaeridae (long-nose chimaeras), making this the most common family of chimaeras in the WIO region of South Africa.

Only one chondrichthyan species is endemic to the Western Indian Ocean region of South Arica, the ornate sleeper ray *Electrolux addisoni*, which has only been recorded from a few specimens (Compagno and Heemstra 2007). An additional 17 chondrichthyan species which occur in South Africa are endemic to the WIO (Table 3.3). Although not endemic to South Africa or the WIO, the longnose pygmy shark *Heteroscymnoides marleyi* is known from the region from a single specimen washed up on a Durban beach in South Africa (Fowler 1934, Ebert et al. 2021c). Of the 26 chondrichthyan species described from the WIO since 2011 (Table 3.3) eight have distributions which occur in South Africa, including the batoid species bluespotted maskray *Neotrygon caeruleopunctata* and Austin's guitarfish *Rhinobatos austini*, and the shark species Human's whaler shark *Carcharhinus humani*, whitecheek lanternshark *Etmopterus alphus,* Barrie's Lanternshark *E. brosei*, sculpted lanternshark *E. sculptus*, long-snouted African spurdog *Squalus bassi* and the Malagasy skinny spurdog *S. mahia*. It is therefore likely that there are more chondrichthyan species present in South Africa that have not yet been recorded.

South Africa is part of a global hotspot for chondrichthyan species richness, endemism and evolutionary distinct species (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020). There are key aggregation sites in South Africa for the Critically Endangered scalloped hammerhead shark *Sphyrna lewini* and whitespotted wedgefish *Rhynchobatus djiddensis,* the Endangered dusky shark *Carcharhinus obscurus* and shortfin devil ray *Mobula kuhlii*, Vulnerable ragged-tooth shark *Carcharias taurus* and copper shark *Carcharhinus brachyurus*, and Near Threatened blacktip shark *Carcharhinus limbatus* (Dicken et al. 2006, Dudley and Cliff 2010, Kiszka and van der Elst 2015, Daly et al. 2018, 2020).

Status of biological and ecological knowledge, South Africa

South Africa has some of most extensive research on chondrichthyan taxonomy, diversity, ecology and behaviour in the WIO, with research in the country dating back to the early 19th century (Ebert et al. 2021c). Limited fishery-independent surveys and fishery observer data exist for about 67 chondrichthyan species, although catch and effort data series suitable for stock assessments exist for very few species (da Silva et al. 2015). Comprehensive stock assessments were done for soupfin shark *Galeorhinus galeus* (overexploited, high fishing pressure) and common smoothhound shark *Mustelus mustelus* (not yet overexploited but fishing pressure is too high) (da Silva et al. 2019, Winker et al. 2020). National data have been provided to the tuna RFMOs of which South Africa is a member (Indian Ocean Tuna Commission and International Commission for the Conservation of Atlantic Tunas) for stock assessments for blue shark *Prionace glauca* and shortfin mako shark *Isurus oxyrinchus*. Stock assessments were previously done for the great white shark *Carcharodon carcharias* (no marked recovery since protection in 1991; Towner et al. 2013, Andreotti et al. 2016);

Carcharias taurus (no change in population size (Dicken et al. 2008); and sharptooth houndshark *Triakis megalopterus* (overexploited; Booth et al. 2010). Another 14 chondrichthyan species have been assessed for the KZN region (DAFF 2013), but some of this work is over a decade old and thus out of date.

Data from the KwaZulu Natal (KZN) bather protection program provide a key source of chondrichthyan population trends in the WIO. Catch rates of 14 species investigated from 1978 to 2003 indicate declines in bull shark *Carcharhinus leucas*, *C. limbatus*, *S. lewini* and great hammerhead shark *S. mokarran* abundance (Dudley and Simpfendorfer 2006). The mean or median length of three species (pigeye shark *C. amboinensis*; *C. limbatus*; and female *Carcharodon carcharias*) also declined. An extended time-series to 2011 revealed additional declines in bather protection gear catch rates of *Carcharhinus obscurus*, sandbar shark *C. plumbeus*, *C. taurus* and *I. oxyrinchus*, whereas *C. limbatus* CPUE stabilized (KZNSB, unpublished data), and tiger shark *Galeocerdo cuvier* catch rates indicated an increasing local population trend (Dicken et al. 2016). Catches of the Critically Endangered *Rhynchobatus djiddensis* have also declined markedly over time (Cliff and Dudley 2011), and from 1981 to 2017 their catches in the KZN bather protection nets exhibited a significant fourfold decline in annual nominal catch per unit effort (Daly et al. 2020).

Chondrichthyans caught in the KZN bather protection nets have also contributed to important age and growth studies in the country (e.g., Wintner and Cliff 1996, Wintner and Dudley 2000, Allen and Wintner 2002, Wintner et al. 2002, Dicken et al. 2016, 2018).

South Africa has undertaken more chondrichthyan stock assessments than other Nairobi Convention Member States, yet this amounts to just seven species, if assessments done by the RFMOs using South African data are included. The data-poor assessment method JARA "*Just another red list assessment"* has been completed on 21 species of chondrichthyans using biomass indices from National Research surveys with four species assessed using both sets of survey data and an additional 5 species using data from the de Hoop angling survey. JARA has been used for the updated IUCN red list assessments for chondrichthyan species from 2018 to 2021.

Stock assessments using other research survey indices need to be prioritized for fisheries species, particularly threatened species, as outlined in Chapter 3. Many research initiatives are underway collecting BRUV data across the country, once the timelines are long enough these can be used for JARA.

A global baited remote underwater video (BRUV) study, which surveyed two reefs in South Africa, revealed relatively abundant shark populations in South Africa (MacNeil et al. 2020). Shark abundance and diversity are seasonally influenced by the Sardine Run, a winter influx of shoals of sardines *Sardinops sagax* from the southwest of South Africa during the austral winter, which attracts vast numbers of sharks to the KZN coast. The presence of *C. brachyurus* and *C. obscurus* are strongly associated with the sardine shoals during June and July (Dudley and Cliff 2010). Spinner sharks *Carcharhinus brevipinna* and smooth hammerhead sharks *Sphyrna zygaena* are normally caught in greater numbers in summer than in winter, but they appear to shift their spatial distribution seasonally to feed on sardine (Dudley and Cliff 2010).

There are several areas in South Africa which are either known or thought to be of importance for shark and ray reproduction. Breeding and parturition for *R. djiddensis* is known to take place between December and February in northern KZN (Wallace 1967b, Smith and Heemstra 1991, van der Elst 1993). *Sphyrna lewini* give birth in South Africa in spring and summer (October–March; de Bruyn et al. 2005), with Thukela Bank in northern KZN likely being an important breeding and nursery area for this species (Fennessy 1994, de Bruyn et al. 2005). *Carcharhinus obscurus* give birth along the KZN coastline (Bass et al. 1973, Dudley et al. 2005, Hussey et al. 2009), with major nursery areas identified in nearshore waters off the KZN coast (Bass et al. 1973). *Carcharhinus brachyurus* females move inshore in spring to breed, possibly south of KZN in the cooler waters of the Eastern Cape, with parturition occurring from June to February (Smale 1991, Cliff and Dudley 1992), while *C. brevipinna* breed in KZN from January to March (Allen and Cliff 2000), and pregnant *Carcharias taurus* spend the early part of their gestation in the warmer waters of northern KZN before giving birth further south off the Eastern Cape (Dicken et al. 2006). The honeycomb whipray *Himantura uarnak* is thought to breed in summer in shallow waters off sandy beaches in northern KZN, with new-born pups sometimes caught in estuaries and sheltered sandy bays along the KZN north coast (Compagno et al. 1989, van der Elst 1993, Dunlop 2013a). *Carcharhinus limbatus* is known to give birth between September and October in South Africa (Bass et al. 1973, Dudley and Cliff 1993). *Carcharhinus leucas* likely have a prolonged mating and pupping season (Cliff and Dudley 1991) as embryos of similar size were found on the KZN coast in both summer and winter. Mating and early pregnancy take place to the north of KZN (Bass et al. 1973), with young being born in late spring or early summer. The St Lucia Estuary is the only known nursery area on the KZN coast for *C. leucas* (van der Elst 1993), however the Umzimvubu River and adjacent rivers are also thought to serve as nursery areas for this species (KZNSB, unpublished data). Cliff and Dudley (1991) suggest that nursery grounds for *C. amboinensis* must lie to the north of KZN, with the capture of a female with enlarged uteri in the KZN bather protection nets in April suggesting that parturition had recently taken place and likely occurs around this time in South Africa.

The recent recordings of the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum* (including mating) at nine-mile reef off Sodwana in September 2020 and October 2021 are noteworthy (both videos were documented by John McCarthy, OCEAN CHILD, while freediving). The presence of this species was only recently verified in Mozambique, resulting in a confirmed range extension for the species (Bennett et al. 2021), as its southernmost range was previously thought to be Tanzania. Documentation of this species mating off Sodwana Bay in October and in southern Mozambique in August (pers. comm., Fransesca Trotman, Love the Oceans NGO, August 2021) suggests this species has multiple mating sites and a mating season at least between August and October. Furthermore, these records off Sodwana Bay further extend the range of this Critically Endangered species into South Africa.

The St Lucia Estuary, which falls within the Isimangaliso MPA, used to be a critical nursery area for largetooth *Pristis pristis* and green *P. zijsron* sawfish, however the last sawfish encountered in South Africa was caught in the KZN bather protection nets in 1999, and they are now thought to be locally extirpated (Harrison and Dulvy 2014, Everett et al. 2015).

Tracking studies have shed some light on movement and behaviour of chondrichthyans in South Africa. The Acoustic Tracking Array Platform (ATAP) provides a network of acoustic receivers that span the entire south and east coasts of South Africa, to monitor coastal migrations of marine species in South Africa (Cowley et al. 2017). From 2011–2016, more than 700 individuals were tagged, representing 27 different species, including several chondrichthyan species such as duckbill rays *Aetomylaeus bovinus*, blue stingrays *Dasyatis chrysonota*, diamond rays *Gymnura natalensis,* common eagle rays *Myliobatis aquila, Carcharias taurus, Carcharhinus brachyurus*, *Carcharhinus leucas*, *Carcharodon carcharias*, common smoothhound sharks *Mustelus mustelus,* broadnose sevengill sharks *Notorynchus cepedianus* and *Galeocerdo cuvier* (Cowley et al. 2017).

A tracking study of one *C. leucas* individual in the Breede River Estuary extended the known range of the species further south by 366 km (McCord and Lamberth 2009), with individuals known to undertake transboundary movements between South Africa and southern Mozambique (pers. comm., Ryan Daly, ORI, September 2021). Similarly, *Carcharias taurus,* grey reef sharks *Carcharhinus amblyrhynchos, C. limbatus*, *G. cuvier* and *S. lewini* are all known to undertake transboundary movements between South Africa and Mozambique (Dunlop et al. 2013, Dicken et al. 2016, Daly et al. 2018).

The Oceanographic Research Institute’s Cooperative Fish Tagging Project (ORI-CFTP) was established in 1984 and has tagged and released over 250,000 fish from 368 species, including many chondrichthyans (Dunlop et al. 2013). Data from this project indicate that *R. djiddensis* undertake southward movements in summer and northward movements into northern KZN and Mozambique in winter (Dunlop 2013b), with 4,768 individuals having been tagged between 1984 and 2017 (Jordaan et al. 2021). However, the degree to which these transboundary movements between Mozambique and South Africa take place for this species are still poorly understood (Daly et al. 2020). From 1984 to 2009, distribution and movement of young *S. lewini* and *S. zygaena* along the east coast of South Africa were investigated using sport fisher tagging data (Diemer et al. 2011).

Carcharodon carcharias seasonally aggregate in winter in the Western Cape to take advantage of newly born Cape fur seals *Arctocephalus pusilus pusilus* (Kock et al. 2013), but opportunistic tagging has indicated that *C. carcharias* migrate up the east coast of South Africa towards Mozambique, Madagascar and other countries within the WIO, spending a significant amount of time offshore and within the Mozambique[100]. These movement studies demonstrate the importance of regional collaboration between shared chondrichthyan stocks, and the need for regional management measures.

South Africa has undertaken the greatest number of chondrichthyan-focused genetic studies in the region, in large part due to a specialised Molecular Breeding and Biodiversity laboratory at the University of Stellenbosch, which has a specific interest in the use of genetic and genomic tools to understand population variability and reproductive aspects of chondrichthyan species[101]. Genetic studies assessing chondrichthyan geographic population connectivity and biogeography in South Africa, and using samples from South Africa to compare against the broader region, include studies focused on *Carcharhinus leucas* (Pirog et al. 2019c), *Carcharias taurus* (Stow et al. 2006, Klein et al. 2020), *Carcharodon carcharias* (Andreotti et al. 2016), *Galeocerdo cuvier* (Pirog et al. 2019a), *Galeorhinus galeus* (Bester-van der Merwe et al. 2017), *Isurus oxyrinchus* (Corrigan et al. 2018), *Sphyrna zygaena* (Kuguru et al. 2019), angel sharks from the genus *Squatina* (Stelbrink et al. 2010), and several houndshark species (Family Triakidae) (Maduna et al. 2016, 2017, 2020).

Whale sharks *Rhincodon typus* occur along the entire South African eastern seaboard, with occasional strandings as far west as Yzerfontein on South Africa's West Coast, but their abundance in South Africa is variable. In aerial surveys off KZN in 2001/2002, only eight *R. typus* were seen, with a sighting rate of 0.21 sharks per 100 km of coastline (Cliff et al. 2007). Subsequent surveys during the summers of 2003/2004 and 2004/2005 recorded a total of 30 *R. typus*, with a mean sighting rate of 0.69 sharks per 100 km of coastline (Cliff et al. 2007). The density of *R. typus* was highest in the far north where it averaged 1.05 sharks per 100 km between January and May.

Many chondrichthyans have also been described from South Africa, including 61 shark, 53 batoid and five chimaera species, with 31 shark, 32 batoid and five chimaera species still considered valid (see Ebert et al. 2021c). A checklist of all chondrichthyans known to occur in South Africa (including east of East London), was recently published by Ebert et al. (2021c).

Knowledge gaps and research priorities

Although South Africa has the most advanced chondrichthyan research of the Nairobi Convention Member States, this research has primarily focused on charismatic species, and there are still many knowledge gaps for the majority of chondrichthyan species within South Africa's EEZ. Research in South Africa has largely focused on catch trends and age and growth studies (primarily of bycatch species in the KZN bather protection program) and movement studies (primarily through the ORI-CFTP and ATAP projects). This is encouraging considering that movement information has been highlighted as a research priority (see Chapter 3). However, there is limited research regarding fine-scale movement behaviour and core use areas, particularly for threatened species. In addition, research regarding ageing and growth, as well as population connectivity for migratory and possibly migratory species, is limited to a few species, therefore these aspects should be prioritized.

Research in South Africa has also highlighted some important breeding and nursery areas for chondrichthyans, and has identified northeast South Africa, particularly the KZN Province, as a vital area for these important life history stages for several chondrichthyan species. This is encouraging as knowledge regarding nursery, parturition and breeding localities is generally lacking, as outlined in Chapter 3. However, much of this research occurred during the 1970s, 1980s and 1990s, and there should thus be a renewed focus on prioritizing research relating to breeding, parturition and nursery areas in South Africa, particularly for threatened species. All of the data gaps identified for these species should thus be prioritized for future research (as outlined in Table 3.7).

[100] ocearch.org

[101] www.sun.ac.za/english/faculty/agri/genetics/research/animal-genetics

Of the 42 data-poor[102] threatened chondrichthyan species identified in Chapter 3, 31 (19 batoid and 12 shark species from seven batoid and six shark families) are present in South Africa (Table 3.3).

There are seven data-poor, threatened species in the family Dasyatidae that occur in South Africa, comprising the Endangered *Himantura uarnak*, and Vulnerable leopard whipray *H. leoparda*, broad cowtail ray *Pastinachus ater*, pink whipray *Pateobatis fai*, Jenkins whipray *P. jenkinsii*, blotched stingray *Taeniurops meyeni* and porcupine ray *Urogymnus asperrimus*. Research priorities for this family and these species primarily relate to the movement and reproduction categories, and the specific age and growth categories of age at maturity and maximum age (for all species), size at birth for *U. asperrimus*, female size at maturity for all species other than *U. asperrimus,* and male size at maturity for *P. ater*, as outlined in Table 3.7.

In the family Mobulidae, there are three data-poor, threatened species which occur in South Africa, the longhorned pygmy devil ray *Mobula eregoodoo*, shortfin devil ray *M. kuhlii* and sicklefin devil ray *M. tarapacana*, all of which are Endangered. Other than litter size and gestation period for *M. eregoodoo* and *M. kuhlii*, information is lacking for the other reproduction categories for all three species, while all movement information other than migratory status is lacking for all three species. All aspects of age and growth, other than age at maturity and maximum age, are known for all three species. Therefore, future research should focus on those categories which are lacking in information, as outlined in Table 3.7.

There are also three data-poor, threatened species in South Africa which belong to the family Myliobatidae: the Critically Endangered duckbill ray *Aetomylaeus bovinus* and common eagle ray *Myliobatis aquila*, and the Endangered ornate eagle ray *Aetomylaeus vespertilio.* Although migratory status and litter size are known for all three species, and gestation period is known for *A. bovinus* and *M. aquila*, information relating to all other categories of movement and reproduction is lacking for these three species. In addition, maximum age is unknown for all three species, age at maturity is unknown for *A. vespertilio* and *M. aquila*, and female size at maturity and size at birth are unknown for *A. vespertilio*.

Two data-poor species of Rajidae occur in South Africa, the Vulnerable yellowspotted skate *Leucoraja wallacei* and Endangered twineyed skate *Raja ocellifera*. Although breeding season is known for *L. wallacei*, all other aspects of movement and reproduction are unknown for both species. In the age and growth categories, information is available for all aspects relating to *L. wallacei*, but only for maximum age and generation length for *R. ocellifera.* This is due, in part, to misidentification issues with *R. ocellifera* and *R. straeleni*, which remains an issue. Therefore, future research should focus on these categories which lack information, for both species, as outlined in Table 3.7.

The families Pristidae (*Pristis zijsron*), Rhinidae (bowmouth guitarfish *Rhina ancylostomus*), Rhinobatidae (greyspot guitarfish *Acroteriobatus leucospilus*) and Rhinopteridae (shorttail cownose ray *Rhinoptera jayakari*) are each characterized by one data-poor, threatened species in South Africa. The Critically Endangered *P. zijsron* is data-poor, but is now considered locally extirpated from South Africa (Everett et al. 2015), and no longer a research priority. For the Critically Endangered *Rhina ancylostomus* and Endangered *A. leucospilus* and *Rhinoptera jayakari*, litter size is known for all three species and migratory status is known for *A. leucospilus*, but information in all other movement and reproduction categories is lacking for these three species. Other than maximum age and age at maturity, there is available information in the other age and growth categories for *A. leucospilus* and *R. ancylostomus*, while *R. jayakari* also lacks information relating to size at birth and female size at maturity (Table 3.7). Although not data-poor, the Critically Endangered *Rhynchobatus djiddensis* also occurs in South Africa. This species is currently the subject of several movement studies in South Africa, which will provide further insight into key areas for this species and the extent of transboundary movements with Mozambique.

[102] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

Taxonomic issues regarding the *Himantura* species complex, '*Rhynchobatus djiddensis*' species complex and the so called "brown rays" also need to be resolved as a priority, as outlined in Chapter 3.

Five data-poor, threatened shark species which belong to the family Pentanchidae occur in South Africa, the Endangered honeycomb catshark *Holohalaelurus favus* and African spotted catshark *H. punctatus*, and the Vulnerable tiger catshark *Halaelurus natalensis*, brown shyshark *Haploblepharus fuscus* and Natal shyshark *H. kistnasamyi*. Virtually all aspects of movement and reproduction for this family require further research, and although maximum length is known for all five species, and generation length for all species except *H. kistnasamyi*, the majority of age and growth categories have no information for this family, as outlined in Table 3.7.

Three species in the family Centrophoridae, the Endangered little gulper shark *Centrophorus uyato*, and Vulnerable smallfin gulper shark *C. moluccensis* and longsnout dogfish *Deania quadrispinosa,* are data-poor and occur in South Africa. Litter size is known for all three species, and reproductive periodicity for *C. moluccensis* and *C. uyato*, but information is lacking in all other movement and reproduction categories for these three species. In the age and growth categories, age at maturity and maximum age remain unknown for all three species (Table 3.7).

Four other data-poor, threatened shark species in South Africa include the Vulnerable flapnose houndshark *Scylliogaleus quecketti* (Triakidae), kitefin shark *Dalatias licha* (Dalatiidae), tawny nurse shark *Nebrius ferrugineus* (Ginglymostomatidae) and whitetip weasel shark *Paragaleus leucolomatus* (Hemigaleidae). Little is known about each of these species in South Africa, and future research should prioritize those age and growth, movement and reproduction aspects as outlined in Table 3.7.

There are also five shark species which are Critically Endangered and occur in South Africa, the oceanic whitetip shark *Carcharhinus longimanus*, *Carcharias taurus, Pseudoginglymostoma brevicaudatum*, *Sphyrna lewini* and *S. mokarran*. There is limited information on parturition and nursery areas within South Africa, or even whether there are such critical habitats for these species in South Africa. A recent sighting of *P. brevicaudatum* mating at nine-mile reef in Sodwana (pers. comm., Grant Smith, Sharklife, September 2021) is notable, particularly as a separate recording of this species in southern Mozambique extended its known range by over 2,000 km (Bennett et al. 2021). As the only Critically Endangered (and therefore most threatened) shark species endemic to the WIO, *P. brevicaudatum* is a key research and conservation priority, in South Africa and other countries in its range. Research regarding these aspects for these Critically Endangered shark species should be prioritized in South Africa.

There are also 14 Data Deficient (as defined by IUCN) chondrichthyan species in South Africa, including nine batoid, four shark and one chimaera species (Table 3.3, Chapter 3). At least seven of these are considered deepwater species from the families Heterodontidae (bullhead sharks), Rajidae, Rhinochimaeridae, and Squalidae (dogfish sharks), and are therefore infrequently encountered, limiting available information, while the remaining six species from the families Carcharhinidae, Dasyatidae, Rhinobatidae and Torpedinidae (torpedo rays) have coastal distributions and are exposed to coastal fisheries. Four of these 14 Data Deficient species are endemic to the WIO region, the rattail skate *Dipturus lanceorostratus*, prownose skate *D. stenorhynchus*, Austin's guitarfish *Rhinobatos austini*, and the slender guitarfish *R. holcorhynchus*. Research should also be prioritized for these Data Deficient species.

6.9.3 Chondrichthyan fisheries, catch and trade

Fisheries

Commercial-scale chondrichthyan fishing in South Africa began in the 1930s, when *Galeorhinus galeus* was the most heavily fished species. Catches rose and fell following demand for natural vitamin A (from shark liver) after the Second World War (da Silva et al. 2015). In 1992, a shark-directed longline fishery was established, initially targeting both demersal and pelagic sharks, but split into the pelagic sharks and demersal shark longline fishery when further industrialisation and motorisation enabled fishers to fish further offshore for longer periods of time (Smale 2008). Currently, South African chondrichthyans are targeted and incidentally captured in at least eight of 16 artisanal and industrial fisheries, by increasing numbers of recreational fishers, and by bather protection nets and drumlines in the KwaZulu-Natal (KZN) Province (da Silva and Bürgener 2007, da Silva et al. 2015; Table 6.9.1). They are directly targeted in the demersal shark longline, pelagic longline, boat-based and shore-based line, beach-seine net (‘treknet’) and gillnet fisheries. Fisheries that take chondrichthyans incidentally include inshore and offshore demersal trawl, hake longline, prawn trawl, and small-pelagic and midwater trawl fisheries. About half of the chondrichthyan species known to occur in southern Africa are frequently captured (Ebert and van Hees 2015). The average South African chondrichthyan catch, including both directed and incidental catch, was estimated at 3,300 t annually (da Silva et al. 2015), with approximately 3,000 t reported to FAO annually.

Table 6.9.1: Fisheries impacting sharks in South African waters (adapted from Sauer et al. 2003).

Activity	Area	Nature
Offshore trawl	West Coast, Agulhas Bank to shelf edge (600m depth)	Incidental catch only
Prawn trawl	Natal East Coast to 600m – shallow water sector not currently financially viable	Incidental catch only
Inshore trawl	South and East Coast to 200m	Incidental catch only
Hake longline	West and South Coast to 500m	Incidental catch only
Domestic tuna longline	Offshore to EEZ	Incidental catch only
Foreign tuna longline	Offshore to beyond EEZ	Target/incidental
Recreational line	Inshore to 200 m	Incidental catch only
Commercial handline	Inshore to 200m	Target/incidental
Gillnet	West Coast	Incidental catch only
Beach seine	West Coast and South Coast	Target/incidental
KZN bather protection gear	KZN, East Coast	Target/incidental

Linefishery

The linefishery operates along the entire coast, and is divided into subsistence, commercial (referred to as “traditional” in South Africa due to its long history, albeit a commercial fishery) and recreational sectors (da Silva et al. 2015). Although chondrichthyans are targeted and incidentally caught, the high numbers of sharks retained make this a target fishery (DAFF 2013). The commercial linefishery is a boat-based activity consisting of 3,450 crew operating from about 450 vessels (effort was capped in 1985 following overexploitation). The gear used is hook-and-line with a maximum of ten hooks. Approximately 200 species of fish are caught, of which only 50 are economically important. Teleosts are the primary targets, but their depletion has led to increased targeting of demersal shark species such as *Galeorhinus galeus*, *Mustelus* spp., *Carcharhinus brachyurus*, and *Notorynchus cepedianus* (da Silva et al. 2015). The commercial linefishery is governed by a slot limit for sharks, which prohibits landing of sharks smaller than 70 cm or larger than 130 cm TL. This slot limit is related to market restrictions with sharks within this size range fetching higher market values. Larger more fecund sharks are released alive according to release protocols.

The recreational line fishery includes shore- and boat-based fishers. *Carcharhinus brachyurus*, *Carcharhinus obscurus*, *Carcharias taurus* and *Mustelus* spp. are the most commonly targeted sharks (da Silva et al. 2015). Trade in recreational catch is prohibited, but valuable species are sometimes sold illegally, and smaller species such as shy sharks *Haploblepharus* spp. are sometimes killed as they are regarded as a nuisance (da Silva et al. 2015). However, most chondrichthyans caught incidentally are now released alive, due to changes in angler attitude (Kiszka and van der Elst 2012). Post-release lethal and sub-lethal effects are, however, unknown (da Silva et al. 2015). Subsistence fishers (predominantly shore-based) are governed by the same regulations as recreational fishers.

Drone fishing, an emerging and illegal form of recreational angling in South Africa, threatens several threatened shark species. Drones are used to target *Carcharodon carcharias* (prohibited in South Africa) and other large predatory sharks, for which post-release mortality is likely to be high. This method of fishing is also a danger to the smaller species of sharks used as bait. The Vulnerable *Sphyrna zygaena* is one of the main species used as bait, despite being prohibited from retention in most other South African fisheries.

Beach seine and gillnet fisheries

Beach seine nets and gillnets are used by traditional fishers in certain areas. The beach seine fishery targets southern mullet *Liza richardsonii* mainly, but about 30 chondrichthyan (mainly small demersal shark) species are also harvested – particularly the St Joseph shark *Callorhinchus capensis*, *Mustelus* spp., lesser sandshark *Acroteriobatus annulatus*, blue stingray *Dasyatis chrysonota* and *Myliobatis aquila* (Lamberth 2006). Permit conditions prohibit the retention of these species in the Western Cape Province (with the exception of *C. capensis*), whereas beach-seine fishers in False Bay are subject to the same catch limitations as the commercial linefishery. However, a decline in beach seine fishing effort from around 200 to 28 operations in 2001 was reported (da Silva et al. 2015). The gillnet fishery targets southern mullet and *C. capensis*, using bottom-set gillnets in St Helena Bay, and other chondrichthyans are meant to be released. However, these fisheries operate to the west of East London, outside of the area considered for this report.

Illegal gillnets are now also used to target sharks in various coastal locations in South Africa, including the east coast; this fishing method has proliferated and expanded since the onset of the COVID-19 pandemic (pers. comm., Steve Lamberth, DFFE, October 2021). Collection of catch data in this fishery is limited by its illicit nature, and therefore comprises mostly of catches from confiscated nets. Catch estimates are extrapolated from known catch per unit effort from research gillnetting with comparable lengths and mesh sizes of confiscated nets. Each operation may work more than 2 km of nets and confiscated catches suggest annual catches of up to 200 t (pers. comm., Steve Lamberth, DFFE, October 2021).

Pelagic longline fishery

Pelagic longline fishing is permitted throughout the South African EEZ, except within 12 nm of the coast (and 20 nm of KZN coast). Historically, foreign fleets dominated this fishery, but rights have now been issued exclusively to South Africans, although many of these rights are fished by foreign operators through joint ventures (FAO 2010). The pelagic shark longline fishery was amalgamated with the tuna and swordfish fishery in 2011, with the aim of increasing catches of swordfish and terminating the targeting of pelagic sharks. Permit conditions prohibit activities used to target pelagic sharks, while landing of *Carcharhinus longimanus,* silky sharks *C. falciformis*, all thresher (*Alopias* spp.) and all hammerhead sharks (*Sphyrna* spp.) are banned (DAFF 2015a). Shark landings are now managed with a precautionary upper catch limit (PUCL) of dressed weight, fins may only be landed with trunks, and transhipments at sea are prohibited. Since 2013, several permit conditions were introduced to reduce the catch of sharks, including prohibition of wire (steel) traces/leaders, that sharks must be landed with fins naturally attached, and that vessels catching more than 60% shark bycatch per quarter are required to have 100% observer coverage over the subsequent quarter. The fishery uses drifting nylon monofilament longlines with around 1,000 hooks per set, and the primary chondrichthyan species caught are *Prionace glauca* and *Isurus oxyrinchus*, along with six other chondrichthyan species (da Silva et al. 2015). *Prionace glauca* comprised 35% (by mass) of all pelagic shark landings in South Africa from 1998 to 2008 (Jolly et al. 2011). Since the 60% bycatch rule, shark catches have declined dramatically. This sector contributes >75% of the total fishing mortality of 15 shark species (reported by species except for mobulids), of which 40% are listed as Vulnerable, 20% as Endangered and 13.3% as Critically Endangered (DFFE, in prep). Except for *I. oxyrinchus* and *P. glauca*, the majority of these species have been added to the prohibited list in this sector. The average annual reported catch of sharks in this sector from 2010 to 2015 was 960 t. However, in response to persistent targeting of pelagic sharks, new permit conditions were introduced in 2016 to reduce pelagic shark catches. This resulted in a reported catch of 248.9 t of pelagic sharks in 2020, a significant reduction. New permit conditions have been imposed on the fishery to restrict the PUCL to 1000 t of *P. glauca* and 154 t of *I. oxyrinchus*, following ICCAT Recommendations (DFFE, in press).

Demersal shark longline fishery

The demersal shark longline fishery operates in coastal waters from the Orange River on the West Coast to the Kei River on the East Coast – northeast of which fishing is prohibited due to high levels of biodiversity (da Silva et al. 2015). This fishery thus operates predominantly outside of the area covered in this report, but chondrichthyan species caught include those with distributions that extend further into the WIO. The demersal longline fishery is managed on a TAE basis (DAFF 2013), with six vessels operating in 2015. Target species include *Mustelus mustelus*, whitespotted smoothhound shark *M. palumbes*, *G. galeus*, *C. brachyurus*, *C. obscurus*, and unidentified skates (da Silva et al. 2015). This fishery is prohibited from landing pelagic shark, hammerhead sharks (*Sphyrna* spp.) and *N. cepedianus*, and the slot limit applies as for the commercial linefishery. During the Fisheries Rights Allocation Process (FRAP) in 2021, rights in this sector were re-allocated, resulting in only a single successful right holder.

KwaZulu-Natal Sharks Board's (KZNSB) bather protection program

Sharks are directly exploited along South Africa's east coast by the KwaZulu-Natal Sharks Board's (KZNSB) bather protection gear, including large-mesh gillnets and drumlines. In 2012, 23.1 km of net and 79 drumlines were deployed at 38 beaches in KZN Province, although the number of nets has gradually declined in favour of drumlines, with 14.8 km of net and 177 drumlines in place, at 37 beaches, by 2019 (M. Dicken, KZNSB, unpublished data). From 2012 to 2019, 5,251 chondrichthyans (3,263 sharks and 1,089 batoids) were caught in these bather protection nets, at an annual average of 656. Over the same period, the drumlines caught 828 chondrichthyans (820 sharks and 8 batoids), at an annual average of 103. At least 23 shark and 15 batoid species were captured in the bather protection nets, and at least 16 shark and four batoid species by the drumlines, from 2012 to 2019.

Carcharhinus brevipinna, *C. limbatus, Carcharhinus obscurus, Carcharias taurus* and *Sphyrna lewini* were the dominant species caught in the nets, while *C. obscurus*, *C. carcharias, Galeocerdo cuvier*, *S. lewini* and *S. zygaena* dominated the catches by the drumlines (M. Dicken, KZNSB, unpublished data). These catches included several threatened species: Critically Endangered *Aetomylaeus bovinus*, *Myliobatis aquila, S. lewini*, *S. mokarran* and *Rhynchobatus djiddensis*, Endangered *C. obscurus* and *I. oxyrinchus*, and several Vulnerable species (M. Dicken, KZNSB, unpublished data).

Incidental shark fisheries

Chondrichthyans are caught as incidental catch in the hake longline, demersal trawl, midwater trawl/purse seine, tuna pole, prawn trawl and lobster trap fisheries (DAFF 2013). Valuable species are often retained, but because the majority of incidental chondrichthyan catch is still discarded at sea, levels of incidental catch are not always recorded (DAFF 2015b).

The demersal trawl fisheries (inshore and offshore), which target deepwater hake *Merluccius paradoxus* and shallow-water hake *M. capensis*, are the most important commercial fisheries in South Africa (Baust et al. 2015). Although they have a strict 'move-on' rule to avoid areas of high incidental catch, there are no incidental catch restrictions and substantial numbers of chondrichthyans are caught – particularly Squalids, Scyliorhinids, *Mustelus* spp., *Callorhinchus capensis, G. galeus*, chimaeras and skates (DAFF 2013). Of concern is species lumping in logbooks; for example, an average of 700 t of "skates" are reported annually. This sector contributes >75% of the total fishing mortality of at least 67 species (with a few generic groups), of which 31% are threatened, including 9% listed as Vulnerable, 16% as Endangered and 6% as Critically Endangered (DFFE 2022). Only two species of shark are reported in this fishery by name: St Joseph *C. capensis* (308.8 t average annual reported catch from 2010 to 2020) and *G. galeus* (28.7 t). The remaining estimated 65 species are lumped under the following categories: dog sharks (1.5 t average annual reported catch from 2010 to 2020), hound sharks (19.9 t), skates (139.3 t), copper shark (0.08 t), and unidentified sharks (11.4 t). This fishery was responsible for 30% of the average annual reported catch of sharks from 2010 to 2020. Due to a massive reduction in catches in the large pelagic sector since 2020, for this most recent aggregation of all catch data, this sector is responsible for 59% of total fishing mortality of sharks in South Africa (DFFE, in prep).

The midwater trawl fishery occasionally catches pelagic chondrichthyans such as *C. brachyurus* and *P. glauca*, as well as species of conservation concern such as mobulid rays (*Mobula* spp.), *I. oxyrinchus, C. falciformis* and *C. longimanus*. Since many of these species aggregate seasonally, they are occasionally caught in large numbers.

The South African prawn trawl fishery operates mainly in deep offshore waters. The inshore fishery had a substantial incidental catch of chondrichthyans (Fennessy 1994) before poor target catch rates caused it to cease operations in 2009 (Kiszka and van der Elst 2015). In the offshore fishery, 22 chondrichthyan species were recorded as incidental catch (Fennessy 1994), while discards of about 901 t of fish and invertebrates were estimated annually (2003 data), of which about 17% were at least 17 species of chondrichthyans (Persad 2005, Kiszka and van der Elst 2015). Inshore discards include stingrays (Dasyatidae), *Sphyrna* spp., requiem sharks (Carcharhinidae), African angelsharks *Squatina africana* and catsharks (Scyliorhinidae); offshore discards are primarily spurdogs *Squalus* spp. and skates *Dipturus* spp. and *Cruriraja* spp. (DAFF 2013).

Fisheries monitoring and reporting

According to WIOFish, 78% of South African fisheries are monitored for catch and effort through telephone surveys, mail surveys, catch returns/logbooks, landing site surveys or onboard observers; but only 24% have regular biological monitoring (Everett et al. 2017). Catch and effort data suitable for comprehensive stock assessments exist for fewer than 10 chondrichthyan species (da Silva et al. 2015), with data poor methods available for approximately 25 species.

Data collected by DAFF include, depending on the fishery: total landed catch of main target species, length frequency data (when possible), factory lengths (when possible), catch and effort data for target fisheries and fishing location (DAFF 2013). Vessels in the linefish, pelagic longline, demersal longline and incidental catch fisheries are monitored by a VMS. Logbooks are required for demersal longliners, linefishers and pelagic longliners, but the data are generally considered to significantly underestimate the total landed catch of sharks, and there is a lack of species-level reporting (da Silva et al. 2015). However, the levels of underreporting are considered to be improving (pers. comm., Charlene da Silva, DFFE, October 2021).

Foreign pelagic longline vessels have 100% observer coverage, but there is no observer coverage for domestic vessels unless their catch comprises more than 60% shark bycatch by quarter. Landings are monitored at landing sites, apart from in the linefishery, where land-based observers have been placed in harbours and slipways. South African authorities are working to improve monitoring efforts for foreign vessels which land shark products in South African ports (DAFF 2013).

There is no method for monitoring in the recreational fishery (da Silva et al. 2015). Catches reported to the FAO exclude subsistence and recreational catches, which are estimated to make up 1% of annual domestic commercial catches (Baust et al. 2015). Baust et al. (2015) found reconstructed total catches (including subsistence and recreational catches, illegal artisanal catch and industrial discards) for South Africa from 1950 to 2010 to be 1.1 times the official landings reported to the FAO by South Africa.

South African chondrichthyan catches are reported to the FAO at species level where possible. *Prionace glauca*, *Callorhinchus capensis, Carcharhinus obscurus* and *Isurus oxyrinchus* are recorded at the species level in the WIO, with additional species recorded to species level in fisheries operating along the south and west coasts of South Africa. In the trawl fisheries, most chondrichthyans are grouped together and reported under the broad categories of 'Rays, stingrays, mantas nei' and 'Sharks, rays, skates, etc. nei'.

Reported chondrichthyan catches

According to the FAO, South Africa landed the fourth largest chondrichthyan catch of all the Nairobi Convention Member States from 2012 to 2019 (FAO 2021). This accounted for 8.2% of the total Nairobi Convention Member State chondrichthyan catch in all oceans, and 2.3% of their catch just in FAO Fishing Area 51 (because 85% of South African catches occurred in the Southeast Atlantic Ocean (SEAO, FAO Fishing Area 47) and only 15% from Fishing Area 51). From 2012 to 2019, South Africa landed an annual average of 477.8 t of sharks from FAO Fishing Area 51, compared to 2,716.2 t from the SEAO (Table 6.9.2; Figure 6.9.2a).

Given the generally unreliable nature of national catch statistics as reported to FAO (Baust et al. 2015), and the discrepancies between catches and reported imports to other countries in some years (Table 6.9.2), these estimates are probably conservative.

Table 6.9.2: Total chondrichthyan catch from FAO Major Fishing Area 51 (WIO) and FAO Major Fishing Area 47 (SEAO) and exports (metric tons, all chondrichthyan commodity codes) reported by South Africa, and reported imports by other countries.

Year	Catch Total [a]	Catch SEAO [a]	Catch WIO [a]	Exports from South Africa [b]	Imports from South Africa, as reported by the world [b]	Shark fin imports by Hong Kong [c]
2012	2,820	2,458	362	852	1,571	57
2013	3,334	2,913	421	873	1,237	66
2014	3,267	2,916	351	1,375	1,621	118
2015	3,585	3,136	449	1,334	1,490	67
2016	3,815	3,028	787	1,534	2,033	45
2017	3,475	2,848	627	1,181	1,438	66
2018	3,017	2,397	617	1,365	2,259	95
2019	2,248	2,033	208	946	1,136	83
Total	**25,564**	**21,729**	**3,822**	**9,459**	**12,786**	**597**
Average	**3,195**	**2,716**	**477**	**1,182**	**1,598**	**75**

a) FishStatJ (FAO 2021)
b) UN Comtrade (2021)
c) Hong Kong Bureau of Statistics (2021)

However, chondrichthyan catches reported to the FAO show significant underreporting for South Africa's commercial fisheries, which is of particular concern given that South Africa is recognized for its leading fisheries management. As chondrichthyans form only a minor part of the landed catch of many different South African fisheries, there has been little cohesion among DFFE's fishery-specific Scientific Working Groups for chondrichthyan management (DEFF 2020), which is largely responsible for data discrepancies in reporting to FAO.

The pelagic longline fishery that targets tuna and swordfish accounted for the majority of shark catches in South Africa (56%), followed by the trawl fishery (27%), the commercial linefishery (10%) and the demersal shark longline fishery (7%), for the period 2012 to 2019. The dominant chondrichthyan species reported in South Africa's catches from 2012 to 2019 in FAO Fishing Area 51 were Endangered *Isurus oxyrinchus* (7,336.8 t, 28.7% of total chondrichthyan catch), which was dominant in every year in this period, *Callorhinchus capensis* (5,951.2 t, 23.3% caught almost exclusively in the SEAO) and *Prionace glauca* (4,525.9 t, 17.7%) (Figure 6.9.2b).

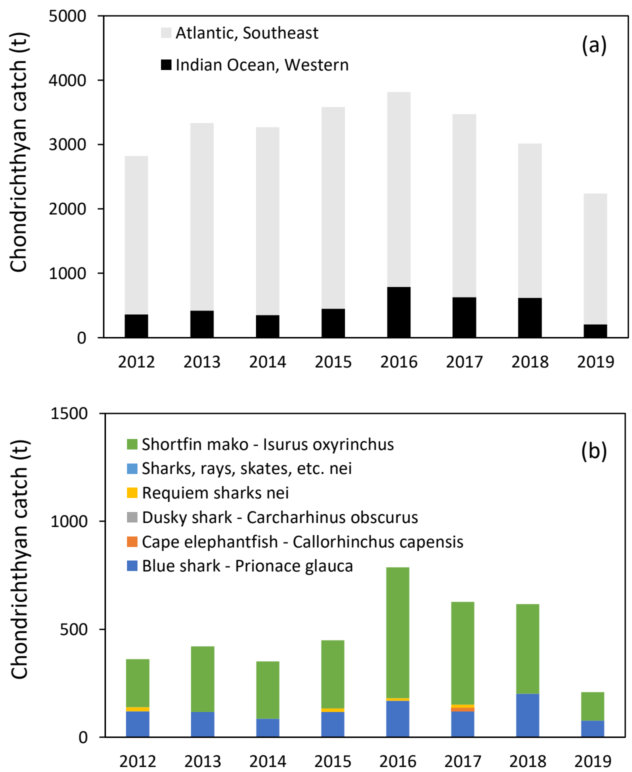


Figure 6.9.2: (a) Total chondrichthyan catch reported by South Africa for FAO Major Fishing Area 51 (including the Western Indian Ocean) and FAO Major Fishing Area 47 (including the Southeast Atlantic Ocean), and (b) South African annual chondrichthyan catches in FAO Major Fishing Area 51 by species and category (2012–2019; FAO 2021).

Trade in chondrichthyan products

Imports of chondrichthyan products into South Africa are minimal compared to exports. There are three main product groups exported from South Africa: shark meat (99% of which is frozen), ray and skate meat, and shark fins (TRAFFIC South Africa, unpublished data). Pelagic sharks, such as *I. oxyrinchus* are considered valuable in both the fin and meat trades, irrespective of size (da Silva et al. 2015).

There is little local demand for demersal shark meat, but demand in Australia is high since the collapse of the Australian *G. galeus* fishery in the 1990s (da Silva and Bürgener 2007). This export market has been a principal driver of the harvest of and trade in South African sharks from the trawl, demersal longline and linefish fisheries (da Silva and Bürgener 2007). Key commercial species in this trade include, in order of importance, *M. mustelus*, *G. galeus*, *C. brachyurus*, *C. obscurus,* and *M. palumbes*. However, in recent years, export destinations have changed, with South American countries taking nearly half of South Africa's shark meat exports. Uruguay has recently become a major re-exporter of frozen shark meat to supply the expanding shark meat markets in South America (Niedermüller et al. 2021). The European shark meat market is also large with the largest demand coming from Italy, Spain and Portugal but is mainly restricted to pelagic shark meat (i.e., *Isurus* spp.). Over the past decade, the dominant countries receiving frozen shark meat from South Africa include Uruguay (37%), Republic of Korea (21%), Italy (13%), Spain (10%), Brazil (7%) and Portugal (6%), with Australia receiving just 2% of the export volume (UN Comtrade 2021).

The Republic of Korea is the largest consumer of shark and batoid meat in east Asia with batoid meat being preferred (Dent and Clarke 2015). Over the past decade, the key countries importing batoid meat from South Africa were Spain (31%), Republic of Korea (27%), Australia (15%), Belgium (8%), France (7%) and Portugal (6%) (UN Comtrade 2021).

Fins are obtained from pelagic and demersal shark species from various fisheries, and their high value provides an incentive to target large sharks, regardless of their meat value (da Silva et al. 2015). Fins are exported to southeast Asia, and over the last decade almost all fins have been exported to Hong Kong (63%) or Singapore (34%) (UN Comtrade 2021).

Official chondrichthyan trade data

South Africa's imports of shark products

South Africa imported an average of 215 t of chondrichthyan products per year from 2012 to 2019 (UN Comtrade 2021). The majority of imported products have been shark meat (on average 160 t per year compared to 54 t per year of shark fins).

South Africa's exports of shark products

According to the UN Comtrade (2021) data, South Africa exported an annual average of 1,182 t of chondrichthyan products from 2012 to 2019 (Table 6.9.2, Figure 6.9.3). Frozen shark meat comprised 87.5% of all exports combined, fins constituted 7.3%, frozen ray and skate meat comprised 4.6%, while fresh shark and fresh ray and skate meat comprised 0.57% and 0.03%, respectively. Importing countries reported 1,598 t per year on average, of all chondrichthyan products from South Africa, from 2012 to 2019 (Table 6.9.2, Figure 6.9.3). Reported South African exports and imports reported by other countries from South Africa were similar in some years but showed large discrepancies in other years, which represents poor reporting; as imports reported by other countries were higher in every year than South Africa's reported exports, this is likely indicative of underreporting by South Africa (Table 6.9.2, Figure 6.9.3).

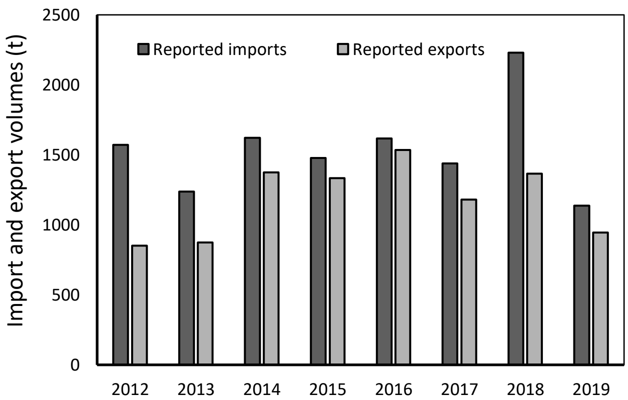


Figure 6.9.3: World imports of chondrichthyan products from South Africa and South Africa's exports of chondrichthyan products to the World, 2012–2019 (UN Comtrade 2021).

Over the period 2012 to 2019, South Africa reported exports of fins totalling 687 t, with annual volumes showing a general decline over this period (Figure 6.9.4a). There were again reporting discrepancies, with export volumes reported by South Africa being lower in most (but not all) years than imports from South Africa as reported by other countries. Hong Kong reported importing an average of 75 t per year of fins from South Africa, from 2012 to 2019 (Figure 6.9.4b, Hong Kong Census and Statistics Department 2021); however, over this same period there are no reported exports of fins by South Africa, to Hong Kong. There was no apparent trend in the volume of fins exported to Hong Kong over this period, but there were again discrepancies indicative of misreporting.

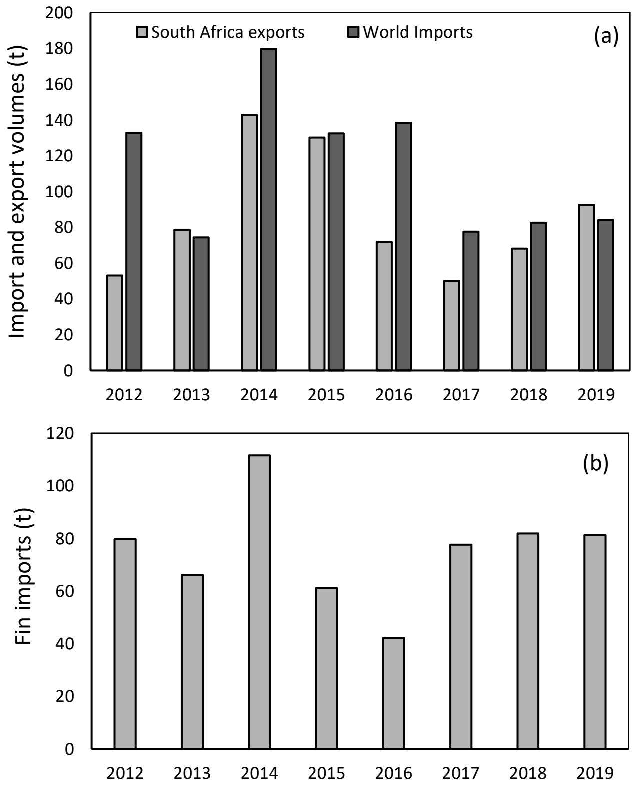


Figure 6.9.4: (a) Dry shark fin exports as reported by South Africa, and imports from South Africa as reported by the World from 2012–2019 (UN Comtrade 2021). (b) Hong Kong (SAR of China) imports of shark fin (HS 03039200, HS 3057111) from South Africa (2012–2019; Hong Kong Census and Statistics Department 2021, ITC 2021).

Illegal export of chondrichthyan products, primarily involving fins, is known to occur. The main issues come from exportation of CITES-listed species without the relevant permits, misdeclaration of consignments of shark fin, and sourcing shark fins from illegal fishing operations (Okes and Sant 2022). For example, several shipments involving meat or fins of pelagic species such as *P. glauca* and *I. oxyrinchus* (DAFF 2015b) and coastal shark species (Asbury et al. 2021) have been confiscated. The destinations and quantities involved in the illegal export trade are unknown. However, Gastrow (2001) linked the illegal fin trade in South Africa with Chinese organized crime syndicates, and Pierce et al. (2008a) described a high-demand market driven by Chinese business interest since the 1990s in Mozambique, for chondrichthyans caught in Mozambique and South Africa.

Trade in CITES-listed chondrichthyan species

There were 41 records of CITES-listed elasmobranch species being exported from South Africa in the last 10 years (i.e., since 2011), comprising 15 different species, 14 of which are listed on CITES Appendix II, with only the narrow sawfish *Anoxypristis cuspidata* being listed on Appendix I (Table 6.9.3). For all but four of these 41 export records, the reported quantity from the exporter (i.e., South Africa) did not match the import quantity as reported by the importing country. While the vast majority of these exports were not for commercial purposes, these discrepancies are of concern, as CITES measures are binding on Parties, to ensure that trade in CITES Appendix II-listed species is not detrimental to their survival in the wild, and that commercial trade in CITES I species is prohibited (see section 6.9.5 and Chapter 5 for details).

Among the Nairobi Convention Member States, South Africa has the highest documented trade in CITES-listed chondrichthyan species, although most records were for non-commercial purposes. Nevertheless, like other countries in the WIO, there are discrepancies between South Africa's reported export trade volumes and those from importing countries. For example, 140 t of *I. oxyrinchus* were exported to the Republic of Korea in 2019. Although South Africa entered a reservation[103] for trade in *I. oxyrinchus*, the Republic of Korea did not, and it is also Party to CITES and therefore requires an import permit for any imports of *I. oxyrinchus*. The absence of an "Importer reported quantity" listed for this particular import (Table 6.9.3) suggests improper and/or underreporting and reporting in breach of CITES reporting requirements.

[103] https://cites.org/eng/app/reserve.php

Table 6.9.3: CITES-listed elasmobranch species exported from South Africa and imported into various importer countries, as determined from the CITES Trade Database[104], for the period 2011–2021. Importer country, importer reported quantity and exporter (i.e., South Africa) reported quantity, export purpose and source of the export specimen are given. App. refers to CITES Appendices. Cells highlighted in grey reflect instances for which reported export quantities from South Africa match the import quantity as reported by the importing country. Where no units are given, the quantity represents the total number of specimens/products traded.

Year	App	Taxon	Importer	Importer reported quantity	Exporter reported quantity	Unit	Term	Purpose	Source
2011	II	*Carcharodon carcharias*	Austria	2			Skins	Educational	Wild
2011	II	*Carcharodon carcharias*	Austria		2		Specimens	Educational	Wild
2011	II	*Carcharodon carcharias*	Canada		2		Specimens	Scientific	Wild
2011	II	*Carcharodon carcharias*	Germany		1		Specimens	Educational	Wild
2011	II	*Carcharodon carcharias*	Hong Kong	87			Specimens	Scientific	Wild
2011	II	*Carcharodon carcharias*	Mexico		112		Fins	Scientific	Wild
2011	II	*Carcharodon carcharias*	Mexico		30		Specimens	Scientific	Wild
2012	I	*Anoxypristis cuspidata*	USA	3			Unspecified	Personal	Confiscation
2012	II	*Carcharodon carcharias*	Austria	1			Skins	Educational	Wild
2014	II	*Carcharodon carcharias*	USA		86	ml	Specimens	Scientific	Wild
2015	II	*Carcharodon carcharias*	Great Britain	4	4		Specimens	Scientific	Wild
2015	II	*Carcharodon carcharias*	Sweden		1		Skulls	Scientific	Wild
2015	II	*Carcharodon carcharias*	Sweden		115		Specimens	Scientific	Wild
2015	II	*Carcharodon carcharias*	USA	161			Specimens	Scientific	Wild
2015	II	*Manta birostris*	USA	3	3		Specimens	Scientific	Wild
2015	II	*Sphyrna lewini*	Great Britain	8		g	Specimens	Scientific	Wild
2015	II	*Sphyrna lewini*	Great Britain		4		Specimens	Scientific	Wild
2016	II	*Carcharhinus longimanus*	Sri Lanka	4	4		Fins	Educational	Wild
2016	II	*Carcharhinus longimanus*	USA	4			Fins	Circus/exhibition	Wild
2016	II	*Carcharodon carcharias*	Canada		20		Skins	Scientific	Wild
2016	II	*Carcharodon carcharias*	Canada		102		Specimens	Scientific	Wild
2016	II	*Carcharodon carcharias*	Great Britain	2	2		Bodies	Educational	Wild
2016	II	*Carcharodon carcharias*	Sweden	116			Specimens	Scientific	Wild
2016	II	*Lamna nasus*	USA	2			Fins	Circus/exhibition	Wild
2016	II	*Manta birostris*	Sri Lanka	4			Gill plates	Educational	Wild
2016	II	*Manta birostris*	Sri Lanka		4		Specimens	Educational	Wild
2016	II	*Sphyrna lewini*	Canada		41		Skins	Scientific	Wild
2016	II	*Sphyrna lewini*	Canada		147		Specimens	Scientific	Wild
2016	II	*Sphyrna lewini*	USA	3			Fins	Circus/exhibition	Wild
2016	II	*Sphyrna mokarran*	Canada		2		Skins	Scientific	Wild
2016	II	*Sphyrna mokarran*	Canada		4		Specimens	Scientific	Wild
2016	II	*Sphyrna mokarran*	USA	2			Fins	Circus/exhibition	Wild
2016	II	*Sphyrna zygaena*	Canada		12		Skins	Scientific	Wild
2016	II	*Sphyrna zygaena*	Canada		56		Specimens	Scientific	Wild
2017	II	*Carcharodon carcharias*	Australia		10		Skeletons	Scientific	Pre-convention
2017	II	*Carcharodon carcharias*	Australia		30		Specimens	Scientific	Pre-convention
2017	II	*Carcharodon carcharias*	Australia		37		Specimens	Scientific	Wild
2017	II	*Carcharodon carcharias*	Italy		4		Specimens	Scientific	Unknown
2017	II	*Carcharodon carcharias*	Italy		28		Specimens	Scientific	Wild
2017	II	*Carcharodon carcharias*	USA		40		Specimens	Scientific	Wild
2018	II	*Alopias pelagicus*	USA	1			Fins	Circus/exhibition	Pre-convention
2018	II	*Alopias superciliosus*	USA	1			Fins	Circus/exhibition	Pre-convention
2018	II	*Alopias vulpinus*	USA	2			Fins	Circus/exhibition	Pre-convention
2018	II	*Carcharhinus falciformis*	USA	3			Fins	Circus/exhibition	Pre-convention
2018	II	*Carcharhinus longimanus*	USA	4			Fins	Circus/exhibition	Pre-convention
2018	II	*Carcharodon carcharias*	Italy		32		Specimens	Scientific	Wild
2018	II	*Lamna nasus*	USA	2			Fins	Circus/exhibition	Pre-convention
2018	II	*Mobula eregoodootenkee*	Australia		3		Specimens	Scientific	Wild
2018	II	*Rhincodon typus*	Australia		17		Specimens	Scientific	Wild
2018	II	*Sphyrna lewini*	USA	3			Fins	Circus/exhibition	Pre-convention
2018	II	*Sphyrna mokarran*	USA	2			Fins	Circus/exhibition	Pre-convention
2019	II	*Isurus oxyrinchus*	Republic of Korea		140,407	kg	Meat	Commercial	Wild
2019	II	*Rhincodon typus*	Australia		10		Specimens	Scientific	Wild

[104] https://trade.cites.org/en/cites_trade

6.9.4 Conservation status

As a consequence of this high fishing pressure, chondrichthyans in South Africa are heavily overexploited, with 77 species (50%) currently considered threatened with extinction (IUCN 2021). These include 37 Vulnerable, 29 Endangered, and 11 Critically Endangered species, according to the IUCN Red List of threatened species (IUCN 2021, Table 3.4). Surprisingly, only four of the 17 chondrichthyan species which occur in South Africa and are endemic to the WIO are threatened; including the Endangered *Acroteriobatus leucospilus*, *Holohalaelurus favus* and *H. punctatus*, and the Critically Endangered *Pseudoginglymostoma brevicaudatum*. The only species endemic to South Africa, *Electrolux addisoni*, is listed as Least Concern. Although *H. favus* was commonly caught in fisheries and research surveys during the 1960s and 1970s, there has only been one record of this species since the 1970s (Pollom et al. 2020). In addition, *P. brevicaudatum* was only recently recorded from South Africa, representing a range extension for this species.

The Critically Endangered *Rhynchobatus djiddensis* was previously relatively common along the KZN coastline; however, catch rates in the KZN shark nets and from the competitive shore fishery have drastically declined since the 1970s, thought to primarily be attributed to overfishing in Mozambique (Daly et al. 2020).

Two sawfish species are known from the WIO, *Pristis pristis* and *P. zijsron*. These species were formally abundant in coastal areas of the WIO, but both have suffered major population declines and are now considered Critically Endangered. In South Africa they are locally extirpated, with the last individual seen in 1999 (Harrison and Dulvy 2014, Everett et al. 2015).

Although illegal fisheries are not as prevalent in South Africa as in many of the other WIO countries, the fisheries that are operating in South Africa and within the region are having a negative impact on the populations of numerous chondrichthyan species in South Africa and, considering that nearly half of all chondrichthyan species in South Africa are threatened with extinction, there is a need for their improved conservation and management.

6.9.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

Fisheries management and research in South Africa were, until recently, the responsibility of the Fisheries Branch of the South African Department of Agriculture, Forestry and Fisheries (DAFF; Table 6.9.4). Until 2016, fisheries regulations in KwaZulu-Natal (KZN) Province specifically were implemented by the provincial conservation authority, Ezemvelo KZN Wildlife (EKZNW), but subsequent to 2016 this responsibility also became that of DAFF. DAFF invested significantly in chondrichthyan research and capacity development through initiatives such as the establishment of a dedicated shark research section; the creation of a Large Pelagic and Sharks Scientific Working Group; and ongoing research investigating the biology, ecology and stock status of commercially harvested shark species (DAFF 2013). Historically, chondrichthyan fisheries were low priority and thus inadequately managed in South Africa (da Silva and Bürgener 2007). Since chondrichthyans form only a minor part of the landed catch of many different South African fisheries, there was little cohesion among DAFF's fishery-specific Scientific Working Groups regarding chondrichthyan management (DEFF 2020).

The Department of Environmental Affairs (DEA) was, until recently, responsible for the control of imports and exports of CITES-listed species, as the CITES management authority, while the South African National Biodiversity Institute (SANBI) is the CITES scientific authority. Furthermore, the South African Constitution places the responsibility for the protection of wild fauna, and in turn the control of international trade therein, with provincial conservation departments, which are also thereby designated as CITES management authorities (Republic of South Africa 2021b). DEA and DAFF were also responsible for trade controls and enforcement relating to trade, jointly with the South African Bureau of Standards (SABS), South African Revenue Services (SARS) and National Regulator for Compulsory Specifications (NRCS; Table 6.9.4).

DEA was also responsible for species conservation and environmental protection (Table 6.9.4). The role of DEA in relation to chondrichthyan species was predominantly related to management of species habitats and species considered valuable to the tourism industry, and associated activities, with little focus on fisheries. Management and enforcement of MPAs were also overseen by DAFF and DEA, with coastal zone management overseen by DAFF, South African National Parks (SANParks), CapeNature and others (Table 6.9.4).

However, in 2019, due to ministerial restructuring, a new consolidated Department of Environment, Forestry and Fisheries (DEFF) was created, by incorporating the forestry and fisheries functions of the former DAFF and DEA. This new department was renamed in 2021, to become the Department of Forestry, Fisheries and the Environment (DFFE) (Table 6.9.4). The DFFE is mandated to ensure a healthy environment for the people of South Africa, and thus focuses on environmental management, conservation and protection for sustainability. The responsibilities of DFFE include *inter alia* development and implementation of a legal regime and licensing or authorisation system to ensure enforcement and compliance with environmental law; and ensuring the regulation and management of all biodiversity, heritage and conservation matters in a manner that facilitates sustainable economic growth and development (Republic of South Africa 2021c).

Regulations are enforced through an MCS strategy, patrol vessels, officers and VMS (FAO 2010). However, the majority of officials conducting monitoring lack the species identification skills to identify demersal sharks correctly to species level (da Silva and Bürgener 2007). Species identification is especially difficult for demersal sharks as they are usually landed as processed trunks, having been headed and gutted at sea. A species identification tool has been developed for the demersal shark trade, to enable identification of specimens that have been headed and finned (da Silva 2006, in (da Silva and Bürgener 2007).

Although IUU fishing in South Africa is relatively lower than many other African countries, chondrichthyans are still impacted by illegal gear use, fishing in prohibited areas, finning, and underreporting rates (da Silva and Bürgener 2007). For instance, it is suspected that vessels from North Indian Ocean countries are fishing illegally in South African waters (NSRI 2011). South Africa's membership to the PSMA should mean that port officials can prohibit foreign vessels suspected of illegal activity from receiving port services and access and can alert other ports to the situation, blocking illegally caught chondrichthyans from entering the global marketplace.

Table 6.9.4: Designated national authorities for chondrichthyan management in South Africa.

Area of management	Designated national authorities
Fisheries management and research	Department of Forestry, Fisheries and the Environment (DFFE, formerly Department of Agriculture, Forestry and Fisheries, DAFF)
Export and import trade controls (including permitting)	DFFE (formerly DAFF); South African Bureau of Standards (SABS); South African Revenue Services (SARS), Department: Customs and Excise; National Regulator for Compulsory Specifications (NRCS)
Permitting of fisheries	DFFE (formally DAFF)
Enforcement of fisheries legislation	DFFE (formally DAFF)
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	DFFE (formally Department of Environmental Affairs, DEA), as national CITES management authority; South African National Biodiversity Institute (SANBI) as national CITES scientific authority; SARS; NRCS; South African Police Services (SAPS)
Species conservation and environmental protection	DFFE (formally DEA)
Coastal zone management	DFFE (formerly DAFF); South African National Parks (SANParks); CapeNature; Northern Cape Nature Conservation; Eastern Cape Parks and Tourism Agency (ECPTA); Ezemvelo KwaZulu-Natal Wildlife
MPA management and enforcement	DFFE (formerly DAFF and DEA)

National legislation and regulations

All fisheries in South Africa, and the processing, sale and trade of most marine resources, are regulated under the Marine Living Resources Act (MRLA; Republic of South Africa 1998a), and the Marine Living Resources Regulations (Republic of South Africa 1998b, as supported by the MLRA). There have been numerous amendments to both, with the latest Act amendment in 2014 (Republic of South Africa 2014), and latest amendment to the Regulations in 2015 (Republic of South Africa 2015b). The MLRA governs permitting, fishing rights, identification of fishing harbours, gear restrictions, foreign fishing vessels, fishing in the high seas, marine protected areas and fisheries law enforcement, among other aspects. Under the MLRA, fishing without a license is forbidden. Entry into any commercial fishery is limited by a rights allocation process, which takes into account scientific recommendations for limiting the number of vessels, crew and Total Allowable Catch (TAC) or Total Allowable Effort (TAE) for target species, as well as precautionary catch limits for bycatch species (DAFF 2013).

Foreign vessels may only be granted a fishing licence if a fishery agreement between their flag State and South Africa exists, or if the owner of the foreign vessel is a member of an international fisheries organization to which South Africa is also a member. Historically, foreign access has been dominated by Japan, China and Taiwan (FAO 2010). Long-term fishing rights for tuna and swordfish were allocated exclusively to South Africans in 2004, so foreign-flagged vessels can only access these resources through joint ventures with South African companies (FAO 2010). There is no fisheries partnership agreement between South Africa and the EU (European Commission 2020).

Under the MRLA (Republic of South Africa 1998a), and its amendments, there are several regulations with relevance to chondrichthyans, including certain prohibitions for seven chondrichthyan species and one family. These include that:

- Sharks may not be landed, transported, transhipped or disposed of other than in a whole State, without a permit;
- Shark fishing by net is prohibited within 12 nm of Cape Hangklip and Cape St Blaize;
- Dumping or discard at sea of any fish species for which there are restrictions is prohibited;
- Great white sharks *Carcharodon carcharias*, basking sharks *Cetorhinus maximus,* whale sharks *Rhincodon typus* and sawfishes (family Pristidae) are prohibited from any fishing;
- Ragged-tooth sharks *Carcharias taurus*, sharptooth houndshark *Triakis megalopterus*, leopard catshark *Poroderma pantherinum* and pyjama catshark *P. africanum* are prohibited from commercial exploitation (Table 6.9.5); these species may be retained by recreational anglers, but sale is prohibited (including live animals);
- For all chondrichthyan species not prohibited, there is a daily bag limit of one per person, and a daily total limit of ten chondrichthyans per person, for recreational and subsistence anglers.

In addition to the MLRA, the National Environmental Management: Biodiversity Act, 2004 (NEMBA, Republic of South Africa 2004) makes provision for the publication by the Minister of a list of threatened or protected species (TOPS list), and empowers the Minister to prohibit any person from carrying out restricted activities involving TOPS-listed species without the appropriate permit (Republic of South Africa 2004). The TOPS list was revised in 2015 (Republic of South Africa 2015c) and includes several chondrichthyan species, which are thereby prohibited from restricted activities unless a permit has been issued. However, these TOPS Regulations remain open to interpretation as to whether a “recreational angling” permit holder is exempt from such restricted activities. These restricted activities include *inter alia* luring, catching, killing, transporting, exporting or importing TOPS-listed species (except for scientific purposes). TOPS-listed species are categorised as Critically Endangered, Endangered, Vulnerable (as per IUCN classifications) or Protected (species in non-threatened IUCN categories but in need of regulation). The 2015 TOPS list includes 17 chondrichthyan species (see Table 6.9.5, in section 6.9.7). However, as the threatened category listings follow the IUCN Red List, they are likely to reflect greater numbers of chondrichthyan species when the TOPS list is next revised, as many chondrichthyan species have been “up-listed” to higher threat categories since the TOPS list was last published in 2015 (see Chapter 3).

Permit conditions are updated regularly to include chondrichthyan-specific management measures (West and Kerwath 2015). Chondrichthyan catches in the pelagic longline fishery were limited by a precautionary upper catch limit (PUCL) of 2,000 t dressed weight of chondrichthyans, applicable to all vessels in this fishery, introduced in 2012, but this will change to 1,200 t of *Prionace glauca* and 154 t of *Isurus oxyrinchus* in 2023. The PUCL works in the following manner: 1) once 60% of the PUCL has been reached, vessels are no longer permitted to use steel/wire traces on the branch lines; and 2) when the PUCL (100%) has been reached the entire fishery will close. Thresher sharks *Alopias* spp., hammerhead sharks *Sphyrna* spp., *Carcharhinus longimanus* and *C. falciformis* may not be retained on board any vessel. Fins may only be landed from shark trunks that are retained on board and both the fins and trunks must be landed together at the first point of landing. If the Permit Holder chooses to remove the shark fins from the trunks, the maximum weight of fins landed or retained on board may not exceed 13% for *P. glauca* and 8% of the total weight of all other shark species trunks. Bycatch reduction devices are not compulsory in the prawn trawl fishery but there is an inshore trawling distance limit of 0.5 nm and a mesh size limit of 50 mm (Kiszka and van der Elst 2015). Chondrichthyan landed catch weight of foreign-flagged fleets may not exceed 10% of the total dressed weight of tuna species per season.

Chondrichthyan product trade should be controlled through CITES and IOTC. CITES Regulations (Republic of South Africa 2010) were developed under the NEMBA Act 2004 (Republic of South Africa 2004) and prohibit international trade, transhipment and transit of species (or parts thereof) listed in the Appendices to these Regulations, other than in accordance with provisions of CITES and these CITES Regulations.

Status of NPOA-sharks

In accordance with the FAO's IPOA-Sharks, South Africa published an NPOA-Sharks in 2013 (DAFF 2013). It has as its vision '*The effective conservation and management of sharks that occur in the South African EEZ to ensure their optimal, long-term, sustainable use for the benefit of all South Africans, including both present and future generations*'. The NPOA-Sharks document formalises and streamlines efforts to improve the conservation and management of chondrichthyans caught in South African waters. As one of only two NPOA-Sharks (the other being the Seychelles NPOA-Sharks) that have so far been implemented in the Nairobi Convention geographic area (aside from the EUPOA-Sharks), South Africa's NPOA sets a good example, particularly in its identification of the issues and risks facing chondrichthyan management, the proposed actions and the noting of priorities.

Having been published in 2013, by 2017 South Africa's first NPOA had reached the end of its implementation timeframe and was thus due for a revision. Accordingly, and in response to media pressure and public concern regarding the decline of *Carcharodon carcharias* observations in previous eco-tourism hotspots, the Minister of DFFE appointed an Expert Panel composed of internal, external and international experts to review the NPOA-Sharks in May 2020 (pers. comm., Charlene da Silva, DFFE, October 2021).

The main objective of the NPOA review was to determine whether the NPOA-Sharks was in line with international standards and covered all the goals of the IPOA-Sharks, as set out by the FAO (FAO 1999). The international and external panel commended the external review process of the NPOA-Sharks as a unique example of accountability and transparency which emphasised the commitment of DFFE to conserve and properly manage chondrichthyan species for their long-term sustainable use (pers. comm., Charlene da Silva, DFFE, October 2021).

The external experts also commended the progress that had been made to implement the plan, particularly the level of scientific assessments, given the human capacity, funding and infrastructure constraints in South Africa. However, while they assessed that the NPOA-Sharks was comprehensive, it was deemed overly ambitious in both extent and timeframes (DFFE 2022).

The final step of the review was to improve the Action Table from the first NPOA to define, with improved accountability and time-frames, actions to be taken for the long-term sustainability of chondrichthyan fisheries. This new action table is the backbone of the second NPOA-Sharks (NPOA-Sharks II, pers. comm., Charlene da Silva, DFFE, October 2021).

The NPOA-Sharks II builds on the achievements and lessons learned from the first. The NPOA defines 41 specific actions to be taken, grouped into five key "clusters": i) more effective communication and coordination; ii) measurable outcomes; iii) recognition of ecosystem effects of fishing and the need for spatial management; iv) a stronger focus on IUU fishing; and v) improvement and modernization of data collection, capture, storage and integration (DFFE 2022). An implementation plan for the NPOA-Sharks II has already been endorsed by the Minister of DFFE with several items added to the work goals of the DFFE as a whole.

A Shark Biodiversity Management Plan was also developed in South Africa (Republic of South Africa 2015a), under NEMBA (Republic of South Africa 2004), which incorporates many of the same objectives and required actions of the NPOA-Sharks, formalising this into law. The purpose of the Management Plan is 'to achieve and maintain a favourable conservation status for resident and migratory sharks within South African waters, taking into account the socioeconomic and other values of these species, based on the best available scientific information'. It aims to be the mechanism which can coordinate and implement this effort on national and international scales, and to identify species and areas where additional efforts are necessary to address threats.

Marine protected areas

South Africa has undertaken dedicated efforts to develop an extensive network of coastal and offshore MPAs, to protect a representative proportion of its key marine habitats. There are 42 MPAs within South Africa's EEZ (5.4% of the EEZ) (Fielding 2021), including some very large, well-established MPAs that have been shown to act as important refuges for coastal fish populations. There are no specific chondrichthyan MPAs in South Africa, but there are several areas in which chondrichthyan fishing is prohibited, and there are several MPAs that offer some level of protection to chondrichthyan species, with some protecting important chondrichthyan nursery and/or breeding areas, particularly as a result of South Africa's recently expanded MPA network (Republic of South Africa 2019). Under the Marine Living Resource Regulations (Republic of South Africa 1998b), shark fishing by means of any kind of net is prohibited within 12 nm of Cape Hangklip and Cape St Blaize (Republic of South Africa 1998b). Also, as a regulation gazetted under the MLRA, all fishing of elasmobranchs is banned in the Breede River Estuary, South Africa (other than for scientific purposes with a permit) and any bycatch must be released alive (Republic of South Africa 2013). This is a highly productive estuary for chondrichthyan species, and this regulation allows the estuary to effectively act as an estuarine protected area for chondrichthyan species. However, both of these areas in which chondrichthyans are protected fall to the west of East London, outside of the WIO (as defined in this report).

East of East London (within the area considered to be part of the WIO, as defined for this report), there are 10 MPAs, some of which are well-suited to provide protection for chondrichthyan species. There is also ban on inshore longlining within 20 nm of the coastline, along the 840-km long coast immediately south of the Mozambique–South African border (the KZN Province), which reduces commercial fishery impacts on chondrichthyan species in this region (Daly et al. 2020).

The largest MPA in this region, and probably of greatest value to chondrichthyans, is the iSimangaliso MPA, which spans 177 km of coastline and extends between 63 and 107 km offshore, adjacent to the Mozambique border, to depths exceeding 2,000 m, and covers an area of 10,715 km^2 (Fielding 2021). The MPA is zoned for multiple uses, including several no-take zones. The MPA boasts a wide diversity of habitats, including extensive coral reefs, rocky reefs, deep rocky reefs, sand habitats, deep soft-sediment habitats and deep canyons (Fielding 2021), all of which offer suitable habitat for certain chondrichthyan species. The MPA is immediately adjacent to the Ponta do Ouro Partial Marine Reserve in southern Mozambique, and both MPAs fall within a global chondrichthyan biodiversity hotspot (Lucifora et al. 2011, Dulvy et al. 2014, Stein et al. 2018, Derrick et al. 2020). iSimangaliso MPA has been identified as an important area for tiger sharks *Galeocerdo cuvier*, *Mobula* spp. and *R. typus*, and provides critical habitat for adult and juvenile whitespotted wedgefish *Rhynchobatus djiddensis* (Kiszka and van der Elst 2015, Daly et al. 2018, 2020). Many other threatened chondrichthyan species have been recorded within this MPA, such as Critically Endangered *Carcharias taurus*, *Pseudoginglymostoma brevicaudatum* and *Sphyrna lewini*, and Endangered *C. amblyrhynchos*. The iSimangaliso MPA therefore needs to be managed in such a way that ensures protection of the chondrichthyan species that utilize the area. In June 2000, a transboundary MPA was declared under the Lubombo Protocol, extending 300 km from Maputo Bay in Mozambique to Cape St. Lucia in South Africa, linking the Ponta do Ouro Partial Marine Reserve to iSimangaliso Wetland Park (Guerreiro et al. 2011, Pereira 2021).

The uThukela MPA spans about 4,100 km^2 and protects a range of habitats from the coast to approximately 500 m deep, including *inter alia* nearshore sandy habitats, rocky reefs, estuaries, continental slope soft sediments, submarine canyons and pelagic habitats (Fielding 2021). These habitats are used by numerous chondrichthyan species, particularly benthic species, and this MPA likely offers some protection from commercial fishing to species such as *R. djiddensis* (which has a known aggregation site in the uThukela area, Daly et al. 2020) and the African angelshark *Squatina africana*, juveniles of which have been recorded in high numbers in the trawl fisheries that operate in close proximity (Fennessy 1994).

The Aliwal Shoal MPA is relatively smaller, covering 680 km^2; however, this MPA covers ecologically important shallow and deep reefs, as well as soft sediment habitats to the shelf edge (Fielding 2021). The Aliwal Shoal MPA[105] is home to *Carcharias taurus, Carcharhinus limbatus, G. cuvier, Mobula kuhlii* and *R. djiddensis* aggregations (Kiszka and van der Elst 2015, Daly et al. 2018, 2020; pers. comm., Michelle Carpenter, UCT, September 2021), and is one of the few locations where the endemic *E. addisoni* has been observed (Compagno and Heemstra 2007). Catches of *C. limbatus* in the nearby bather protection gear do not mirror the periodic increase seen in Aliwal Shoal, confirming a localised aggregation within the MPA (Dudley and Cliff 2010). The nearby Protea Banks offshore MPA[106] spans 1,190 km^2 and extends up to 35 km offshore, to waters of 2,650 m deep (Fielding 2021). This MPA is host to large aggregations of *C. taurus*, *R. djiddensis* and *S. lewini* (Daly et al. 2020).

The Pondoland MPA spans 90 km of shoreline and covers 1,236 km^2 and is zoned for multiple uses (Fielding 2021). The MPA is bounded to the south by the Mzimvubu Estuary, a possible nursery for bull sharks *Carcharhinus leucas* (Daly et al. 2021), and the MPA is known to have high densities of shark species, such as juvenile *S. lewini*. However, all of these South African MPAs are threatened by IUU fishing and many are threatened by commercial fishing in close proximity (Fielding 2021).

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

South Africa is signatory to several MEAs and RFBs (see Table 5.2). South Africa became Party to CMS in 1991 and is thereby bound by CMS commitments. There are 13 chondrichthyan species listed on Appendix I and a further 13 listed on Appendix II of CMS (excluding those also listed on Appendix I), which are known to occur in the South African EEZ, east of East London (i.e., within the area defined herein as the Nairobi Convention area of the WIO; Table 6.9.5, and see Table 3.3, Chapter 3). South Africa is thus obliged to protect the 13 species listed on Appendix I, and this has been partly achieved, through full prohibition or commercial prohibition of several species under the MLRA, TOPS list and/or permit restrictions (Table 6.9.5). As a Party to CMS, South Africa is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. The State is also obliged to implement the CMS concerted actions for whale sharks and mobula rays. Many of the Appendix II species are shared with other Nairobi Convention Member States, and South Africa should participate in the development of regional management plans, as appropriate, for these species (Table 5.1). South Africa is also signatory to the CMS Sharks MOU (Table 5.2), signed in 2011, and was actively involved in finalising the Conservation Plan presented in Annex 3 therein, and should thus implement measures to effectively manage the species listed in Annex I of the MOU.

South Africa has been Party to CITES since 1975 and is thereby required to implement measures to ensure

[105] https://www.marineprotectedareas.org.za/aliwal-shoal-mpa

[106] https://www.marineprotectedareas.org.za/protea-banks-mpa

that international trade in chondrichthyan species listed on Appendices I and II is regulated appropriately. Two chondrichthyan species (previously) known from South Africa (east of East London) are listed on CITES Appendix I and 22 species on CITES Appendix II (Table 3.3, Chapter 3). However, the two Appendix I species are sawfishes (Pristidae), which are considered locally extinct within South Africa (Everett et al. 2015). Furthermore, South Africa took a reservation on the listing of mako sharks (*Isurus* spp.) and is therefore bound by the listings of the remaining 20 Appendix II species only. South African legislation is considered to generally meet all four of the requirements for effective implementation of CITES (CITES 2021). Despite this, no NDF assessments for the export of CITES Appendix II chondrichthyan species have been conducted in South Africa (SANBI 2019).

In terms of RFBs, South Africa is a member of SWIOFC and became a member of the IOTC in 2016, but has not joined SIOFA (Table 5.2). Under the IOTC, shark, tuna and swordfish fisheries in South Africa must report their catches and follow the IOTC regulations concerning chondrichthyan species, retention bans, finning and reporting (see section 5.4.1). These measures include retention bans in IOTC-managed fisheries for 12 species of chondrichthyans that occur in South African waters (Table 3.3). All 12 of these species are prohibited from capture within the Large Pelagic Fishery, through specific permit conditions (IOTC Secretariat 2021j), while *R. typus* is fully protected under the MLRA and *Mobula alfredi* and *M. birostris* are protected under the TOPS list (Table 6.9.5). Furthermore, the 2020 IOTC compliance report identified South Africa as being generally compliant with the requirements to report nominal catch, catch and effort, and size frequency data on sharks to IOTC, as well as in terms of implementing prohibitions on large-scale drift nets, shark finning and the retention bans on *C. longimanus*, manta and devil rays (Mobulidae) and thresher sharks (Alopiidae) (IOTC Secretariat 2021j). The prohibition of intentionally setting a purse seine net around *R. typus* is not applicable as South Africa operates no purse seine vessels (IOTC Secretariat 2021j). This is a significant improvement from the 2015 report that reflected high levels of partial and non-compliance (IOTC Secretariat 2015c).

South Africa is also a Member of the Nairobi Convention, SADC (and thus the SADC Protocol on Fisheries) and the PSMA (Table 5.2). While none of these instruments specifies management measures or commitments for chondrichthyan species, the Nairobi Convention does list species-specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future. All three of these instruments are binding on Member States, and South Africa is thus obliged to implement the required measures. All three instruments have the potential to facilitate improved chondrichthyan management and decreased IUU fishing of chondrichthyans in South Africa.

South Africa is also Party to the Ramsar Convention, which commits South Africa to appropriately manage its wetlands. There are currently 27 sites designated as Wetlands of International Importance, 15 of which are marine or coastal, and some of which have significance for shark conservation such as the St. Lucia System; although most of these are west of East London, and thus outside of the South African EEZ considered in this report to fall within the WIO.

South Africa is also Party to UNCLOS, the UN Fish Stocks Agreement and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments to these and the UN General Assembly Resolution on sustainable fisheries. While the UN Fish Stocks Agreement does not carry specific measures for chondrichthyan species, UNCLOS and the UN General Assembly Resolution present specific chondrichthyan measures, such as reduced chondrichthyan mortality and strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999) (see section 5.2.3). All three instruments impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks for sustainable fisheries, and South Africa should ensure that all measures are implemented effectively.

As a Member of the FAO since 1993, South Africa is also encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, many of which present specific chondrichthyan measures (see section 5.3).

6.9.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in South Africa

There is extensive fishing pressure throughout South Africa, and chondrichthyans are targeted or caught as bycatch in most fisheries. Chondrichthyans have been commercially exploited in South Africa since the 1930s (von Bonde 1934), with increased demand during World War II for natural vitamin A, which was sourced from shark liver (van Zyl 1993). In 1992 a longline fishery specifically targeting demersal and pelagic sharks was established (Kroese and Sauer 1998). Chondrichthyans are targeted in seven commercial fisheries, including the demersal shark longline and pelagic longline fisheries, boat- and shore-based linefisheries, beach-seine and gillnet fisheries and the KZN bather protection program (da Silva et al. 2015). Bycatch fisheries for chondrichthyans in South Africa comprise the inshore and offshore demersal trawl, hake longline, prawn trawl, small-pelagic and midwater trawl fisheries (da Silva et al. 2015).

Fishery impacts

- South African fisheries catch many threatened chondrichthyan species.
- Several threatened species (e.g., *Carcharhinus brachyurus, Galeorhinus galeus* and *Isurus oxyrinchus*) are primary targets in some fisheries. Improved management measures are necessary, to reduce the mortality of these species.
- There is evidence of IUU fishing, use of illegal gears, and fishing in prohibited areas, which must be prevented.
- Targeting of sharks using gillnets and the recent illegal targeting of sharks in the recreational fishery using drones need to be prevented.
- Of major concern is the stock status of *G. galeus*, recently assessed as Critically Endangered, as a comprehensive stock assessment (Winker et al. 2020) indicated that the species would be commercially extinct by 2055 if catches are not reduced. While scientific recommendations aimed at reducing catch of the species have been introduced in the commercial linefishery and the demersal shark longline fishery, through a slot limit of 0.7 to 1.3 m that aims to reduce the capture of large fecund sharks, recommendations aimed at reducing *G. galeus* catches in the trawl fishery have not been implemented. This scientific recommendation requires a 20-t PUCL to be implemented for this fishery. While the slot limit has recently reduced catches in the demersal shark longline fishery and commercial linefishery according to catch data and length frequency measures at shark processing establishments, the trawl fishery continues to catch large volumes of *G. galeus*. However, catches from 2020/2021 were low as a result of the COVID-19 pandemic so actual reductions as a result of the slot limit are difficult to quantify.

Governance, policy, legislation, enforcement and capacity needs

- There has been inadequate coordination in shark fishery management (DAFF 2013, DFFE 2022).
- Most sharks are caught by more than one fishery, but currently there is no mechanism in place for management of species across multiple fisheries, and no formal mechanism in place to coordinate with the tourism sector.
- Each fishery has a Scientific Working Group but there is not a common framework for capturing data and making scientific recommendations for sharks; and no formal system for sharing shark info and advice across the working groups (DAFF 2015b).
- Implementation of the South African NPOA-Sharks has been constrained by limited human resources, inadequate political will and insufficient funding (DAFF 2015b, DFFE 2022).
- Low compliance with finning regulations and permit conditions in commercial fisheries and noncompliance in the recreational fisheries are a result of limited capacity for enforcement (DAFF 2013, 2015b).
- The implementation of CITES and other trade controls is constrained by shortcomings in the legal/regulatory framework, a lack of knowledge on chondrichthyans, limited human resources, inadequate political will, lack of trained personnel and insufficient funding (DAFF 2015b).
- While South Africa is Party to CITES, and positive NDFs are a prerequisite for the export of CITES-listed species, no NDFs have been conducted on chondrichthyan species in South Africa.

Monitoring and reporting

- Chondrichthyans are caught as bycatch in at least seven fisheries in South Africa and targeted in at least three. However, there are limited data in terms of catches of chondrichthyan species, and very limited data on the level of discards, for most fisheries that catch chondrichthyans as bycatch.
- While catch data are recorded in most fisheries, there are limited data at species level, with many species of chondrichthyans reported in very general groups. This is especially an issue in the trawl fisheries, for species such as skates.
- Misidentification and grouping of species into generic categories by fisheries have complicated stock assessment processes.
- Logbooks are enforced in certain fisheries but are believed to underrepresent true catch quantities.
- Monitoring and enforcement of recreational fisheries is inadequate (DAFF 2013).
- There is also inadequate capacity for fisheries inspectors and observers to identify the full diversity of chondrichthyans caught, to species level – particularly for the deeper-water species.
- Catches reported to FAO do not consider recreational or subsistence catch volumes, and commercial catch data reported to FAO are not consistently reported, with apparent omissions of catches of certain species or species groups, or even entire fisheries, from the data reported in some years.
- Observer programs do not collect appropriate data to provide insight into the impacts of fishing on discarded species (DAFF 2013).
- International trade data present large discrepancies between exports from South Africa and imports to other countries reported to have been sourced from South Africa. This is indicative of underreporting in South Africa, likely associated in some instances with illegal exports.

Availability of ecological and biological information

- Despite having a considerably greater history of chondrichthyan research than other Nairobi Convention Member States, particularly in terms of taxonomy, there remain many gaps in the ecological and biological knowledge regarding chondrichthyan species in South Africa.
- The limited knowledge on biology, population structures and movement patterns of many species severely restricts the implementation of a successful chondrichthyan management strategy (DAFF 2013).
- There is limited biological monitoring in most fisheries, due in part to the lack of the National Observer project which has not run for over a decade.

Required and recommended actions

Governance, policy, legislation, enforcement and capacity needs

South Africa is well advanced among the Nairobi Convention Member States in terms of chondrichthyan research and management. The revised NPOA-Sharks (NPOA-Sharks II) provides an updated threat assessment, and clearly defines key actions for improved sustainability of South Africa's chondrichthyan species. Some of the main gaps and needs include:

- The TOPS list should be revised, considering the recently published IUCN Red List assessments (amendments), with existing text amended to ensure that TOPS-listed species and restricted activities apply to all fisheries, including recreational fisheries.
- South Africa has formally prohibited the capture of some but not all chondrichthyan species listed on CMS Appendix I, which the State is bound to protect; therefore, full protections should be implemented for the CMS Appendix I species not yet fully protected.
- There are numerous chondrichthyan species that are of conservation concern but that are not protected or regulated at species level. These should be considered for protection (see section 6.9.7, and Table 6.9.5).
- There are numerous species present in South African waters that are shared with other States, which are threatened and listed under CMS Appendix II, or Annex I of the CMS Sharks-MOU, and South Africa should pursue multilateral management plans for such species.
- CITES Appendix II species are not required to be protected. However, international trade in such

products requires evidence that the trade has no detrimental impacts (through NDF assessment) on the wild population of the target species; therefore, such species must be managed so as to maintain populations at sustainable levels (and prohibited in certain fisheries if necessary).

- As there are few CITES-listed chondrichthyan species targeted by South African fisheries, the prospect of strengthening trade controls is good, with training for fisheries observers and customs staff a priority for improved implementation.
- NDF assessments need to be conducted for all CITES Appendix II chondrichthyans that are to be traded internationally.
- The introduction of more detailed tariff codes for chondrichthyan products traded would provide opportunities for more accurate reporting, and improved checks and balances.
- The Shark Biodiversity Management Plan provides a complement to the NPOA-Sharks, covering non-fishery threats and if implemented effectively could have a positive impact on chondrichthyan populations. Chondrichthyan-specific management plans should be considered by other Nairobi Convention Member States.
- New funding avenues should be investigated for the effective implementation of the revised NPOA-Sharks.
- Retained, finned sharks are not fully utilized, so value adding and product development should be explored (DAFF 2013).
- Capacity building of fisheries control officers, observers and other relevant compliance officials should be undertaken to improve identification skills. In combination with the use of the species identification materials developed as part of South Africa's NPOA-Sharks (DAFF 2015c), such training should result in better quality species-level data on chondrichthyan catches. Further recommendations have been made to have species identification training filmed, so as to make it more widely available to fishers, fisheries compliance officers and observers.
- Education and awareness programs are required to change misconceptions surrounding shark fisheries (DAFF 2013).

Data collection and research priorities

- There is a need for further ecological and biological research on chondrichthyan species in South Africa (see section 6.9.2 for a detailed description on research needs and priority species).
- Research should be conducted on stock status, structure and life history of key commercial species, spatio-temporal patterns of habitat use and how these may overlap with fisheries.
- Research on stock delineation, and engagement with neighbouring countries on data sharing for shared stocks, would be beneficial (DAFF 2013).
- Further taxonomic and ecological research and training of locally-based chondrichthyan taxonomists are needed (Ebert and van Hees 2015), to reduce the number of Data Deficient chondrichthyan species and resolve the taxonomic issues surrounding many groups of chondrichthyans.
- Research and monitoring remain poor for batoid species (Ebert and van Hees 2015), even though they are fished in considerable numbers, and future research programs should aim to incorporate at least commercially important ray and skate species (DAFF 2015b).
- Improved species-level monitoring is necessary in many of South Africa's fisheries that take chondrichthyans as bycatch.
- The National Observer program should be reinstated, to allow for improved biological monitoring and the recording of discards, and should be extended to cover all fisheries (pers. comm., Charlene da Silva, DFFE, October 2021).
- The implementation of improved identification guides and monitoring protocols for chondrichthyan families (particularly batoids and deepwater shark species) would improve species-level data. Several such guides and training materials are currently in development (pers. comm., Charlene da Silva, DFFE, October 2021).

6.9.7 Priority chondrichthyan species for protection

As a signatory to CMS and a Contracting Party to the IOTC, South Africa is obliged to protect all chondrichthyan species listed on CMS Appendix I that occur in the State's waters (of which there are 13) and to prohibit (within fisheries under the management of IOTC) the capture of any species present in South African waters that have retention bans under IOTC resolutions (of which there are 12, of which 9 are shared with CMS I); this totals 16 chondrichthyan species. It is noteworthy that South Africa already provides some protection for all 16 of these species, either through full protection, commercial bans or permit conditions preventing retention in certain fisheries (Table 6.9.5); however, *Carcharhinus longimanus* and all mobulid rays (other than *Mobula alfredi* and *M. birostris*) are listed on CMS Appendix I but are not fully protected – these species have retention bans through permit conditions in the pelagic longline fishery and demersal longline fishery (*C. longimanus* only). Therefore, South Africa should fully protect these species in order to adhere to CMS requirements. Aside from these species, South Africa is one of only two Nairobi Convention Member States that protects most (Mozambique fully protects all) of the chondrichthyan taxa that the State is legally and directly bound to protect, through its associated MEAs and RFBs.

There are, however, other chondrichthyan species assessed as threatened by the IUCN Red List of Threatened Species, which should also be considered for national protection, particularly those species which are caught frequently in fisheries and are Endangered or Critically Endangered, as these species are facing a very high to extremely high risk of extinction in the wild. Therefore, efforts should be taken to safeguard the remaining populations of these species to ensure that threatened species stocks do not decline further. Aside from the species listed under CMS Appendix I and prohibited through IOTC resolutions, there are eight Critically Endangered chondrichthyan species in South Africa, of which four are already protected under the TOPS list (Republic of South Africa 2015c) or through a commercial ban under the MLRA (Table 6.9.5), as well as 20 Endangered chondrichthyan species, none of which is currently protected. Considering amendments to the IUCN Red List categories of many chondrichthyan species since the 2015 TOPS list publication (Republic of South Africa 2015c), a revision of the TOPS list should by definition include these 24 Critically Endangered and Endangered chondrichthyan species that are not currently protected, as well as the 29 Vulnerable chondrichthyan species (of the 37 present in South Africa) that are not already protected.

Several agreements also call for the development of multinational or regional management plans, to ensure effective management for the sustainable harvesting of threatened species, such as the species listed on CMS Appendix II. As many of these species occur in South Africa's waters, such management plans should be discussed and developed regionally and with neighbouring States, through multilateral agreements.

Table 6.9.5: Chondrichthyan species confirmed or reported (*not confirmed) from the waters of South Africa (east of East London), for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries). Species regulated or protected under national measures (Measures), including prohibition (MLRA) or commercial ban (MLRA/C) under the Marine Living Resources Act (Republic of South Africa 1998a) or commercial ban under the Threatened or Protected (TOPS) species list (Republic of South Africa 2015c) are shaded in green, or prohibition through fishery-specific permit conditions (shaded in blue) in the pelagic longline (P), demersal longline (D) or beach seine and gillnet (S/G) fisheries (see National legislation section). Critically Endangered and Endangered species not already protected are also presented, as these are recommended by virtue of their conservation status for protection (e.g., MLRA) or commercial prohibition (e.g., TOPS or permit conditions). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern). Species in bold = WIO endemic.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN	Rationale	Measure
Species for which prohibition is binding (some or all fisheries)								
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC	P, D
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC	P, D
	Alopias vulpinus	Common thresher shark	II	Yes	II	VU	IOTC	P, D
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC	P, D
Cetorhinidae	*Cetorhinus maximus*	Basking shark	I, II		II	EN	CMS I	MLRA
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I	MLRA
Mobulidae	*Mobula alfredi*	Reef manta ray	I, II	Yes	II	VU	CMS I; IOTC	TOPS
	Mobula birostris *	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC	TOPS
	Mobula eregoodoo	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC	P
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC	P
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC	P
	Mobula tarapacana	Sicklefin devil ray	I, II	Yes	II	EN	CMS I; IOTC	P
	Mobula thurstoni	Bentfin devil ray	I, II	Yes	II	EN	CMS I; IOTC	P
Pristidae	*Pristis pristis*	Largetooth sawfish	I, II		I	CR	CMS I	MLRA
	Pristis zijsron	Green sawfish	I, II		I	CR	CMS I	MLRA
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC	MLRA
Other species already partly or fully protected								
Carcharhinidae	*Carcharhinus falciformis*	Silky shark	II		II	VU		P
Carchariidae	*Carcharias taurus*	Ragged-tooth shark				CR	CR	MLRA/C
Dasyatidae	*Dasyatis chrysonota*	Blue stingray				NT		S/G
Galeocerdidae	*Galeocerdo cuvier*	Tiger shark				NT		TOPS
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN	D
	Isurus paucus	Longfin mako shark	II		II	EN	EN	D
Myliobatidae	*Myliobatis aquila*	Common eagle ray				CR	CR	S/G
Narkidae	***Electrolux addisoni***	**Ornate sleeper ray**				LC		TOPS
Pentanchidae	*Haploblepharus kistnasamyi*	Natal shyshark				VU		TOPS
Rhinidae	*Rhynchobatus djiddensis*	Whitespotted wedgefish **			II	CR	CR	TOPS
Rhinobatidae	*Acroteriobatus annulatus*	Lesser guitarfish				VU		S/G
Scyliorhinidae	*Poroderma africanum*	Pyjama catshark				LC		MLRA/C
	Poroderma pantherinum	Leopard catshark				LC		MLRA/C
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR	TOPS, P, D
	Sphyrna mokarran	Great hammerhead shark	II		II	CR	CR	TOPS, P, D
	Sphyrna zygaena	Smooth hammerhead shark	II		II	VU		P, D
Triakidae	*Mustelus mustelus*	Common smoothhound				EN	EN	S/G
	Mustelus spp.	Smoothhound sharks						S/G
	Scylliogaleus quecketti	Flapnose houndshark						TOPS
	Triakis megalopterus	Spotted gully shark				LC		MLRA/C

Table 6.9.5 continued

Family	Species name	Common name	CMS	IOTC	CITES	IUCN	Rationale	Measure
Critically Endangered and Endangered species not already protected, for which protection is recommended								
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN	
	Carcharhinus obscurus	Dusky shark	II			EN	EN	
	Carcharhinus plumbeus	Sandbar shark				EN	EN	
	Negaprion acutidens	Sicklefin lemon shark				EN	EN	
Centrophoridae	*Centrophorus granulosus*	Gulper shark				EN	EN	
	Centrophorus squamosus	Leafscale gulper shark				EN	EN	
	Centrophorus uyato	Little gulper shark				EN	EN	
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN	
Echinorhinidae	*Echinorhinus brucus*	Bramble shark				EN	EN	
Ginglymostomatidae	*Pseudoginglymostoma brevicaudatum*	Shorttail nurse shark				CR	CR	
Myliobatidae	*Aetomylaeus bovinus*	Duckbill ray				CR	CR	
	Aetomylaeus vespertilio	Ornate eagle ray				EN	EN	
Pentanchidae	*Holohalaelurus favus*	Honeycomb catshark				EN	EN	
	Holohalaelurus punctatus	African spotted catshark				EN	EN	
Rajidae	*Raja ocellifera*	Twineyed skate				EN	EN	
	Rostroraja alba	Spearnose skate				EN	EN	
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR	
Rhinobatidae	*Acroteriobatus leucospilus*	Greyspot guitarfish				EN	EN	
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray				EN	EN	
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN	

* Presented in NEMBA as *Manta birostris*

** Presented in NEMBA as giant guitarfish

6.10 United Republic of Tanzania

6.10.1 Introduction

The United Republic of Tanzania is situated between Mozambique and Kenya along the Mozambique Channel, and comprises the mainland area together with Zanzibar Archipelago (Unguja and Pemba islands, Figure 6.10.1). Tanzania (including its islands) has a coastline of 1,424 km and an EEZ of approximately 223,000 km^2 (United Republic of Tanzania 2003). The continental shelf is generally narrow, with the 200-m isobath occurring around 4 km offshore, except around the Mafia and Zanzibar channels, where it can extend for up to 80 km from the mainland coast (Machumu 2021). The Pemba Channel splits the mainland and Pemba Island and, at approximately 50 km in width, it drops off to an incredible 1,000 m depth. The Pemba Channel is unique in that it is characterized by a deep oceanic setting which connects directly to the open ocean, but is also bordered by shallower coastal areas characterized by coral reef and mangrove habitats (Sekadende et al. 2020). As such, this channel comprises an extensive range of habitats that support broad species diversity.

Much of Tanzania is characterized by highly productive fringing and barrier coral reefs, interspersed with estuaries and wetlands, such as the Rufiji Delta (Lundin 1992). Tanzanian waters are species rich, owing to its varied geography and scattered islands which result in a variety of habitats (Machumu 2021). Of great importance are the coral reefs, which are characteristic of both the mainland and outer islands and are home to a variety of fish species (Yahya 2021).

Tanzania was classified as a lower-middle income country in 2020, being one of just seven countries to have moved to a higher economic level since the previous year, having moved from the low-income category in 2019 (World Bank 2018). The population of Tanzania was approximately 59.7 million people[107] in 2020, of which 69% is rural (FAO 2016b). Although fishing is an important economic activity in Zanzibar and Pemba, only 0.9% of the mainland population are fishers (Republic of Tanzania 2014). Fisheries in Tanzania play an important subsistence role for coastal communities. Over 90% of the fisheries in Tanzania are artisanal, operating primarily in shallow coastal waters along reefs, using traditional fishing vessels such as sailboats, and outrigger and dugout canoes (Jiddawi and Öhman 2002, Yahya 2021). Fishing occurs throughout the year, with peak fishing 'seasons' associated with the two monsoon seasons (Barrowclift et al. 2017) and the highest catch rates occurring during the northeastern monsoon (Obura et al. 2002). Common fishing gears include basket traps, seine nets, gillnets and handlines (Yahya 2021).

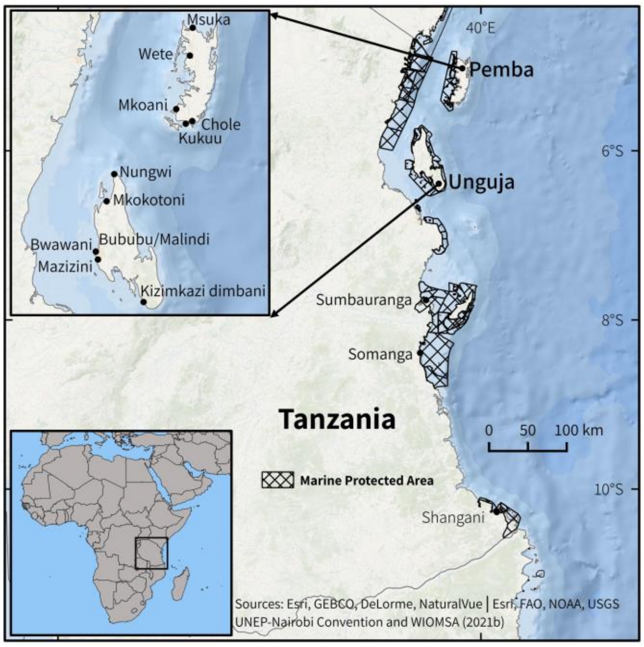


Figure 6.10.1. Map of the United Republic of Tanzania, showing its position in the Western Indian Ocean, mainland Tanzania and the Zanzibar Archipelago, and place names mentioned in text.

6.10.2 Chondrichthyan biodiversity and status of knowledge, Tanzania

Biodiversity

In Tanzania, 98 chondrichthyan species have been documented to date (Table 3.1), comprising 57 species of shark (representing 23 families), 40 batoid species (representing 12 families) and one chimaera species, and a further seven shark and five batoid species which are thought to occur in Tanzania, but have not been confirmed (Table 3.3). Tanzania therefore has the fourth highest chondrichthyan species richness in the WIO, after South Africa, Mozambique and Madagascar (Table 3.1).

[107] https://data.worldbank.org/indicator/

The most common shark family in Tanzania is Carcharhinidae (requiem sharks), comprising 19 species, with all other shark families comprising three or fewer species. Dasyatidae (whiptail stingrays) and Mobulidae (manta and devil rays) are the most common batoid families, representing 13 and seven species, respectively.

The Zanzibar guitarfish *Acroteriobatus zanzibarensis* is the only chondrichthyan species currently considered to be endemic to Tanzania, although taxonomic work is required to confirm its distribution range. The recently described Anna's sixgill shark *Pliotrema annae* is known only from Zanzibar to date, although descriptions of sawsharks from Kenya and Somalia suggest it could have a wider range (Weigmann et al. 2020). Furthermore, the Andaman legskate *Cruriraja andamanica*, which occurs in the Andaman Sea in the Eastern Indian Ocean, has also been recorded from a single specimen caught off Tanzania (McEachran and Fechhelm 1982); however, the presence of this species in Tanzania requires validation (Last et al. 2016c). An additional 12 chondrichthyan species which occur in Tanzania are endemic to the WIO (Table 3.3). Artisanal fishery catch surveys have resulted in new country records of at least 17 chondrichthyan species into Tanzania's waters (Temple et al. 2019; WCS unpublished data), but these require further confirmation. In addition, of the 26 chondrichthyan species described from the WIO since 2011 (see Table 3.3, Chapter 3) seven have distributions which occur in Tanzania, including the narrowhead catshark *Bythaelurus tenuicephalus*, Human's whaler shark *Carcharhinus humani*, Baraka's whipray *Maculabatis ambigua*, bluespotted maskray *Neotrygon caeruleopunctata*, *Pliotrema annae*, African dwarf sawshark *Pristiophorus nancyae* and Austin's guitarfish *Rhinobatos austini*. Due to the limited taxonomic work that has been conducted on chondrichthyans in Tanzania, it is highly likely that there are other chondrichthyan species present in Tanzania that have not yet been recorded.

Status of biological and ecological knowledge

Chondrichthyans in Tanzania have been poorly studied in comparison to other countries in East Africa, with published research on chondrichthyans in Tanzania being very limited and focusing primarily on shark fisheries and trade (see Barnett 1997, Shehe and Jiddawi 1997, Cliff et al. 2000, Ngusaru 2000, Jiddawi and Öhman 2002, Schaeffer 2004, Kiszka 2012, Barrowclift et al. 2017, Temple et al. 2019). Information regarding chondrichthyan species present in Tanzania is questionable due to the limited research in this country. One of the first field guides for marine species in Tanzania was published in the early 1980s (Bianchi 1985), and listed at least 26 shark and 18 batoid species as occurring in Tanzania, substantially fewer than the 57 shark and 40 batoid species that are now confirmed (Table 3.1). However, it is likely that there are more chondrichthyan species present in Tanzania than are currently confirmed.

No population assessments or stock assessments have been conducted on chondrichthyans in Tanzania, with much of the focused chondrichthyan research to date having been conducted on large charismatic species, particularly the Endangered whale shark *Rhincodon typus,* which is known to aggregate seasonally off Zanzibar (Rowat 2007), and which has a well-documented aggregation off Mafia Island in central Tanzania (Potenski 2007, Cagua et al. 2015, Rohner et al. 2015, 2020).

Other studies on chondrichthyans in Tanzania include the use of Local Ecological Knowledge to assess the status of sawfishes (family Pristidae) in Tanzania, which documented their large-scale decline in the country (Braulik et al. 2020). This study also found no verification of green sawfish *Pristis zijsron* presently or historically ever occurring in Tanzania, and suggested that Tanzania be removed as a Range State for this species. In a separate global study, baited remote underwater video (BRUV) was used to survey two different reefs in Tanzania, the findings of which suggest that Tanzania had among the lowest abundances of reef sharks anywhere in the world (MacNeil et al. 2020). BRUVs were also used to survey reefs off southern mainland Tanzania and off Zanzibar, and found that batoid species richness was higher than that of sharks, with generally low densities of sharks in both areas (WCS, unpublished data). Chondrichthyans have also been documented inadvertently off the Tanzanian coast. For example, the scalloped hammerhead shark *Sphyrna lewini* was observed opportunistically during a hydrocarbon exploration survey in the Ruvuma basin using a remotely operated vehicle at 1,042 m depth, resulting in the deepest known record for this species (Moore and Gates 2020).

There have also been global studies investigating the population structure of bull sharks *Carcharhinus leucas* (Pirog et al. 2019c) and tiger sharks *Galeocerdo cuvier* (Pirog et al. 2019a), both of which used genetic samples from specimens occurring in Zanzibar. These studies demonstrated high levels of connectivity in the population structure of *C. leucas* in the WIO (Pirog et al. 2019c), and of *G. cuvier* throughout the Indian ocean (Pirog et al. 2019a).

There is very little information available regarding areas of importance for chondrichthyan reproduction in Tanzania, with the only information being reported for the largetooth sawfish *Pristis pristis.* Regular sightings of small *P. pristis* have been documented from the Rufiji Delta on mainland Tanzania, suggesting that this area could be a possible nursery area for this species, however this requires further confirmation (Braulik et al. 2020).

Knowledge gaps and research priorities

Chondrichthyan research in Tanzania is limited, resulting in many knowledge gaps for the majority of chondrichthyan species in Tanzania's EEZ; as such, greater focus should be placed on research relating to chondrichthyans, particularly for threatened species. All of the data gaps identified for these species should thus be prioritized for future research (as outlined in Table 3.7). Of the 42 data-poor[108], threatened chondrichthyan species identified in Chapter 3, 22 (17 batoid and 5 shark) are present in Tanzania, including six batoid and four shark families.

There are seven data-poor, threatened species in the family Dasyatidae that occur in Tanzania, comprising the Endangered honeycomb stingray *Himantura uarnak*, and Vulnerable leopard whipray *H. leoparda*, broad cowtail ray *Pastinachus ater*, pink whipray *Pateobatis fai*, Jenkins whipray *P. jenkinsii*, blotched stingray *Taeniurops meyeni* and porcupine ray *Urogymnus asperrimus*. Research priorities for this family and these species primarily relate to the majority of movement and reproduction categories, and the specific age and growth categories of age at maturity and maximum age for all species, size at birth for *U. asperrimus*, female size at maturity for all species other than *U. asperrimus,* and male size at maturity for *P. ater*, as outlined in Table 3.7.

In the family Mobulidae, there are three data-poor, threatened species which occur in Tanzania, the longhorned pygmy devil ray *Mobula eregoodoo*, shortfin devil ray *M. kuhlii* and sicklefin devil ray *M. tarapacana*, all of which are Endangered. Other than gestation period and migratory status, which are known for all three species, and gestation period which is known for *M. eregoodoo* and *M. kuhlii,* aspects of these species' movement and reproduction are poorly known, in addition to age at maturity and maximum age for all three species (Table 3.7).

There are also three data-poor, threatened species in the family Myliobatidae in Tanzania, the Critically Endangered duckbill ray *Aetomylaeus bovinus* and common eagle ray *Myliobatis aquila*, and the Endangered ornate eagle ray *Aetomylaeus vespertilio.* Although migratory status and litter size are known for all three species, and gestation period is known for *A. bovinus* and *M. aquila*, information relating to all other aspects of movement and reproduction remain poorly known for these three species. In addition, maximum age is unknown for all three species, age at maturity is unknown for *A. vespertilio* and *M. aquila*, and female size at maturity and size at birth are unknown for *A. vespertilio* (Table 3.7).

There are two data-poor, Critically Endangered species belonging to the family Rhinidae in Tanzania (the bowmouth guitarfish *Rhina ancylostomus* and bottlenose wedgefish *Rhynchobatus australiae*). Other than litter size, all other aspects relating to movement and reproduction for these species should be prioritized in Tanzania, in addition to age at maturity and maximum age (Table 3.7).

The families Rhinobatidae and Rhinopteridae are each characterized by one data-poor threatened species in Tanzania, the greyspot guitarfish *Acroteriobatus*

[108] The term data-poor is used in this context to distinguish a species for which there is information available in less than 50% of the information categories assessed in this study, and is applied here only to IUCN threatened species; the term should not be confused with Data Deficient, as defined by the IUCN. The 17 information categories include: Age and growth: Size at birth, Male and female size at maturity, Age at maturity, Maximum length, Maximum age, Generation length; Movement/area use: Migratory status, Population connectivity, Aggregation sites, Breeding localities, Parturition localities, Nursery localities; Reproduction: Reproductive periodicity, Gestation period, Litter size/number of eggs, Breeding season, Parturition season.

leucospilus and shorttail cownose ray *Rhinoptera jayakari*, respectively. Litter size in known for both species, and migratory status is known for *A. leucospilus*, however other aspects of movement and reproduction remain poorly known for both. Age at maturity and maximum age are also unknown for both species, and female size at maturity and size at birth are unknown for *R. jayakari* (Table 3.7).

While *Pristis pristis* is not classified as data-poor (Figure 3.6; Table 3.7), it is classified as Critically Endangered. The most recent records of this species in Tanzania are from 2014 and, considering the potential nursery area in the Rufiji Delta which requires further confirmation (Braulik et al. 2020), identification of areas still used by this species remains a priority.

There are numerous taxonomic uncertainties in terms of species present and their associated distributions in Tanzania, therefore further taxonomic research is required, particularly among the batoids. Species of the *Himantura* and *Rhynchobatus* genera*,* and the so called "brown rays" (several genera within the family Dasyatidae) are common in Tanzania, and require taxonomic clarifications, as outlined in Chapter 3.

Two data-poor threatened shark species representing the family Centrophoridae occur in Tanzania, comprising the smallfin gulper shark *Centrophorus moluccensis* and little gulper shark *C. uyato*, and one species (the kitefin shark *Dalatias licha*) represents the family Dalatiidae. Litter size is known for all three species, and reproductive periodicity is known for both *Centrophorus* species; however, all other aspects of movement and reproduction remain poorly known for these three species and should be prioritized for future research, in addition to age at maturity and maximum age for all three species (Table 3.7).

The remaining two data-poor, threatened shark species in Tanzania comprise the sicklefin weasel shark *Hemigaleus microstoma* (family Hemigaleidae) and tawny nurse shark *Nebrius ferrugineus* (family Ginglymostomatidae), both of which are classified as Vulnerable. Breeding season and migratory status are known for *N. ferrugineus* and litter size is known for *H. microstoma*; however, other aspects relating to movement and reproduction remain poorly known for these two species, in addition to age at maturity and maximum age (Table 3.7).

Although not data-poor, there are five shark species which are Critically Endangered and occur in Tanzania, the oceanic whitetip shark *Carcharhinus longimanus*, ragged tooth shark *Carcharias taurus,* shorttail nurse shark *Pseudoginglymostoma brevicaudatum*, *Sphyrna lewini* and great hammerhead shark *S. mokarran*. There is limited information regarding areas of importance for reproduction for these species, or even whether there are such critical habitats for these species, in Tanzania. However, artisanal fishery catches from Tanzania and the islands of Unguja and Pemba include juvenile *C. longimanus* and pregnant *S. lewini*, suggesting the presence of nearby nursery and parturition areas, however these areas have not been confirmed or located (WCS, unpublished data), and require further investigation. In addition, as the only Critically Endangered (and therefore most threatened) shark species endemic to the WIO, *P. brevicaudatum* is a key research and conservation priority, in Tanzania and other countries in its range, particularly as this species has also been documented in artisanal fisher catches in Tanzania (WCS, unpublished data).

There are also 14 Data Deficient (as defined by the IUCN) chondrichthyan species in Tanzania, comprising nine batoid and five shark species (Table 3.3, Chapter 3). At least nine of these are considered deepwater species comprising the roughskin spurdog *Cirrhigaleus asper*, *Cruriraja andamanica*, travancore skate *Dipturus johannisdavisi*, prownose skate *D. stenorhynchus*, whitespotted bullhead shark *Heterodontus ramalheira*, grinning spotted izak *Holohalaelurus grennian*, Mozambique electric ray *Narcine rierai*, *Rhinobatos austini* and slender guitarfish *R. holcorhynchus*, and are therefore infrequently encountered, limiting available information. The remaining five species, *Carcharhinus humani*, smalleye stingray *Megatrygon microps, Pliotrema annae*, blackspot electric ray *Torpedo fuscomaculata* and the marbled electric ray *T. sinuspersici* have coastal distributions and are thus exposed to coastal fisheries. In addition, of these 14 Data Deficient species, six are either endemic to Tanzania or the WIO region (Table 3.3, Chapter 3), including *P. annae*, *R. austini*, *R. holcorhynchus, H. grennian*, *D. stenorhynchus* and *N. rierai*. As such, research should also be prioritized for these Data Deficient species.

6.10.3 Chondrichthyan fisheries, catch and trade

Fisheries

Most of Tanzania's fisheries are artisanal (Bultel et al. 2015, Barrowclift et al. 2017, Mbukwa et al. 2019, Sekadende et al. 2020). These fishers have targeted chondrichthyans for centuries, especially in Zanzibar during the austral summer (Barnett 1997, Kiszka and van der Elst 2015). Two decades ago, these fisheries were reported to be unsustainable due to a lack of regulation (Shehe and Jiddawi 1997). Sharks are important resources for Tanzania; shark oil is used in traditional boat maintenance, the meat is a staple cheap food, and they provide a major source of income from the sale of meat and fins (Barnett 1997, Schaeffer 2004). The most recent WIOFish report indicated that no chondrichthyans were reported to be retained as incidental catch in any of Tanzania's fisheries (Everett et al. 2017). This seems unlikely, as any incidental catch would almost certainly be used (Braulik 2015). Catch reconstructions in Tanzania's marine fisheries from 1950–2010 were 77% higher than reported to the FAO, with discards representing an estimated 2% and chondrichthyans comprising an estimated 7% of total catch (Bultel et al. 2015).

Artisanal fisheries

Tanzania's artisanal fishers use traditional vessels ranging from non-motorised dugout canoes of 3 m in length, to boats of 11 m with inboard engines (Mngulwi 2006). They operate inshore, mostly in reef areas, using manually handled drift nets and anchored gillnets, ring nets, handlines and bottom-set long lines (Mbukwa et al. 2019). Around 9,242 vessels and 53,035 artisanal fishers were identified in the most recent nationwide frame survey (MLFD 2018). Chondrichthyans are targeted using bottom-set gillnets, known locally as 'jarife', of up to 450 m, with mesh sizes ranging from 20–40 cm (Jiddawi and Öhman 2002), longlines, and handlines (Everett et al. 2017). Chondrichthyans are also caught incidentally with drift and bottom-set gillnets, especially off Zanzibar (Marshall and Barnett 1997, Schaeffer 2004, Barrowclift et al. 2017, Temple et al. 2019). In 2018, the artisanal tuna fishery reported 3,087 t of shark to the IOTC, compared with 5,007 t of tuna and 2,593 t of billfish (Mbukwa et al. 2019).

In the 1990s, interviews were used to assess the status of shark fisheries in Zanzibar, indicating that 26 species were being caught (Shehe and Jiddawi 1997). Surveys carried out in Zanzibar in 2004 identified 16 shark species landed by local fishers, with grey reef sharks *Carcharhinus amblyrhynchos,* hardnose sharks *C. macloti*, dusky sharks *C. obscurus,* milk sharks *Rhizoprionodon acutus* and African angelsharks *Squatina africana* commonly caught (Schaeffer 2004). Artisanal catch surveys from 2019 to 2021 across mainland Tanzania and Pemba and Unguja islands revealed at least 61 chondrichthyan species being caught, representing 62% of confirmed chondrichthyan species in Tanzania (WCS, unpublished data). In Zanzibar, 58 species were caught, with more than double and nearly four times more species than reported by Shehe and Jiddawi (1997) and Schaeffer (2004), respectively (Table 6.10.1). Furthermore, although *S. africana* was the dominant species in artisanal catch in Zanzibar in the 1990s (Shehe and Jiddawi 1997), not a single record of this species has been recorded in artisanal fisher catch from 2019 to 2021 (WCS, unpublished data).

In mainland Tanzania and Unguja island, the most common species caught were *Maculabatis ambigua*, and *Himantura uarnak*, with the most common shark species caught being *Sphyrna lewini*. In Pemba Island, *Neotrygon caeruleopunctata* and *Carcharhinus falciformis* were the most commonly caught species of chondrichthyan.

At mainland Tanzania catch sites, 44% of the individuals caught were classified as threatened, compared to 47% at Unguja and 53% at Pemba sites. There are also many CMS and CITES-listed species, as well as IOTC-prohibited species, recorded in the artisanal catches across Tanzania (Table 6.10.1). These findings demonstrate the importance of species-level, long-term catch monitoring. The high levels of threatened and MEA-listed species indicate that improved conservation and management measures are needed for chondrichthyans in Tanzania.

Table 6.10.1: Chondrichthyan species caught by artisanal fishers at various sites in mainland Tanzania (Mainland), Pemba Island (Pemba) and Unguja Island (Unguja; WCS, unpublished data). Species listings on Appendix I and/or II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) or the Convention on the Conservation of Migratory Species of Wild Animals (CMS), or prohibited from capture by a Resolution of the Indian Ocean Tuna Commission (IOTC) are given. IUCN refers to the conservation status of each species as assessed by the IUCN Red List of Threatened Species (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient).

Family	Species name	Common name	Mainland	Pemba	Unguja	CMS	IOTC	CITES	IUCN
Batoids									
Aetobatidae	*Aetobatus ocellatus*	Indian eagle ray	x	x	x				VU
Dasyatidae	*Bathytoshia lata*	Brown stingray	x		x				VU
	Himantura leoparda	Leopard whipray	x	x	x				VU
	Himantura uarnak	Honeycomb stingray	x	x	x				EN
	Maculabatis ambigua	Baraka's whipray	x	x	x				NT
	Megatrygon microps	Smalleye stingray			x				DD
	Neotrygon caeruleopunctata	Bluespotted maskray	x	x	x				LC
	Pastinachus ater	Broad cowtail ray	x	x	x				VU
	Pateobatis fai	Pink whipray	x	x	x				VU
	Pateobatis jenkinsii	Jenkins whipray	x	x	x				VU
	Taeniura lymma	Bluespotted ribbon-tailed stingray	x		x				LC
	Taeniurops meyeni	Blotched stingray	x	x	x				VU
	Urogymnus asperrimus	Porcupine ray	x	x	x				VU
Mobulidae	*Mobula eregoodoo*	Longhorned pygmy devil ray		x		I, II	x	II	EN
	Mobula kuhlii	Shortfin devil ray	x	x	x	I, II	x	II	EN
	Mobula mobular	Spinetail devil ray	x	x	x	I, II	x	II	EN
	Mobula tarapacana	Sicklefin devil ray		x	x	I, II	x	II	EN
	Mobula thurstoni	Bentfin devil ray	x	x		I, II	x	II	EN
Myliobatidae	*Aetomylaeus vespertilio*	Ornate eagle ray	x		x				EN
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish	x	x	x			II	CR
	Rhynchobatus australiae	Bottlenose wedgefish	x	x	x	II		II	CR
Rhinobatidae	*Acroteriobatus zanzibarensis*	Zanzibar guitarfish	x		x				NT
	Rhinobatos austini	Austin's guitarfish			x				DD
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray	x	x	x				EN
Torpedinidae	*Torpedo fuscomaculata*	Blackspotted electric ray		x					DD
Sharks									
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	x	x	x	II	x	II	EN
	Alopias superciliosus	Bigeye thresher shark	x	x		II	x	II	VU
Carcharhinidae	*Carcharhinus albimarginatus*	Silvertip shark		x	x				VU
	Carcharhinus altimus	Bignose shark		x					NT
	Carcharhinus amblyrhynchos	Grey reef shark	x		x				EN
	Carcharhinus brevipinna	Spinner shark		x					VU
	Carcharhinus falciformis	Silky shark	x	x	x	II		II	VU
	Carcharhinus humani	Human's whaler shark	x		x				DD
	Carcharhinus leucas	Bull shark	x	x	x				VU
	Carcharhinus longimanus	Oceanic whitetip shark		x	x	I	x	II	CR
	Carcharhinus melanopterus	Blacktip reef shark	x						VU
	Carcharhinus obscurus	Dusky shark	x	x					EN
	Carcharhinus sorrah	Spottail shark	x	x	x				NT
	Loxodon macrorhinus	Sliteye shark	x	x	x				NT
	Prionace glauca	Blue shark		x		II			NT
	Rhizoprionodon acutus	Milk shark			x				VU
	Triaenodon obesus	Whitetip reef shark	x	x	x				VU
Centrophoridae	*Centrophorus* spp.	Unknown gulper shark		x					
	Centrophorus moluccensis	Smallfin gulper shark			x				VU
Galeocerdidae	*Galeocerdo cuvier*	Tiger shark	x	x	x				NT
Ginglymostomatidae	*Pseudoginglymostoma brevicaudatum*	Shorttail nurse shark	x	x					CR
Hemigaleidae	*Hemipristis elongata*	Snaggletooth shark	x	x	x				VU
Hexanchidae	*Heptranchias perlo*	Sharpnose sevengill shark		x					NT
	Hexanchus griseus	Bluntnose sixgill shark		x					NT
	Hexanchus nakamurai	Bigeyed sixgill shark	x						NT

Table 6.10.1 continued

Family	Species name	Common name	Mainland	Pemba	Unguja	CMS	IOTC	CITES	IUCN
	Hexanchus nakamurai	Bigeyed sixgill shark	x						NT
Lamnidae	*Carcharodon carcharias*	Great white shark	x			I, II		II	VU
	Isurus oxyrinchus	Shortfin mako shark	x	x	x	II		II	EN
	Isurus paucus	Longfin mako shark		x		II		II	EN
Odontaspididae	*Odontaspis ferox*	Smalltooth sand tiger shark		x					VU
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	x	x	x	II		II	CR
	Sphyrna mokarran	Great hammerhead shark		x		II		II	CR
	Sphyrna zygaena	Smooth hammerhead shark	x	x	x	II		II	VU
Squalidae	*Cirrhigaleus asper*	Roughskin spurdog		x					DD
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark	x		x				EN
Triakidae	*Hypogaleus hyugaensis*	Blacktip topeshark		x					LC
	Mustelus manazo	Starspotted smoothhound		x					EN
	Mustelus mosis	Arabian smoothhound		x	x				NT

Industrial fisheries

There was a small industrial inshore shrimp fishery in Tanzania, which caught sharks incidentally (Kiszka and van der Elst 2015). Industrial shrimp catches peaked in 1998 (Bultel et al. 2015), but in 2008 – at which time 25 vessels were licensed – the fishery was closed due to declining shrimp stocks (Kiszka and van der Elst 2015). Shrimp fishing was subsequently permitted only by artisanal vessels, but the industrial fishery was expected to resume operations at some point, with the use of bycatch reduction devices intended to reduce the high levels of turtle bycatch in this fishery (Kiszka and van der Elst 2015).

The majority of industrial fishing in Tanzania is conducted by Distant Water Fishing Nations, which use large-scale longline and purse seine vessels to target tuna, although chondrichthyan species are caught as bycatch (Davies et al. 2014, Mbukwa et al. 2019). All incidental catch should be landed in Tanzania (pers. comm., Hakim Davis Matola, TAFIRI, April 2017), but there is no monitoring or policing and so it is unlikely that much, if any, is landed in the country (pers. comm., Tim Davenport, WCS, May 2017). There are no active fisheries agreements between Tanzania and any other government and there are no agreements with the EU (European Commission 2020), but licenses are issued to foreign vessels. As many as 50 licences were issued to foreign purse-seine and longline vessels in 2010 (Breuil and Grima 2014c). The extent of foreign longline vessel activity in deep offshore waters cannot be accurately determined, and fleets are known to have been fishing illegally (AU-IBAR 2016, MLFD 2018).

Fisheries monitoring and reporting

WIOFish reported that most Tanzanian fisheries are monitored for catch and effort using catch returns, creel surveys, voluntary monitoring, interviews, observers or frame surveys; and that most have some biological monitoring (species compositions, lengths and weights, size composition, reproductive states and otolith collection) (Everett et al. 2017). The collection of fisheries statistics in Tanzania began in the 1960s, recording the catch of every vessel in several villages and extrapolating monthly catches using a frame survey of vessels and gear to obtain annual estimates (Nhwani 1981). Despite improvements in data collection (Nhwani 1984), data remained underreported and/or unreported, and until the year 2000, data from Zanzibar were omitted due to separate systems of reporting (Jacquet and Zeller 2007b). As a result, the reconstructed total marine catch in Tanzania from 1950 to 2010 was estimated to be 77% higher than that reported to the FAO (Jacquet et al. 2010b, Bultel et al. 2015).

Under the Fisheries Regulations Act of 2009 (Republic of Tanzania 2009a), artisanal fishery catch data should be collected daily by a fisheries beach recorder or Beach Management Unit enumerator, and fish landing stations should be regularly inspected. Before 2015, sharks and batoids in the national catch assessment survey (CAS) were grouped as "sharks and rays" (not even to family level as for teleosts). However, there has been some improvement since 2017, whereby some common species of shark and batoid are now recorded to species level after a collaborative project was initiated through WCS, Tanzania Fisheries

Research Institute (TAFIRI) and CORDIO-East Africa, through an Indian Ocean Commission grant. However, Swahili common names of sharks are often used and there is uncertainty due to the fact that several species of the same genus are reported as one species.

Reported chondrichthyan catches

Of all Nairobi Convention Member States, Tanzania landed the second largest catch of chondrichthyans for all oceans, and the largest catch for FAO Major Fishing Area 51 from 2012 to 2019, accounting for 23.8% of the total Nairobi Convention Member State catch, and 45.5% of their catch in FAO Major Fishing Area 51 (FAO 2021). During this period, Tanzania mainland landed an annual average of 9,289.4 t of chondrichthyans, whereas Zanzibar landed an annual average catch of 1,714.9 t exclusively from FAO Major Fishing Area 51 (Figure 6.10.2).

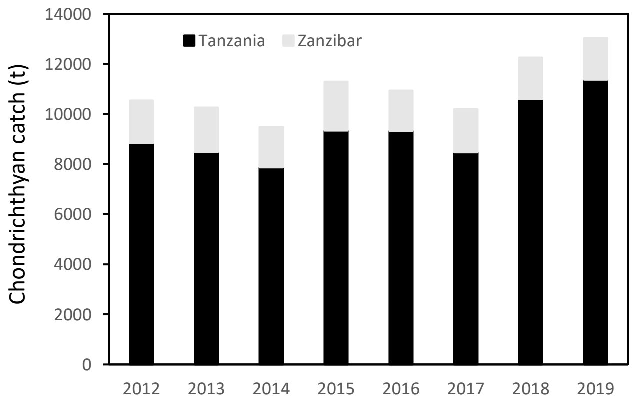


Figure 6.10.2: Total chondrichthyan catch in FAO Major Fishing Area 51 by mainland Tanzania and Zanzibar, 2012–2019 (FAO 2021).

Chondrichthyan catches were predominantly reported to the FAO in two main groups: 'Sharks, rays, skates, etc. nei' and 'Rays, stingrays, mantas nei'. Due to IOTC reporting requirements, four species of shark were recorded at species level on the mainland: *Carcharhinus falciformis*, *C. longimanus*, *Isurus oxyrinchus* and *Prionace glauca* (Figure 6.10.3). In addition to the limited species-level reporting, these data are likely to be underreported. No data are currently being collected on utilized or discarded incidental chondrichthyan catch (Everett et al. 2017).

[109] The term "sharks" refers to all species of sharks, skates, rays and ghost sharks (cartilaginous fishes, Class Chondrichthyes).

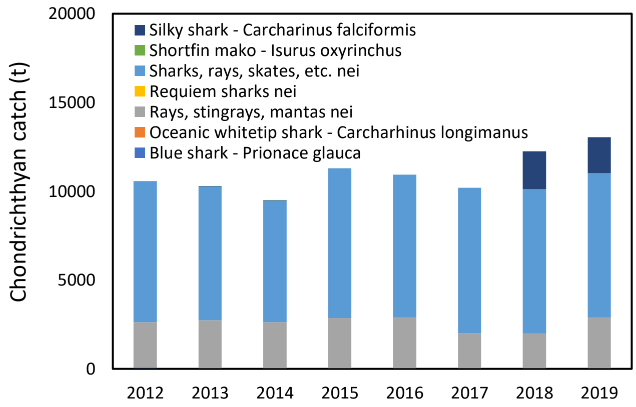


Figure 6.10.3: Chondrichthyan catches for the United Republic of Tanzania (i.e., including Zanzibar), disaggregated by species and category from FAO Major Fishing Area 51 (2012–2019; FAO 2021).

Trade in chondrichthyan products

Authorities in Tanzania and Zanzibar collect data on trade in sharks[109] and batoids at a national level, but the market chain is not well known (Jiddawi 2015). Fins are often transhipped from Tanzania mainland to Zanzibar for export (pers. comm., Narriman Saleh Jiddawi, UDSM, April 2017), although the shark fin trade in Zanzibar has reportedly declined in recent decades, with some species becoming rare (Jiddawi and Öhman 2002). There is also illegal trade across the borders with Kenya and Mozambique, in which chondrichthyan products are often transported hidden amongst other fish products (pers. comm., Hakim Davis Matola, TAFIRI, April 2017; pers. comm., Tim Davenport, WCS, May 2017).

Notable target species for the shark fin trade in Tanzania include wedgefishes *Rhynchobatus* spp. and *Acroteriobatus zanzibarensis*, which have historically been targeted for their particularly valuable 'white' fins (Compagno et al. 2005). Imports of chondrichthyan products by Tanzania are not regulated, and no data are available, but illegal imports of chondrichthyan products are not known to occur (Jiddawi 2015). There are three records of countries exporting chondrichthyan products to Tanzania: in 2013, South Africa reported an export of 40 kg of shark fin to Tanzania; in 2015, Yemen reported an export of 26,130 kg of shark fin to Tanzania; and, in 2018, South Africa reported an export of 203 kg of fresh shark meat to Tanzania (UN Comtrade 2021).

Official chondrichthyan trade data

From 2012 to 2019, Tanzania reported shark exports in 2013 and 2014 only, when 44 kg of fresh rays and skates (HS code 030282) were exported to Singapore, and 75 kg of shark fins (HS code 030571) were exported to Hong Kong, respectively (Table 6.10.2). However, other countries reported imports of chondrichthyan products from Tanzania over this period, and there are clear discrepancies between these reported imports and Tanzania's reported exports (Table 6.10.2). UN Comtrade records of World shark fin and meat (fresh and frozen) from Tanzania indicate that 1) shark fins were imported from Tanzania by Hong Kong SAR (annual average 418 kg, 2012–2018), Denmark (10 kg in 2018) and Singapore (1.1 t in 2012); and 2) that France imported 610 kg of fresh shark meat in 2015, Singapore imported 370 kg of frozen shark meat in 2013, and Taiwan imported 15,913 kg of frozen shark meat in 2016.

Table 6.10.2: Catch and export of chondrichthyan products (metric tonnes) from the United Republic of Tanzania (including Zanzibar) as reported by Tanzania and by importing countries.

Year	Total Catch (t) [a]	Exports from Tanzania, all codes (t) [b]	Imports from Tanzania - as reported by the world, all codes (t) [b]	Shark fin imports by Hong Kong from Tanzania (t) [c]
2012	10,549	0	1.090	1.080
2013	10,266	0.044	1.232	0.862
2014	9,483	0.075	0.825	0.825
2015	11,300	0	1.320	0.710
2016	10,946	0	16.938	0.985
2017	10,196	0	0.115	0.115
2018	12,256	0	0.138	0.128
2019	13,038	0	0*	0*
Total	88,034	0.119	21.658	4.705
Average	11,004	0.015	3.094	0.588

[a] FishStatJ (FAO 2021)
[b] UN Comtrade (2021)
[c] Hong Kong Bureau of Statistics (2021)
* Data not yet reported to UN Comtrade by Tanzania

Furthermore, according to the Hong Kong Bureau of Statistics (2021), from 2012 to 2019 Hong Kong imported on average 588 kg of shark fins per year from Tanzania (Table 6.10.2; Figure 6.10.4); however, chondrichthyan exports from Tanzania during that same period averaged just 15 kg per year, with no reports of exports in 2012 or 2015–2019 (Table 6.10.2). This makes it challenging to quantify the shark fin trade in Tanzania, as there are major discrepancies between export volumes reported by Tanzania and imports reported by other countries (Table 6.10.2). There is also evidence to suggest that volumes stated by shark traders historically were double those reported (Barnett 1997).

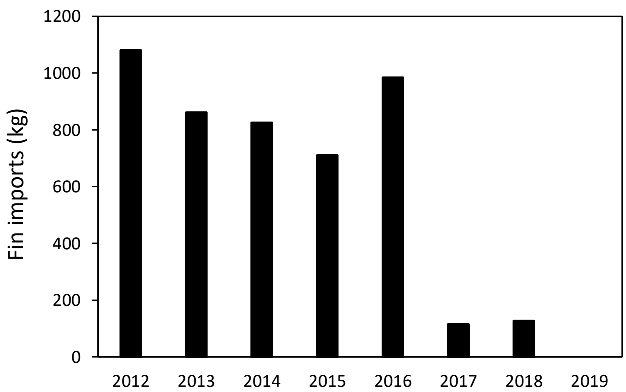


Figure 6.10.4: Hong Kong SAR imports of shark fins (kilograms) from Tanzania from 2012–2019 (Hong Kong Census and Statistics Department 2021). Note: Data for 2019 had not yet been reported to UN Comtrade by Tanzania; and Hong Kong Bureau of Statistics data for that year were not available at the time of writing.

Trade in CITES-listed chondrichthyan species

According to the CITES Trade Database[110], there are no official records of any CITES-listed chondrichthyan species being exported from Tanzania.

6.10.4 Conservation status

Chondrichthyan populations in Tanzania have shown signs of overexploitation since the 1990s, with declines in catch already being reported more than two decades ago (Shehe and Jiddawi 1997). Furthermore, fishers in Zanzibar have attributed the perceived declines in their shark catches primarily to overfishing (Schaeffer 2004, Barrowclift et al. 2017). There is therefore strong evidence indicating that legal and illegal fisheries, as well as the shark fin trade, are negatively impacting chondrichthyan species in Tanzania which, along with their life-history styles, has had a negative impact on the populations of numerous chondrichthyan species in Tanzania.

As a consequence of these high levels of legal and illegal fishing pressure, 55 (56%) of the 98 confirmed chondrichthyan species in Tanzania are currently considered threatened with extinction (IUCN 2021). These include 25 Vulnerable, 20 Endangered, and 10 Critically Endangered species, according to the IUCN Red List of Threatened Species (IUCN 2021; Table 3.4). Only two of the 14 chondrichthyan species which occur in Tanzania and are endemic to the WIO are threatened; these include the Endangered *Acroteriobatus leucospilus* and the Critically Endangered *Pseudoginglymostoma brevicaudatum*. The only species currently believed to be endemic to Tanzania, *Acroteriobatus zanzibarensis* is listed as Near Threatened, while the other species possibly endemic to Tanzania, *Pliotrema annae*, is classified as Data Deficient.

The formally abundant *Pristis pristis* has suffered major population declines and is now considered Critically Endangered. A countrywide baseline assessment revealed no catch or observation records of this species since 2014 (Braulik et al. 2020), therefore further research is necessary to determine whether this species persists in Tanzania, or whether it is now locally extinct, as it is in South Africa (Everett et al. 2015).

6.10.5 Governance framework

Chondrichthyan management and policy at national level

Institutional governance framework

Zanzibar and mainland Tanzania have autonomous institutional and legal structures for fisheries management. Fisheries in the territorial waters of mainland Tanzania are managed through the Fisheries Development Division of the Ministry of Livestock and Fisheries (MLFD), and fisheries in the territorial waters of Zanzibar are managed through the Ministry of Agriculture, Livestock, Natural Resources and Fisheries (MALNF; Table 6.10.3).

The Tanzania Fisheries Research Institute (TAFIRI) was established in 1980 to promote, conduct, and co-ordinate fisheries research in Tanzania, and continues under the Act of 2016 (Republic of Tanzania 2016). The Tanzania Deep Sea Fishing Authority (DSFA) is empowered to negotiate fisheries access agreements on behalf of the Tanzanian government and sets the regulations for these.

In mainland Tanzania, some oversight and planning has been decentralized to the community level through Beach Management Units (BMUs) and Collaborative Fisheries Management Areas (CFMAs), which empower local fishers to monitor and control fisheries resources, giving them the rights to restrict certain gears and control access through licencing (Fisheries Development Division 2009). Rocliffe et al. (2014) recorded six CFMAs and 179 coastal BMUs, of which 68 had management plans and 39 had legal recognition through by-laws. In Zanzibar, Village Fisheries Committees (VFCs), which also share management responsibilities with the government, were formed in all coastal fishing villages when decentralization began in 1994 (Levine 2007, Cinner et al. 2012). Both mainland Tanzania's BMUs and Zanzibar's VFCs lack capacity in most crucial areas including conflict resolution, financial management, governance structures, transparency, project planning and marine ecology (Anderson 2012; pers. comm., Tim Davenport, WCS, May 2017).

The MLFD and DSFA are responsible for export and import trade controls in Tanzania, including permitting, while enforcement relating to trade is the

[110] https://trade.cites.org

responsibility of the Ministry of Trade, Industry and Marketing and the MLFD (Table 6.10.3). A permit is required for the transport of shark fins, and shark fin exporters require a licence, although Compagno et al. (2005) reported that the exporting procedure was rarely adhered to and that loopholes in the system were easily exploited. The CITES Management Authorities for Tanzania are the Wildlife Division of the Ministry of Natural Resources and Tourism (for issuance of CITES permits and certificates only) and the Tanzania Wildlife Management Authority (TAWA), while the CITES Scientific Authority is the Tanzania Wildlife Research Institute (TAWIRI) (CITES 2021). Enforcement relating to CITES trade controls is also the responsibility of the Ministry of Natural Resources and Tourism.

Species conservation and environmental protection are the joint responsibility of the MLFD and the Department of Environment (DoE) in Tanzania (Table 6.10.3). The Marine Parks and Reserves Unit is responsible for MPA management and enforcement in mainland Tanzania. These portfolios fall under MALNF in Zanzibar. In mainland Tanzania, coastal zone management is the responsibility of MLFD and DoE, and falls under the DoE in Zanzibar (Table 6.10.3).

Table 6.10.3: Designated competent authorities responsible for chondrichthyan management in Tanzania.

Area of management	Designated authority Tanzania	Designated authority Zanzibar
Fisheries management and research	Fisheries Development Division of the Ministry of Livestock and Fisheries (MLFD), Deep Sea Fishing Authority (DSFA), Tanzania Fisheries Research Institute (TAFIRI)	The Department of Fisheries Development and Marine Resources (DFMR), within the Ministry of Agriculture, Livestock, Natural Resources and Fisheries (MALNF)
Export and import trade controls (including permitting)	MLFD, DSFA, Ministry of Natural Resources and Tourism (national CITES management authority)	MALNF
Permitting of fisheries	MLFD, DSFA	MALNF
Enforcement of fisheries legislation	MLFD, DSFA	MALNF, DSFA
Enforcement relating to trade (including enforcement of CITES- and IOTC-related provisions)	Ministry of Trade, Industry and Marketing; MLFD; Ministry of Natural Resources and Tourism	MALNF
Species conservation and environmental protection	MLFD, Department of Environment (DoE)	DoE
Coastal zone management	MLFD, DoE	DoE
MPA management and enforcement	Marine Parks and Reserves Unit (MPRU)	MALNF

The MLFD's Directorate for Fisheries Resource Protection (mainland Tanzania) and MALNF (Zanzibar) are responsible for MCS, but capacities are low and there are no means to carry out at-sea inspections (Davies et al. 2014, AU-IBAR 2016). The DSFA is responsible for MCS activities in the pelagic fishery, and relies on its VMS to monitor authorized vessels, but has limited capacity to locate illegal fishing vessels in its EEZ (Davies et al. 2014). The Fisheries Development Division concentrates on small-scale fisheries, distributing patrol boats in most of the coastal districts. The reduction of IUU fishing has historically been limited by poor internal coordination and cooperation between the Ministry in mainland Tanzania, the Ministry in Zanzibar, and the DSFA (Davies et al. 2014). However, since 2012 there has been a technical committee and a steering committee with members from both Zanzibar and Tanzania mainland responsible for the running of the DSFA (pers. comm., Narriman Saleh Jiddawi, UDSM, April 2017). The threat of piracy from the north has limited data collection and vessel inspections (Anderson 2012), and until 2017 there was no observer scheme coverage of the industrial or small-scale fleets (IOTC Secretariat 2015d). Some observer activities have now begun with support from SWIOFish (pers. comm., Hakim Davis Matola, TAFIRI, April 2017).

National legislation and regulations

The mainland fisheries sector is guided by the National Fisheries Policy (MLFD 2015), supported by the Fisheries Act of 2003 (Republic of Tanzania 2003) and Regulations of 2005, amended in 2009 (Republic of Tanzania 2009a). Zanzibar fisheries are managed under the Fisheries Act of 2010 (Zanzibar 2010).

The Deep-Sea Fishing Authority (DSFA) Act of 1998 (Republic of Tanzania 1998), amended in 2009, provides Regulations (Republic of Tanzania 2009b) for the management of fisheries resources throughout the EEZ on mainland Tanzania and Zanzibar.

In Zanzibar, MPAs are established and managed under the Environmental Management for Sustainable Development Act of 1996 (Zanzibar 1996a), the Forest Resource Management Act of 1996 (Zanzibar 1996b), and the Fisheries Act of 2010 (Zanzibar 2010). The Marine Parks and Reserves Act of 1994 (Republic of Tanzania 1994) promotes sustainable management of critical marine resources and habitats of mainland Tanzania through community participation.

Outside of CFMAs and MPAs, fisheries in Tanzania are largely open access. Although licenses are required for certain gear types and fisheries (e.g., for hook-and-line, bottom-set gillnet and purse seine fisheries; Everett et al. 2017), compliance is extremely low (pers. comm., Narriman Saleh Jiddawi, UDSM, April 2017). Tanzania has some gear and effort restrictions, for example mesh sizes for nets used in rivers, river mouths and bays must be less than 76 mm, and nets with a mesh size of less than 10 mm are prohibited in marine waters; the migration of breeding fish must not be obstructed by any net or fishing gear; monofilament nets, beach seine nets, spear guns and the electrocution of fish as a means of capture are prohibited (Republic of Tanzania 2009a). There are also provisions for closed seasons, size limits and restrictions on harvesting of specific species, no-take and limited take reserves, and prohibition on some fisheries (Everett et al. 2017). Furthermore, fishing vessels exceeding 11 m in overall length must be equipped with electronic vessel monitoring systems (VMS) which must be on at all times while at sea, but few fisheries are monitored or policed (pers. comm., Tim Davenport, WCS, May 2017). The 2009 Fisheries (Amendment) Regulations Second Schedule indicates that collection of, or fishing for, shark fins is prohibited for non-citizens of Tanzania. Since 2013, shark fin export has been 'verbally' banned in Zanzibar, but it is still widespread (pers. comm., Narriman Saleh Jiddawi, UDSM, April 2017).

The legislation in place for the protection of chondrichthyan species in Tanzania is limited to provisions in the Fisheries (Amendment) Regulations of 2009 (Republic of Tanzania 2009a). The Regulations prohibit the fishing, possession, processing, trade or export of species listed in Third Schedule of the Regulations; which include both *Rhincodon typus* and basking sharks *Cetorhinus maximus*, which are listed under "Marine waters Endangered fish species", and if a specimen of either of these species is caught accidentally, it must be immediately released (Republic of Tanzania 2009a). The Third Schedule also lists the longheaded eagle ray *Aetobatus flagellum*, ornate (presented as reticulated) eagle ray *Aetomylaeus vespertilio*, narrow (presented as knifetooth) sawfish *Anoxypristis cuspidata*, largetooth sawfish *Pristis pristis* (although presented as *P. microdon*, a junior synonym), smalltooth (although presented as wide) sawfish *Pristis pectinata*, green (although presented as narrowsnout) sawfish *Pristis zijsron*, bottlenose (or spearnose) Skate *Rostroraja alba*, and great hammerhead shark *Sphyrna mokarran* (Republic of Tanzania 2009a), which are thereby presumably also protected. However, *C. maximus, A. flagellum, A. cuspidata* and *P. pectinata* are not known from Tanzanian waters (See Table 3.3 in Chapter 3), and *P. zijsron* is questionable (Braulik et al. 2020).

Status of NPOA-Sharks

The process to develop an NPOA-Sharks in Tanzania has been initiated. In the United Republic of Tanzania (URT), the Zanzibar Archipelago is classified as an autonomous entity of Tanzania for certain matters (but not all), including fisheries. Therefore, fisheries matters in Tanzania coastal waters, Zanzibar coastal waters and the offshore waters of the URT are managed by different authorities, which complicates management and policy development. In March and April 2019, the DSFA co-hosted two multi-stakeholder meetings, primarily among government agencies, but including other stakeholders, in Zanzibar and Dar es Salaam (Tanzania), respectively, to initiate the process of developing a shark roadmap or Shark-NPOA for the

United Republic of Tanzania. Delegates attending these meetings represented the Tanzanian Vice President's office, Tanzania Ministry of Livestock and Fisheries Development (MLFD), Tanzania Marine Parks and Research Unit (MPRU), Zanzibar Ministry of Agriculture Natural Resources Livestock and Fisheries (MANRLF), Zanzibar Conservation Management Unit, DSFA, Tanzania Fisheries Research Institute (TAFIRI), Zanzibar Fisheries Research Institute (ZAFIRI), and several other government agencies, scientific institutions, and NGOs.

The two main outcomes of the first meeting were that the parties agreed to develop a shark NPOA rather than a national roadmap, and this was agreed to be a joint initiative for the URT, rather than separate policy documents for Tanzania, Zanzibar, and the offshore waters (i.e., a joint NPOA for the Union). The outcome of the second meeting was the identification of DSFA as the lead government agency for the NPOA development process, and a document was prepared explaining the rationale for an NPOA in URT, the NPOA process, the status of chondrichthyan populations and fisheries in the URT, and a preliminary draft of the main components of the NPOA. The DSFA will continue to lead the process, and the baseline assessment and risk assessment reports were scheduled for completion by the end of 2021.

Marine protected areas

At the national level, legislation and management of marine protected areas (MPAs) differ between mainland Tanzania and Zanzibar. On mainland Tanzania, the establishment, management and administration of MPAs fall under Act No. 29 of 1994, the Marine Parks and Reserves Act (Republic of Tanzania 1994). The Act legislates for the establishment of the Marine Parks and Reserves Unit, whose function is to establish, monitor, administer and manage marine parks and reserves on mainland Tanzania (Republic of Tanzania 1994). Prior to 1994, several sites were legislated as marine reserves under the Fisheries Act of 1975 (Machumu 2021). MPAs in mainland Tanzania are either Marine Parks (multiple use areas in which users must comply with regulations set out for the Park) or Marine Reserves (no-take areas where all forms of resource extraction are prohibited; Machumu 2021).

In Zanzibar, under the Zanzibar Environmental Management Act of 2015, the minister overseeing terrestrial or marine natural resources, together with the Minister of Environment, can declare any area of ecological importance in Zanzibar as a protected area (Yahya 2021). Prior to this Act, the Director responsible for fisheries was able to establish marine parks and sanctuaries through the Fisheries Act No. 7 of 2010 (Yahya 2021). MPAs in Zanzibar are termed Marine Conservation Areas, and are premised around integrating communities into their management and administration (McLean et al. 2012, Richmond et al. 2014). The first MPA to be established was Chumbe Island Coral Park, a private marine reserve. Zanzibar also has three formally established Marine Conservation Areas under collaborative management.

At the World Parks Congress in 2003, the Tanzanian government set a goal of protecting 10% of territorial waters by 2012, and 20% by 2025, and developed a national plan for eight networks of MPAs in Tanzania, Zanzibar, and offshore areas (World Bank 2005). There are currently 18 MPAs in mainland Tanzania, encompassing a total area of ~2,143 km^2 and covering just 1% of the EEZ (Machumu 2021). Of these 18 MPAs, 15 are Marine Reserves and three are Marine Parks. In Zanzibar there are nine MPAs, encompassing 2,282 km^2 (1% of the EEZ). Rocliffe et al. (2014) reported 12 LMMAs (including CFMAs) in Tanzania mainland and one in Zanzibar, covering 46% and 5% of the continental shelf, respectively, although UNEP-WCMC and IUCN (2021h) has records of only one.

None of the MPAs in mainland Tanzania or Zanzibar was established specifically to protect chondrichthyan species, although *Rhincodon typus* are known to aggregate within the Mafia Island Marine Park (Cagua et al. 2013, Rohner et al. 2015), which encompasses much of the eastern and southern sides of the island, and thus *R. typus* receive some protection during these important aggregation events. In addition, the MPAs across Tanzania cover a diverse range of habitats, many of which are suitable for sharks and batoids. For example, in Zanzibar the Pemba Channel Conservation Area (PECCA) covers an area of 826 km^2, which encompasses the whole western side of Pemba Island up to 3 km offshore, and incorporates various habitats such as coral islands, fringing reef, sandy beach, intertidal and subtidal flats and seagrass beds, while the offshore section of PECCA covers pelagic habitat bordering the Pemba Channel, which drops quickly to 1,000 m deep (Machumu 2021). Similarly, across the Pemba Channel off mainland Tanzania, the Tanga Coelacanth Marine Park also provides some level of protection to coastal, epipelagic and deep-sea habitats. In Unguja, the Chumbe Island Coral Park/Sanctuary, Changu-Bawe Marine Conservation Area, Menai Bay Conservation Area, Mnemba Island Marine Conservation Area and Tumbatu Marine Conservation Area together form a connection of Marine Conservation Areas which encircle much of Unguja Island, providing protection to a variety of habitat types also suitable for chondrichthyan species (Yahya 2021).

Although many of these MPAs in mainland Tanzania are no-take areas, and MPAs in Zanzibar are meant to be administered in collaboration with local communities, the high levels of chondrichthyan catch taking place in artisanal fisheries across these areas (WCS, unpublished data) suggests that these protected areas offer limited protection to chondrichthyan species. Illegal and destructive fishing practices and a lack of capacity to effectively manage and enforce these MPAs have been highlighted as key threats to MPAs in Tanzania and Zanzibar (Machumu 2021, Yahya 2021).

Multilateral Environmental Agreements (MEAs) and Regional Fishery Bodies (RFBs)

Tanzania is signatory to several MEAs and RFBs (see Table 5.2). Tanzania ratified CMS in 1999 and is thereby bound by CMS commitments (see section 5.2.1). There are 11 chondrichthyan species listed on Appendix I of CMS and a further nine listed on Appendix II (excluding those also listed on Appendix I), which are known to occur in the Tanzanian EEZ (Table 3.3, Chapter 3). Tanzania is thus obliged to protect the 11 species listed on Appendix I, and to implement the CMS concerted actions for whale sharks and mobula rays. As a Party State, Tanzania is also obliged to conserve or restore the habitats that these species occupy, mitigate obstacles to migration and control other factors that might endanger them. Many of the CMS Appendix II species present in Tanzania are shared with other Nairobi Convention Member States (Table 5.1), therefore Tanzania should participate in the development of regional management plans, as appropriate, for these species. Tanzania is not signatory to the CMS Sharks MOU (Table 5.2); however, it is a Range State to many of the species listed in Annex I of the MOU (Table 5.1), and should therefore consider joining the Sharks MOU, to improve regional management of these species.

Tanzania has been Party to CITES since 1980 and is thereby required to regulate the international trade in chondrichthyan species listed on CITES Appendices I and II (see section 5.2.2). One chondrichthyan species known from Tanzania is listed on CITES Appendix I and 19 species on CITES Appendix II (Table 3.3, Chapter 3). However, the Appendix I species is the Critically Endangered *Pristis pristis*, which may already be locally extinct within Tanzania. Furthermore, Tanzania took a reservation on the listing of mako sharks (*Isurus* spp.) on CITES Appendix II and is therefore bound by the listings of the remaining 17 Appendix II species only. There is no policy in place in Tanzania to regulate international trade in CITES-listed sharks and rays (even though there is provision under the Fisheries (Amendment) Regulations of 2009 for imports and exports of fish species), and the systems to implement CITES trade controls and to record and report on CITES shipments are likewise not in place. However, an implementing regulation for Tanzania has been set in place, and regulations for Zanzibar have also been adopted (CITES 2021). There is now agreement between Tanzania and the CITES Secretariat on the revised legislative analysis, including the possibility of elevating Tanzania to Category 1 (generally compliant) legal status. Despite this, no NDF assessments or stock assessments have been undertaken to ensure that the export of CITES-listed shark and ray species is not detrimental the survival of the species in the wild.

In terms of RFBs, Tanzania is also a member of SWIOFC and became a member of the IOTC in 2007, but has not joined SIOFA (Table 5.2). Under the IOTC, shark, tuna and swordfish fisheries in Tanzania must report their catches and follow the IOTC regulations concerning chondrichthyan species, retention bans, finning and reporting (see section 5.4.1). These measures include the need for retention bans in IOTC-managed fisheries for 11 species of chondrichthyans that occur in Tanzanian waters (Table 3.3). The 2021 IOTC compliance report indicated general compliance by Tanzania with the requirements for prohibition of large-scale drift nets and shark finning, and the prohibition on the capture of thresher sharks *Alopias* spp., *Carcharhinus longimanus* and mobulid rays *Mobula* spp., but only partial compliance in terms of reporting nominal catch, catch and effort and size frequency data, for chondrichthyan species (IOTC Secretariat 2015d, 2021k). *Rhincodon typus* are protected under the Tanzania Fisheries (Amendment) Regulations of 2009 (Republic of Tanzania 2009a).

Tanzania is also a Member of the Nairobi Convention and SADC (and thus the SADC Protocol on Fisheries) (see Table 5.2 in Chapter 5). While neither of these instruments specifies management measures or commitments for chondrichthyan species, the Nairobi Convention lists species-specific measures for listed species, and there is potential for chondrichthyan species to be included under this Convention at some point in the future. Both instruments are binding on Member States, and Tanzania is thus obliged to implement the required measures. Tanzania has not signed the PSMA (Table 5.2), which would require more action in blocking illegally caught chondrichthyans from entering Tanzania, but which may contribute significantly to curbing illegal trade in chondrichthyan products within and out of the WIO. The Ramsar Convention came into force in Tanzania in 2000 and there are now four Wetlands of International Importance, one of which is marine (Rufiji-Mafia-Kilwa) and could be contributing to the protection of chondrichthyans.

Tanzania is also Party to UNCLOS and, by virtue of membership to the UN, is a Member of the UN General Assembly (Table 5.2). The State is thus bound by commitments to these measures. Both instruments carry specific measures for chondrichthyan species and both impose strong commitments on Member States, to ensure strengthened national fisheries management frameworks, for sustainable fisheries. As a Member of the FAO since 1962, Tanzania is also encouraged to follow and implement the measures presented in the many guiding documents the FAO has published, many of which present specific chondrichthyan measures (see section 5.3).

6.10.6 Conservation and management issues, gaps and priorities

Threats to chondrichthyans in Tanzania

There is extensive fishing pressure throughout Tanzania, and chondrichthyans are targeted or caught as bycatch in most fisheries. Sharks have been caught and their fins have been traded from Zanzibar since at least 1919 (Last 1929), and they continue to be traded today. Chondrichthyans are exploited for their liver oil, which is used for waterproofing wooden boats (Barnett 1997, Braulik et al. 2020), their fins, meat, skin, cartilage, jaws and teeth (Barnett 1997). It appears that fisher effort has increased dramatically over the years (Barrowclift et al. 2017) and that elasmobranch catch rates have declined as a result (Shehe and Jiddawi 1997, Schaeffer 2004, Barrowclift et al. 2017).

The use of dynamite (blast) fishing has also been prevalent in Tanzania, with reports of this fishing method being used to kill marine fish since the 1960s (Guard and Masaiganah 1997) and, despite this fishing method being prohibited in Tanzania since 1970, it is still in use today, albeit to a reduced extent (Slade and Kalangahe 2015, Machumu 2021). Many coastal chondrichthyan species depend on reefs as critical habitat, however dynamited reefs result in damage to the reef structure and decreasing habitat and refugia for fishes to breed, rest and seek shelter from predators (Carpenter et al. 1981). Therefore, reefs that have been blast fished tend to have drastically reduced fish diversity and abundance (Guard and Masaiganah 1997).

Fisheries

- Tanzania landed the largest catch for FAO Major Fishing Area 51 between 2012 and 2019, accounting for 23.8% of the total Nairobi Convention Member State catch and 45.5% of their catch solely in this area.
- Chondrichthyan catches in Tanzania have shown signs of overexploitation for several decades, with declines in catch reported as early as the 1990s (Shehe and Jiddawi 1997).

- Artisanal fishers have been targeting chondrichthyans for centuries, and two decades ago these fisheries were already reported to be unsustainable due to a lack of regulation.
- The extent of foreign longline vessel activity in deep offshore waters cannot be accurately determined, and fleets are known to have been fishing illegally (MLFD 2014, AU-IBAR 2016).
- There are many CMS- and CITES-listed species, and IOTC prohibited species recorded in the artisanal catch across Tanzania.
- The shark species most commonly caught in artisanal fisheries from 2019 to 2021 in mainland Tanzania was the Critically Endangered *Sphyrna lewini*, while the Endangered *Himantura uarnak* was one of the most common batoid species caught in mainland Tanzania and Unguja Island.
- Although the Near Threatened *Squatina africana* was the dominant species in artisanal catch in Zanzibar in the 1990s (Shehe and Jiddawi 1997), this species has not been recorded in artisanal fisher catch surveys from 2019 to 2021 (WCS, unpublished data).
- As a consequence of overfishing, 55 (56%) of the 98 confirmed chondrichthyan species in Tanzania are currently considered threatened with extinction (IUCN 2021).
- There is currently poor monitoring of fisheries, despite legislation providing for such monitoring.
- Chondrichthyan catches are generally not identified to species or family level in reports to the FAO, but rather grouped as 'Sharks, rays, skates, etc. nei' and 'Rays, stingrays, mantas nei'.
- Reconstructed catch estimates in Tanzania's marine fisheries from 1950–2010 were found to be 77% higher than the figure reported to the FAO (Bultel et al. 2015). This disparity suggests that official reports are considerably underestimated.
- Discarded incidental chondrichthyan catches are not recorded, despite chondrichthyans being frequently taken as incidental catch in all sectors.
- The threat of piracy from the north has limited the collection of data and vessel inspections (Anderson 2012), and until 2017 there was no observer coverage of the industrial or small-scale fleets.
- No population assessments or stock assessments have been conducted on chondrichthyans in Tanzania.

Trade

- The value chain of shark fins is not well known for mainland Tanzania or Zanzibar.
- The shark fin trade in Zanzibar has reportedly declined in recent decades, with some species becoming rare.
- Notable target species for the shark fin trade in Tanzania include Critically Endangered *Rhynchobatus* species.
- Despite high levels of chondrichthyan trade from Tanzania, there are no official records of any CITES-listed chondrichthyan species being exported from Tanzania in the past 10 years.
- There are clear discrepancies between reported exports of chondrichthyan products from Tanzania and imports reported by other countries for products originating from Tanzania, indicating underreporting of exports.
- Although illegal imports of chondrichthyan products into Tanzania are not known to occur, chondrichthyan imports are not regulated and no data are available (Jiddawi 2015).
- There is illegal trade across the borders with Kenya and Mozambique, with chondrichthyan products transported hidden among other fish products.

Governance

- Zanzibar and mainland Tanzania have autonomous institutional and legal structures for fisheries management. This results in poor internal coordination and cooperation between the Ministry in mainland Tanzania, the Ministry in Zanzibar, and the DSFA (Davies et al. 2014), and complicates management and policy development.
- Chondrichthyan species are inadequately accommodated in national legislation in Tanzania. Current chondrichthyan-specific measures protect ten chondrichthyan species, four of which do not occur in Tanzania. These

Regulations are outdated and require further amendments.

- There is no policy in place in Tanzania to regulate international trade in CITES-listed chondrichthyan species (even though there is legislation under the Fisheries Regulations Act of 2009 that provides for imports and exports of fish species). The systems to implement CITES trade controls and to record and report on CITES shipments are also not in place.
- Despite initiating the process of the NPOA-Sharks in 2019, this process is yet to be completed.
- A permit is required for the transport of shark fins, and shark fin exporters require a license, although exporting procedures are rarely adhered to and loopholes in the system are easily exploited (Compagno et al. 2005).
- The MLFD's Directorate for Fisheries Resource Protection (mainland Tanzania) and MALNF (Zanzibar) are responsible for MCS, but capacities are low and there are no means to carry out at-sea inspections.
- Although licenses are required for certain gear types, compliance is extremely low.
- The Fisheries (Amendment) Regulations of 2009 prohibit obstructions of the migration of breeding fish by any net or fishing gear, but there is limited research on migration routes for chondrichthyan species in Tanzania.
- Fishing vessels must be equipped with a VMS, which is meant to be on at all times while at sea, but few fisheries are monitored or policed.
- Illegal and destructive fishing practices and a lack of capacity to effectively manage and enforce MPAs have been highlighted as key threats to MPAs in the United Republic of Tanzania (Machumu 2021, Yahya 2021).

Information

- There has been limited research on chondrichthyans in Tanzania, with much of the research undertaken having focused primarily on shark fisheries and trade. There is thus limited biological and ecological information to inform their management at national level.

Required and recommended actions

Governance, policy, legislation, enforcement and capacity needs

- The high levels of threatened and MEA-listed chondrichthyan species in the catches and documented declines in chondrichthyan catches indicate that improved conservation and management of chondrichthyans are needed in Tanzania.
- The NPOA-Sharks must be completed and implemented, to guide the necessary steps for effective conservation and management of chondrichthyans in Tanzania.
- Improved monitoring and enforcement of existing regulations are required, particularly those pertaining to prohibited gear types and prohibited species.
- Considering the differences in habitats and chondrichthyan species recorded at mainland Tanzania, Pemba and Unguja landing sites, area-specific gear, species and catch restrictions should be developed.
- As Tanzania is Party to CMS, CITES and the IOTC, all of which are legally binding on members, the binding provisions regarding chondrichthyans must be incorporated into the management and conservation of chondrichthyan stocks in Tanzania and Zanzibar, particularly as many CMS, CITES and IOTC-prohibited chondrichthyan species are being caught and landed in Tanzania's fisheries (see Table 6.10.5 in section 6.10.7 for priority species for protection).
- Improved compliance with IOTC is necessary.
- Tanzania is not Party to the PSMA or SIOFA, and should consider ratifying both agreements, which would require more action in blocking illegally caught chondrichthyans from entering or exiting Tanzania, and which would likely contribute to curbing illegal trade in chondrichthyan products within and out of the WIO.
- Tanzania is not signatory to the CMS Sharks MOU, however, it is a Range State to many of the species listed in Annex I of the MOU and should therefore consider joining the Sharks MOU, to improve regional management of these species.
- National legislation should be revised to make provision for international trade controls imposed by CITES, and systems to implement

CITES trade controls and to record and report on CITES shipments must be established (particularly as these relate to shark fins). Furthermore, an improved legal and regulatory framework, a bolstering of capacity, increased funding and trained personnel will help to improve CITES implementation and enforcement.

- Chondrichthyan imports must be regulated and monitored to reduce instances of illegal trade.
- Loopholes in exporting procedures must be identified and resolved.
- Non-detriment findings assessments must be conducted for all CITES Appendix II-listed chondrichthyan species proposed for export from Tanzania, to ensure that exports (trade) of such species do not impact negatively on wild populations.
- Co-management structures for monitoring trade in chondrichthyan products along the value chain should be implemented, particularly for valuable products like shark meat and fins that drive the market for chondrichthyans.
- Management plans for Tanzania's MPAs need to consider chondrichthyan conservation goals; these should be identified and incorporated into the development of new MPAs, while the potential protective benefits of existing MPAs should be assessed where relevant, to identify how their contribution to chondrichthyan conservation might be improved.
- Improved monitoring and enforcement of MPA regulations is needed, particularly with regards to the use of illegal and destructive fishing gears within MPA boundaries.
- Training must be provided on MCS activities, such as vessel inspections, port inspections, use of rapid genetic sequencers and the legal frameworks for effective implementation of MEAs such as CITES.
- Training on species identification is required for fisheries inspectors, customs and conservation staff (Braulik 2015, Jiddawi 2015).
- Improved internal coordination among authorities would improve the efficacy of efforts to improve fisheries management, decrease IUU fishing, reduce bureaucracy and increase transparency (Davies et al. 2014).

Fisheries and trade monitoring

- Improved recording of catch composition (including discards) to species level is needed.
- Stock assessments should be completed for all chondrichthyan species caught in fisheries (which is in turn dependent on collection of species-level catch data).
- Long term, species-level catch monitoring must be implemented across all fisheries sectors. The data collection application currently being used to monitor artisanal fisheries in Tanzania should be modified for use in other fisheries.
- Species-level data must also be recorded for discarded incidental chondrichthyan catch.
- All incidental catches by Distant Water Fishing Nations should be landed in Tanzania and monitored.
- Observer coverage (including automated photographic coverage or electronic monitoring) should be expanded to greater proportions of (or all) industrial fishing vessels that catch chondrichthyan species, whether as target or incidental catch.
- Improved mechanisms are needed to monitor foreign longline vessel activity in offshore waters.
- Studies should be conducted to assess the value chains of shark fins from Tanzania and Zanzibar.
- Improved monitoring, reporting and enforcement of trade controls are necessary, including recording of export (and import) quantities, particularly relating to the trade in CITES-listed chondrichthyan products (and particularly for fins).
- Discrepancies (and the causes thereof) between reported export and import quantities of chondrichthyan products must be investigated and mitigated.
- Tanzania should develop a national fisheries trade and monitoring program which includes chondrichthyans (Braulik 2015, Jiddawi 2015).

Data collection and research priorities

- Research on chondrichthyans should be encouraged and facilitated. Priority aspects for chondrichthyan research include confirmation of distribution ranges, movement behaviour (including migratory behaviour, fine-scale movements and habitat use), identification of critical chondrichthyan habitats, such as mating areas, breeding grounds, parturition/pupping grounds, nursery areas, aggregation sites and migration corridors), genetic connectivity, and aspects of age and growth (in particular age at maturity and maximum age) (see section 6.10.2).

- Awareness should be raised of the value of chondrichthyans both to fisheries and tourism, particularly the potential economic value of ecotourism.
- The poor state of knowledge of chondrichthyans in Tanzania can be rectified through increased funding, improved capacity and stronger inter-sectoral coordination (pers. comm., Hakim Davis Matola, TAFIRI, April 2017).

6.10.7 Priority chondrichthyan species for protection

There are 11 (possibly 12) chondrichthyan species either confirmed or reported from Tanzanian waters that are listed on CMS Appendix I, and thereby require national level protection (Table 6.10.4). *Pristis zijsron* is listed on CMS Appendix I, but its presence in Tanzania is in question. As a signatory State to CMS, these species should be fully protected in Tanzania. The Tanzania Fisheries (Amendment) Regulations of 2009 (Republic of Tanzania 2009a) prohibit the capture of just two CMS Appendix I species known from Tanzanian waters, *Pristis pristis* and *Rhincodon typus*, while the other CMS Appendix I species (*Carcharodon carcharias, Carcharhinus longimanus* and *Mobula* spp.) are not fully protected (Table 6.10.4). The regulations also protect *Cetorhinus maximus* and *P. zijsron*, both of which are listed in CMS Appendix I, but which are not confirmed or not known from Tanzanian waters (see Table 3.3, chapter 3).

There are also 11 confirmed (possibly 12) species (nine of which are also listed on CMS Appendix I) that are required to be prohibited in fisheries for tuna and tuna-like species in the IOTC area, through IOTC resolutions (Table 6.10.4). All thresher sharks *Alopias* spp. are subject to a retention ban under the IOTC, although the presence of the common thresher shark *Alopias vulpinus* anywhere in the WIO has recently been brought into question. As a signatory State to IOTC, retention of these species in the relevant fisheries under IOTC management should be banned in Tanzania. All 12 of these IOTC-listed species are restricted or prohibited in Tanzania, with *Alopias* spp. (Directive 004/2020, DSFA Act) and *C. longimanus* (Directive 005/2020, DSFA Act), as well as *Mobula* spp. (Directive 011/2020, DSFA Act), prohibited in the fisheries for tuna and tuna-like species through Directives under the Deep-Sea Fishing Authority Act (Republic of Tanzania 1998, IOTC Secretariat 2021k), while the harvesting of *R. typus* is prohibited under the Tanzania Fisheries (Amendment) Regulations 2009 (Republic of Tanzania 2009a). Therefore, Tanzania has implemented many of the binding species protections, although not all CMS Appendix I species are fully prohibited, as required by CMS.

There are also nine Critically Endangered and 15 Endangered chondrichthyan species (including four species with unconfirmed distributions) in Tanzania, other than those listed in CMS Appendix I or prohibited by IOTC resolutions, which should be considered for protection (at least from commercial harvesting and trade) by virtue of their poor conservation status. The Nairobi Convention text and the FAO Code of Conduct for Responsible Fisheries suggest that Endangered (assumption is made that this includes Critically Endangered) species should not be harvested (UNEP 1985, FAO 1999); therefore, as a Member State of both Organizations, Tanzania should implement the precautionary principle and prohibit the take of Endangered and Critically Endangered species (Table 6.10.4). However, just two of these species, *Aetomylaeus vespertilio* and *Sphyrna mokarran* are currently protected under the Tanzania Fisheries (Amendment) Regulations of 2009 (Republic of Tanzania 2009a), and the remaining species should be considered for protection. These Regulations, however, also prohibit the capture of three other chondrichthyan species, including *Rostroraja alba* and *Anoxypristis cuspidata,* neither of which is considered present in Tanzanian waters, as well as *Aetobatus flagellum*, which is not present anywhere in the WIO. This highlights the need for further taxonomic assessments in the WIO and the revision of Tanzania's Fisheries (Amendment) Regulations of 2009.

Table 6.10.4. Chondrichthyan species confirmed or reported (*not confirmed, or considered not present) from the waters of the United Republic of Tanzania (i.e., mainland Tanzania and the Zanzibar Archipelago), for which national protection or certain fishery prohibitions are binding on the State, through Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; full protection) or a resolution of the Indian Ocean Tuna Commission (IOTC; prohibition in certain fisheries). Species already protected at national level are shaded in green, and those prohibited from retention in IOTC-related fisheries are shaded in blue (see National legislation section). Also presented are listings on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List status (IUCN RL; CR = Critically Endangered, EN = Endangered, VU = Vulnerable). Species in bold = WIO endemic; species underlined = protected but not considered present in Tanzania.

Family	Species name	Common name	CMS	IOTC	CITES	IUCN RL	Rationale
Species for which prohibition is binding (some or all fisheries)							
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	II	Yes	II	EN	IOTC
	Alopias superciliosus	Bigeye thresher shark	II	Yes	II	VU	IOTC
	Alopias vulpinus *	Common thresher shark	II	Yes	II	VU	IOTC
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	I	Yes	II	CR	CMS I; IOTC
Cetorhinidae	*Cetorhinus maximus* [a]	Basking shark	I, II		II	EN	CMS I
Lamnidae	*Carcharodon carcharias*	Great white shark	I, II		II	VU	CMS I
Mobulidae	*Mobula alfredi*	Reef manta ray	I, II	Yes	II	VU	CMS I; IOTC
	Mobula birostris	Giant manta ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula eregoodoo	Longhorned pygmy devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula kuhlii	Shortfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula mobular	Spinetail devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula tarapacana	Sicklefin devil ray	I, II	Yes	II	EN	CMS I; IOTC
	Mobula thurstoni	Bentfin devil ray	I, II	Yes	II	EN	CMS I; IOTC
Pristidae	*Anoxypristis cuspidata* [b]	Narrow sawfish	I, II		I	EN	CMS I
	Pristis pectinata [c]	Smalltooth sawfish	I, II		I	CR	CMS I
	Pristis pristis	Largetooth sawfish	I, II		I	CR	CMS I
	Pristis zijsron *	Green sawfish	I, II		I	CR	CMS I
Rhincodontidae	*Rhincodon typus*	Whale shark	I, II	Yes	II	EN	CMS I; IOTC
Species for which prohibition is recommended							
Carchariidae	*Carcharias taurus*	Ragged-tooth shark				CR	CR
Ginglymostomatidae	***Pseudoginglymostoma brevicaudatum***	**Shorttail nurse shark**				CR	CR
Myliobatidae	*Aetomylaeus bovinus*	Duckbill ray				CR	CR
	Myliobatis aquila	Common eagle ray				CR	CR
Rhinidae	*Rhina ancylostomus*	Bowmouth guitarfish			II	CR	CR
	Rhynchobatus australiae	Bottlenose wedgefish	II		II	CR	CR
	Rhynchobatus djiddensis *	Whitespotted wedgefish			II	CR	CR
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark	II		II	CR	CR
Sphyrnidae	*Sphyrna mokarran*	Great hammerhead shark	II		II	CR	CR
Carcharhinidae	*Carcharhinus amblyrhynchos*	Grey Reef shark				EN	EN
	Carcharhinus obscurus *	Dusky shark	II			EN	EN
	Carcharhinus plumbeus	Sandbar shark				EN	EN
	Negaprion acutidens	Sicklefin lemon shark				EN	EN
Centrophoridae	*Centrophorus uyato*	Little gulper shark				EN	EN
Dasyatidae	*Himantura uarnak*	Honeycomb stingray				EN	EN
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	II		II	EN	EN
	Isurus paucus	Longfin mako shark	II		II	EN	EN
Myliobatidae	*Aetomylaeus vespertilio*	Ornate eagle ray				EN	EN
Oxynotidae	*Oxynotus centrina* *	Angular rough shark				EN	EN
Rajidae	*Raja ocellifera* *	Twineyed skate				EN	EN
	Rostroraja alba [d]	Spearnose skate				EN	EN
Rhinobatidae	***Acroteriobatus leucospilus***	**Greyspot guitarfish**				EN	EN
Rhinopteridae	*Rhinoptera jayakari*	Shorttail cownose ray				EN	EN
Stegostomatidae	*Stegostoma tigrinum*	Zebra shark				EN	EN
Triakidae	*Mustelus manazo*	Starspotted smoothhound				EN	EN

[a] *Cetorhinus maximus*, [b] *Anoxypristis cuspidate*, [c] *Pristis pectinata* and [d] *Rostroraja alba* are listed as prohibited in the 2009 Tanzania Fisheries Regulations, yet none of these species is considered present in Tanzanian waters (see Table 3.3 in chapter 3)

CHAPTER 7

Main Findings and Recommendations

The Western Indian Ocean (WIO) is a global hotspot of chondrichthyan biodiversity, harboring more species, more endemic species, and more threatened species than many other regions globally. However, chondrichthyan populations in the WIO are overexploited in various fisheries and in urgent need of improved management. The current Report draws attention to this need, highlighting the status of the WIO chondrichthyan resources, including biodiversity, fishery threats, knowledge gaps, legislation inadequacies and capacity limitations.

This final chapter thus draws on the regional- and national-level chapters, to present the current knowledge of the threats, issues and recommended actions, relating to chondrichthyan populations, fisheries, conservation and management, in the Nairobi Convention area of the WIO.

The chapter presents a summary of the conservation status of WIO chondrichthyans (section 7.1) and a brief overview (a quick reference list) of the threats and recommended actions (section 7.2).

The chapter then presents a detailed assessment (section 7.3) of the many threats and issues faced by chondrichthyans and imposed by their fisheries, as they relate to policy and management, fisheries, trade, knowledge, and capacity, and identifies the limitations and challenges impeding improved chondrichthyan management, in the WIO.

The chapter identifies six key areas for improved chondrichthyan management and conservation in the WIO, and then concludes with a detailed list (section 7.4) of actions to be taken, within each of the six key areas. Actions detailed include those that are required (through binding commitments to conservation and management instruments) and those that are recommended (based on best practice, management guidelines and recommendations presented in the scientific literature, and the measures defined in voluntary instruments to which Nairobi Convention Member States are Party).

7.1 Conservation status of chondrichthyans in the Western Indian Ocean

Based on global conservation status assessments by the IUCN Shark Specialist Group (SSG), 89 (40%) of the WIO's 224 chondrichthyan species are now considered *Threatened* (IUCN 2021), i.e., they fall within one of the threatened Red List categories (Vulnerable, Endangered or Critically Endangered), and thus face a high to extremely high risk of extinction. This is an increase of 14%, from 26%, over the past 10 years (see section 3.3.2). This is a major cause for concern.

The main threat to chondrichthyans in the WIO, as it is globally, is overfishing (the only threat identified across all chondrichthyan species assessed, Dulvy et al. 2021), followed by habitat loss and climate change.

Thirty-seven (17%) of WIO chondrichthyan species are Data Deficient; that is, available data are inadequate for a conservation threat assessment.

This high proportion of threatened chondrichthyan species in the WIO (40%) is considerably worse than the global situation (33%, Dulvy et al. 2021), and makes chondrichthyans the second most threatened marine species group in the WIO after turtles.

The most threatened chondrichthyan families in the WIO are Pristidae (sawfishes), Rhinidae (wedgefishes), Sphyrnidae (hammerhead sharks), Glaucostegidae (giant guitarfishes), Rhinobatidae (guitarfishes), Mobulidae (manta and devil rays), Myliobatidae (eagle rays), Alopiidae (thresher sharks), Lamnidae (mackerel sharks) and Centrophoridae (gulper sharks). These are predominantly larger-bodied species, and/or those of fishery value or value to the global trade in fins (including sharks and shark-like rays), shark liver oil or mobulid gill plates.

7.2 Summary of overarching findings, threats and recommended actions

Major issues and threats facing chondrichthyans in the Nairobi Convention area of the WIO (Table 7.1) are:

- **overexploitation and excessive mortality** of chondrichthyans, particularly threatened species;
- **inadequate national-level policy, legislation** and MPA protection in most countries;
- **poor implementation of management** and conservation measures defined under MEAs;
- **high levels of IUU chondrichthyan fishing** and trade (through poor compliance/enforcement);
- **inadequate species-level catch data** (across most fisheries) and biological/ecological knowledge;
- **inadequate capacity and awareness** for effective chondrichthyan conservation and management.

The report highlights six key areas for improved chondrichthyan management and conservation in the WIO (Table 7.1), including:

- **strengthening management and conservation** measures to reduce chondrichthyan mortality;
- **strengthening policy and legislation**;
- **improving compliance and enforcement**;
- **improving data collection and reporting**, particularly fishery data, and knowledge on WIO chondrichthyans;
- **strengthening** national and regional **capacity**;
- **improving awareness** and communication of the threat status and management needs.

Table 7.1: Threats, issues and recommended actions, relating to chondrichthyan populations, fisheries, conservation and management, in the Nairobi Convention area of the Western Indian Ocean.

Threats and issues	Required and recommended actions
Management measures are inadequate • Excessive mortality of chondrichthyan species, particularly threatened species; • Current MPA network offers limited protective benefit for chondrichthyans; • Poor implementation of measures defined under multilateral environmental agreements (MEAs).	Strengthen management and conservation measures • Reduce fishing-related mortality, through improved and (where necessary) stricter regulations and management measures; • Designs of new MPAs to account for chondrichthyan needs; • Amend management plans of existing MPAs to provide increased conservation benefits to chondrichthyan species present; • Improve adherence to and implementation of binding and voluntary measures defined under MEAs (see chapter 5).
National level policy and legislation are inadequate • Chondrichthyan species are poorly represented in national legislation of most Nairobi Convention Member States.	Strengthen policy and legislation • Improve policy and legislation specifically for chondrichthyan species, including full protection of species where relevant; • Improve legal frameworks for implementation of MEAs and global measures.
Inadequate compliance and enforcement • Concerning levels of IUU fishing of chondrichthyans; • Concerning levels of illegal trade in chondrichthyan products.	Improve compliance and enforcement • Improve monitoring, control and surveillance (MCS) and enforcement of regulations required in most countries; • Implement measures to combat/mitigate Illegal fisheries and illegal trade; • Awareness raising among fishers could improve compliance.
Inadequate information for effective management • Species-level catch data are inadequate across most fisheries that take chondrichthyans; • Export volumes are grossly underestimated; • Biological and ecological knowledge are relatively limited.	Improve data collection, reporting and knowledge on chondrichthyans in the WIO • Improve biological and ecological data (using data from WIO populations); • Improve and standardize collection of catch data in all fisheries that take chondrichthyans, particularly species-level data; • Increase observer coverage in commercial and industrial fisheries; • Improve platforms for catch monitoring and reporting; • Improve platforms for trade monitoring and reporting;
Inadequate capacity for effective management • Limited human and technical capacity (incl. for management, research and MCS).	Strengthen national and regional capacity • Improve capacity for chondrichthyan management, data collection, fishery and trade monitoring, MCS, enforcement, research, species identification.
Inadequate awareness • Inadequate awareness of conservation issues, regulations and needed actions.	Improve awareness-raising and communication • Improve awareness among fishers, governments and other stakeholders; • Improve communication of information, regulations and best practices.

7.3 Current situation, threats and issues in detail

7.3.1 Chondrichthyan policy, management and conservation

National legislation and policy

- Forty percent of WIO chondrichthyan species are now threatened (globally), with overfishing defined as the primary cause thereof for all of these species. There is a dire need for improved chondrichthyan management, particularly in nations where large proportions of the human population depend on these resources.
- Chondrichthyans are generally poorly protected with limited consideration under current national legislation in the WIO. While some States, such as South Africa and Mozambique, now protect several chondrichthyan species, most Nairobi Convention Member States protect few.
- There are numerous threatened chondrichthyan species in the WIO that have not been considered for legal protection or concerted conservation action (see section 5.6 for details), despite their threatened status.
- Most States also fall short of the required protections at national level, as imposed by MEAs to which they are Party.
- WIO States have been slow to develop and implement specific national plans of action for the conservation and management of their chondrichthyan species. Despite the FAO's IPOA-Sharks (FAO 1999) calling for NPOAs to be developed by 2001, by 2021 only Madagascar, Mauritius, Seychelles, South Africa and France (through the EUPOA-Sharks) has developed their NPOA-Sharks. Few States have conducted thorough Shark Assessment Reports (SAR), suggesting limited knowledge of the key threats that national management plans should address.
- International trade controls for chondrichthyans and their products (including licensing and permitting, inspection and control) are poorly implemented in most countries.
- While all Nairobi Convention Member States, except Somalia, have declared numerous MPAs, few were developed to include chondrichthyan species as targets for protection.

International/regional mandates and policies

- The ten WIO States covered in this report are all signatory to numerous MEAs and regional fisheries bodies (RFBs), but implementation of such measures is patchy, national legislation in some States is inadequate to support effective implementation, and adherence to binding measures is poor.
- *Convention on the Conservation of Migratory Species of Wild Animals* (CMS, see section 5.2.1): CMS is intended to provide a legal framework for the effective conservation and management of migratory species. In the WIO, 13 chondrichthyan species are listed in CMS Appendix I (Table 5.1), which calls for immediate and strict protection in Party States. Twenty-five chondrichthyan species (including 12 of those listed in Appendix I) are listed in CMS Appendix II (Table 5.1), which calls for the development of regional management plans to ensure effective management of the stocks. The CMS text and Appendices are legally binding on CMS Parties. All Nairobi Convention Member States, except Comoros, are Party to CMS and are thereby bound by the measures imposed. However, only Mozambique fully protects all CMS Appendix I chondrichthyan species present in its waters, and there are few regional management plans for Appendix II species. Comoros is a Range State to many of these species and is thus encouraged to implement the same measures.
- *CMS Sharks-MOU* (see section 5.2.1): Comoros, France, Kenya, Madagascar, Somalia and South Africa are signatory to the CMS Sharks-MOU – a non-binding, taxon-specific MOU under CMS that recommends management measures for signatory States, for chondrichthyan species listed in its Annex I. States should follow the guidance presented in the MOU text, for improved management of chondrichthyan species, and are encouraged to implement the proposed measures.
- *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES, see section 5.2.2): CITES regulates trade in species, to ensure trade does not negatively impact wild

populations. The Convention and its Appendices are binding on Parties. All ten Nairobi Convention Member States are Party to CITES and are thereby bound by CITES trade controls. These include i) prohibiting international commercial trade in all chondrichthyan species listed on CITES Appendix I, which includes two or possibly three sawfish species (Pristidae) in the WIO, ii) regulating the trade in the 25[111] chondrichthyan species listed on CITES Appendix II that occur in the WIO (see Table 5.1 in Chapter 5) to ensure that trade is not detrimental to wild populations, and iii) reporting on an annual basis all trade in products of CITES-listed species. However, the 2021 Status of Legislative Progress for Implementing CITES (CITES 2021) indicates that few Nairobi Convention Member States are implementing CITES effectively (national legislation in Kenya, Mozambique, Seychelles and Tanzania meets some but not all of the CITES legal requirements[112] (see section 5.2.2), while legislation in Comoros and Somalia is believed to not meet any of the CITES legal requirements). There is a high level of underreporting of CITES exports, and there is evidence of trade that is in breach of CITES trade controls.

- *United Nations Convention on the Law of the Sea* (UNCLOS), *UN Fish Stocks Agreement* (UNFSA) and *UN General Assembly (UNGA) Resolution on Sustainable Fisheries* (see section 5.2.3): UNCLOS provides an important global framework for maritime operations. UNFSA and the UNGA Resolution on Sustainable Fisheries present specific guidelines for Members to follow, to ensure that fisheries are sustainable, as they pertain to areas beyond (UNFSA) and within (UNGA) national jurisdiction. UNCLOS and the UNGA Resolution call for specific chondrichthyan measures such as reduced chondrichthyan mortality, strengthened management and conservation, and full implementation of the IPOA-Sharks (FAO 1999). All three instruments impose legally binding commitments on Member States to strengthen national fisheries management frameworks for sustainable fisheries. All ten Nairobi Convention Member States are Party to UNCLOS, the UN and thereby the UN General Assembly, while France, Kenya, Mauritius, Mozambique, Seychelles and South Africa are also signatory to the UNFSA. Many of the threatened chondrichthyan species in the WIO are migratory and straddle multiple WIO EEZs and ABNJ including most of those listed in the Appendices of CMS and CITES, and those with retention bans defined under resolutions of the IOTC. There is little evidence that the binding provisions of UNFSA and UNGA are followed, and these must be incorporated into management and conservation of chondrichthyan stocks in the Nairobi Convention Member States.
- *Ramsar Convention* (see section 5.2.4): The Ramsar Convention is intended to guide and commit nations to the conservation and wise use of all wetlands through local and national actions and international cooperation. All Nairobi Convention Member States, other than Somalia, are Party to the Convention and thereby bound by the associated commitments. There are 71 Ramsar sites within the Nairobi Convention area of the WIO, including at least 18 that cover habitat potentially important for chondrichthyan species.
- *Food and Agriculture Organization of the UN* (FAO, see section 5.3): The FAO has produced several policies and guiding documents intended to support improved fisheries management, including certain guiding documents specific to chondrichthyan species and their management. The *International Plan of Action for the Conservation and Management of Sharks* (IPOA-Sharks, see section 5.3.1) is a guiding instrument established to ensure the conservation and long-term sustainable use of chondrichthyan resources (FAO 1999). The *FAO Fisheries management. 1. Conservation and management of sharks* (see section 5.3.2), are technical guidelines for the implementation of the IPOA-Sharks (FAO 2000). While non-binding, these are useful for governments to follow, encourage the development of policy documents, provide

[111] Eleven of these 25 CITES Appendix II species are also listed on CMS Appendix I and should therefore be protected at national level in CMS Party States, and thus capture (acquisition) would not be legal (according to CITES requirements) and therefore international trade would not be permitted; this leaves 14 CITES Appendix II chondrichthyan species in the WIO that can be legally traded (if all appropriate trade documents are in place) (see Table 5.6 in Chapter 5)

[112] https://cites.org/eng/legislation/National_Legislation_Project

guidelines on reporting levels and propose management measures that should be considered at national level. All ten Nairobi Convention Member States are signatory to the FAO, and are therefore encouraged to follow the principles of these guiding documents.

- The *FAO Code of Conduct for Responsible Fisheries* (see section 5.3.3) is a collection of principles and international standards for action towards sustainable fishery and aquaculture operations (FAO 1995). The *Ecosystem Approach to Fisheries* (EAF, see section 5.3.4), is a practical strategy for inclusion of sustainable development principles in fisheries management (FAO 2003). Although not specific to chondrichthyans, these instruments provide valuable guidance for the improved sustainability of fisheries and should be followed by all Nairobi Convention Member States.
- The *Port State Measures Agreement* (PSMA, see section 5.3.5) is a legally binding international instrument intended to provide States with the power to prevent illegally caught fish from entering the market, through effective Port State Measures. The Agreement has been ratified, accessioned or approved by all Nairobi Convention Member States, other than Comoros and Tanzania. Although the agreement is relatively new, it both empowers and obliges Port States to impede the flow of illegal fishery products, and thereby has potential to contribute to a reduction in IUU chondrichthyan fishing. Comoros and Tanzania are encouraged to accede to and implement the Agreement and its measures, for comprehensive implementation across the WIO.
- *Indian Ocean Tuna Commission* (IOTC, see section 5.4.1): The IOTC is a tuna RFMO, intended for the effective management of tuna and tuna-like fisheries in the Indian Ocean, but has a strong emphasis on managing bycatch of non-target species, including chondrichthyans. Binding measures for chondrichthyan species include the prohibition on finning and removal of fins at sea, and retention bans for 12 chondrichthyan species that occur in the WIO (see Table 5.1), including all three thresher sharks (Alopiidae), whale sharks *Rhincodon typus*, oceanic whitetip sharks *Carcharhinus longimanus* and all seven species of mobulid rays present (Mobulidae). While these measures are binding and all ten Nairobi Convention Member States are Party to the IOTC, only South Africa was considered by the IOTC to be fully compliant in 2020. Comoros, Madagascar, Mauritius, Mozambique, Seychelles and Tanzania were all considered to be compliant with measures to prevent capture in the IOTC-managed fisheries of prohibited chondrichthyan species, while Kenya was reported as partially compliant and Somalia as non-compliant. In terms of reporting of chondrichthyan catch data (as required by IOTC), Comoros, Kenya, the French territories, Madagascar, Mauritius, Seychelles and Tanzania were reportedly only partially compliant, while Mozambique and Somalia were considered non-compliant.
- *Southern Indian Ocean Fisheries Agreement* (SIOFA, see section 5.4.2): SIOFA was established specifically for the effective management of deep-sea fish stocks on the high seas. Specific chondrichthyan measures were imposed in 2019, including the prohibition of targeting of certain deep-sea shark and chimaera species, setting of reporting requirements, and others. Mauritius, France and the Seychelles are Parties to SIOFA, Kenya, Madagascar and Mozambique are Signatories but have not yet ratified the Agreement, and Comoros is a Cooperating non-Contracting Party (Table 5.2). However, not all of these States are compliant with SIOFA's binding measures; for example, there is a targeted deep-sea shark fishery in Mozambique, including species listed in the "no-targeting" list of SIOFA's chondrichthyan measures.
- *Southwest Indian Ocean Fisheries Commission* (SWIOFC, see section 5.4.3): SWIOFC provides a platform for regional cooperation for sustainable use and management of SWIO living marine resources. SWIOFC cannot impose regulations on Members but promotes application of the FAO Code of Conduct for Responsible Fisheries (FAO 1995), the precautionary approach and the EAF (FAO 2003), with sharks being one its eight focus species groups. All ten Nairobi Convention Member States are SWIOFC Members (Table 5.2) and are thus encouraged to cooperate.

- *Nairobi Convention* (see section 5.4.4): All ten WIO States are members of the Nairobi Convention. While the Convention does not impose chondrichthyan-specific measures on Member States, chondrichthyans are now included in the Convention's Program of Work, and it is possible that specific chondrichthyan measures will be imposed in the future.
- The *SADC Fisheries Protocol* (see section 5.4.6) was developed to promote responsible and sustainable use of living aquatic resources that are of interest to the SADC Member States, with a strong focus on policy measures. While there are no chondrichthyan-specific measures, several measures relate to chondrichthyan species. Member States are required to regulate the use of living aquatic resources (both within and beyond national jurisdiction); prevent overexploitation whilst enabling sustainable utilization of the resources; and take measures that lead to harmonized legislation, policies, plans and programs on fisheries, and that align with international measures and requirements, as they relate to the management of shared stocks. There is also a strong focus on supporting research. SADC States are obliged to implement the measures of this protocol.

7.3.2 Chondrichthyan fisheries in the WIO

Fisheries catches

- Chondrichthyan species are targeted and/or caught incidentally in all fishery sectors (industrial, commercial, artisanal) in all WIO countries. Growing demand for marine resources also increases fishing pressure on chondrichthyan species, particularly as many teleost target species are in decline, thus forcing some fishers to shift their focus to chondrichthyans.
- At current levels of fishing effort, there is considerable risk to the stock status for many WIO chondrichthyan species, and the stocks of most species are likely to decline further if effective management measures are not implemented and well-enforced.
- Small-scale (including traditional, subsistence and artisanal) fisheries contribute significantly to total fishery (and chondrichthyan) catches in many WIO States. These fishers and their dependents (amounting to millions of individuals) are highly dependent on fishing for their livelihoods and a source of protein. The threats to chondrichthyan species are thus intense. The high dependence on the resources makes their sustainability of critical socioeconomic importance.
- Small-scale fisheries are widespread in coastal waters, operating in a diversity of coastal and nearshore habitats, with a range of fishing gears, therefore the threats from such fisheries are greatest on coastal chondrichthyans.
- Industrial fisheries impact predominantly pelagic species, therefore several oceanic pelagic sharks (and some rays) taken at industrial scales on the high seas and within country EEZs are at a high risk of overexploitation.
- At least 15 species of chondrichthyan are frequently caught in industrial longlines, purse seines and pelagic drift nets in the WIO (see Table 4.3 in Chapter 4), as target and incidental catch, many of which are threatened.
- Pelagic longline fisheries (which usually target tuna, swordfish and sharks) are responsible for considerable shark catches and discards of lower-value shark products. The use of wire leaders in longline fisheries increases shark mortality.
- Industrial purse-seine fisheries catchoceanic whitetip sharks *Carcharhinus longimanus*. They also have major impacts on silky sharks *C. falciformis* (including juveniles) through direct capture and incidental mortality in the material structure of the FADs with which purse-seine fishing is often associated. This incidental mortality is highly detrimental to the populations and was unknown until recently but is now considered a significant threat to this species (Filmalter et al. 2013b).
- Demersal industrial fisheries also have major impacts on deepwater chondrichthyan species, such as the targeted fishery for gulper sharks *Centrophorus* spp. in Mozambique and demersal longline fisheries in South Africa, and those that target deepwater shark species for liver oil; many of which are threatened or Data Deficient
- As the different fisheries compete for resources, there is evidence of increasing overlap and thus

conflict between small-scale fisheries that operate mainly in coastal waters and industrial fisheries that operate mainly offshore (see catches in Fisheries sections in country profiles, Chapter 6). This subjects those species caught in multiple sectors to significantly greater threat, particularly larger-bodied coastal and pelagic shark species, such as thresher, hammerhead, mackerel and certain requiem sharks and mobulid rays that are accessible by both sectors.

- For some chondrichthyan species, targeted fisheries (commercial, industrial and illegal fisheries) are the primary cause of population declines. Targeted fisheries have been active for many decades, for meat, liver oil and the shark fin trade, and the level of targeting has tended to increase in the past 30 to 40 years.
- However, for some chondrichthyans, including some of the most threatened (and depleted) species, incidental capture is a primary cause of decline (e.g., sawfishes *Pristis* spp. caught in high numbers in coastal gillnet fisheries targeting fish).
- Trawl fisheries, particularly bottom trawl, have high proportions of chondrichthyan bycatch, particularly batoids, small shark species and juveniles of larger shark species, and the mortality of this catch is very high. Bycatch reduction devices (BRDs) can reduce bycatch of chondrichthyans in prawn trawl fisheries; but the use of such devices remains low in the WIO.
- Pregnant female chondrichthyans are recorded in several (particularly artisanal) fisheries, as well as high proportions of juveniles of some species. Capture of excessive juveniles reduces i) potential fishery yield (a juvenile offers less meat than an adult) and ii) numbers of animals reaching maturity and thus contributing to population growth (i.e., growth overfishing[113]). Excessive capture of adults (particularly pregnant females) reduces the number of births, and in turn the population's potential for growth (recruitment overfishing[114]). Specific measures, such as seasonal or area closures, can reduce such impacts, but biological and ecological knowledge gaps limit the robustness of such designs.

Catch statistics

- Commercial and industrial chondrichthyan catches in FAO Major Fishing Area 51 (an area encompassing the WIO and marginal seas to the north) were the third highest of all FAO Fishing Areas globally from 1990–2019, highlighting major fishing impact on WIO chondrichthyans.
- As defined, the WIO contributed 12% of the global reported chondrichthyan catch (by all countries) from 2012–2019, at an annual average of 87,322 t.
- The ten Nairobi Convention Member States together contributed an annual average of 5% to the global reported chondrichthyan catch, and 23% of all chondrichthyan catches reported from FAO Fishing Area 51 from 2012–2019.
- The top ten countries catching chondrichthyans in FAO Fishing Area 51 account for 90% of the total combined catch in this area. Madagascar, Mozambique and Tanzania are the only Nairobi Convention Member States in the top 10, contributing a combined 20% to the total chondrichthyan catch reported by all countries fishing in this Area. Other countries reporting significant chondrichthyan catches in this Area include India, Islamic Republic of Iran, Yemen, Pakistan, Oman, Taiwan Province of China and Spain (see section 4.2 in Chapter 4).
- Small-scale fisheries have been poorly monitored and catch statistics are largely incomplete. However, catch reconstructions suggest that artisanal fisheries contribute significantly to (in some cases the majority of) total annual fishery catches at national level, in some WIO countries.
- Threatened species contribute significant proportions of the total chondrichthyan catches in the artisanal fisheries in many WIO countries, for example 39% in Mozambique, 43% in Kenya and 53% off Pemba Island, Tanzania.
- Catch reconstructions estimate that the true total chondrichthyan catch from the WIO is likely to be three or four times greater than reported.

[113] Growth overfishing refers to the effect of capturing fish "before they have time to realize their growth potential" (Pauly 1994)

[114] Recruitment overfishing refers to "fishery-induced reductions of the number of young fish entering fishing grounds", which can be caused by a reduction of the adult (reproductive) stock (Pauly 1994)

7.3.3 International trade in chondrichthyans

Trade dynamics

- Significant volumes of chondrichthyan products are exported from or among WIO countries each year. Nairobi Convention Member States exported an annual average of 1,223 t during the period 2012–2019, totaling 9,787 t and contributing, on average, 1.16% to global chondrichthyan exports each year.
- South Africa is reportedly the dominant exporter, contributing 96% of the total reported export volume of all Nairobi Convention Member States.
- Frozen shark meat dominates chondrichthyan product trade by volume. Although most shark meat appears to be retained at a local level within the WIO, large quantities are traded among WIO countries. Kenya is the largest importer of shark meat from other WIO countries.
- There is also some international trade in shark meat – predominantly meat of demersal shark species, which is mostly exported from South Africa to South America.
- Shark fins were reported to constitute 12% by weight (>1,000 t) of the Nairobi Convention Member State total chondrichthyan export volume in the period 2012–2019 – triple the volume of exports in the preceding decade (although export codes for shark fins were not introduced until 2012, which may have skewed earlier estimates). This is a notable quantity of fins and represents hundreds of thousands of individual sharks (from selected species only). Nairobi Convention Member States are thus responsible for significant chondrichthyan mortality.
- Based on the significantly higher value of shark fins than meat, the export of fins from the Nairobi Convention Member States would have realized a monetary value several orders greater than that obtained from the meat exports.
- Reported trade volumes indicate that chondrichthyan product trade from the WIO is notable on a global scale and thus should be managed appropriately. However, national product value chains and regional trade dynamics for chondrichthyan parts and products are not well understood.

Trade reporting

- Discrepancies between chondrichthyan product export volumes reported by exporting Nairobi Convention Member States and imports reported by other countries (notably Hong Kong), reveal that export volumes are grossly underreported by some WIO countries, particularly Tanzania, Mauritius, Mozambique, Seychelles and Somalia.
- Comoros, Somalia, Kenya and France (La Réunion and Mayotte) reported no chondrichthyan product exports for the period 2012–2019, despite other nations reporting imports of chondrichthyans from these countries.
- Kenya has a regulated international shark fin and meat trade, with licensed dealers. Shark fins originating in Mozambique, Zanzibar and Somalia are reportedly exported to Asia, via Mombasa (IOC-SmartFish 2016), yet Kenya reported no chondrichthyan exports for 2012–2019.
- CITES requires that Parties report all trade in CITES-listed species (including imports and re-exports) and that trade only be permitted with a non-detriment finding (NDF) that confirms that the trade in the species will not negatively impact the wild population. However, while products of CITES-listed chondrichthyan species are being commercially traded from many WIO countries, there are no public records of positive NDFs for any CITES-listed chondrichthyan species, for any WIO country. This suggests a breach of CITES trade controls by all countries exporting such species.
- Sharks are reportedly sold and transhipped at sea, from Somalia to Yemen, indicating that chondrichthyan export quantities are not fully reported. This may occur in other WIO countries.
- There is illegal trade in the fins of sharks and shark-like rays from certain WIO countries. There have been confiscations of illegal shipments in Mozambique, destined for export, confirming unreported exports are taking place, and in some cases in contravention of national laws or CITES trade controls.
- In Kenya's artisanal fishery, sharks are commonly landed without fins, likely a result of removal at sea and suggestive of exports for the fin trade, and most of these are likely to go unreported.

7.3.4 Drivers of catch and trade

- The chondrichthyan product trade in the WIO is both demand- and supply-driven – the latter based on maximizing returns on fishery catches.
- There is demand for meat (domestic or regional trade retained within the WIO for local consumption, but also considerable international export quantities), liver oil and fins.
- Shark (and shark-like ray) fins are among the most valuable of all seafood commodities, fetching extremely high prices in the global fin trade. There is huge demand (largely from East Asia) for fins from regions where the most-valued species are still readily available and where trade controls are poorly implemented, such as the WIO.
- The fins of certain shark species, such as hammerhead sharks (Sphyrnidae), and shark-like rays, such as wedgefishes (Rhinidae), sawfishes (Pristidae) and guitarfishes (Rhinobatidae), almost all of which are highly threatened, fetch the highest prices in this trade. Many of these species are targeted within the WIO for their fins.
- While the global demand for shark fins is reportedly declining, reported annual fin export volumes from the WIO have shown little evidence of declining, suggesting that demand and targeting within the WIO remain high.
- Targeted fisheries exist for mobulid rays *Mobula* spp., particularly for their gill plates. Mobulids are targeted in Kenya, Madagascar, Mozambique, Tanzania and Somalia, although it is not clear whether the target is meat, gill plates or both. Directed fisheries for these threatened species are not sustainable and must be mitigated.
- Directed fisheries exist for shark liver extracts, particularly squalene (from liver oil), which is used in many applications (e.g., the composition of several vaccines for the 2019 Coronavirus Disease). High returns of squalene come from the livers of slow-growing deepwater sharks and chimaeras. Kenya, Madagascar, Mozambique, Somalia and South Africa have directed fisheries for such species, yet many are threatened or Data Deficient, with little information on the sustainability of these fisheries.
- There is demand for live chondrichthyans in the WIO, for the aquarium trade. While some trade follows correct legal processes, there is evidence of live chondrichthyan trade in contravention of trade regulations, including threatened species, e.g., the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum.*

7.3.5 Status of knowledge on chondrichthyan fisheries, ecology and biology

Monitoring and available data on chondrichthyan stocks and fisheries

- Limited human expertise and resources, limited funding and an apparent historical lack of interest (possibly due to low perceived values for chondrichthyan products), have resulted in poor collection of chondrichthyan catch data in the WIO. Recording of chondrichthyan catch has thus lagged behind that of teleost species, with chondrichthyan catches often entirely unreported, whether retained or discarded.
- The limited availability of accurate, species-specific chondrichthyan catch and trade data impedes effective management. Nevertheless, available data widely confirm population declines, and local extirpation in some areas.
- Industrial fisheries licensed by applicable Member States are required to report to FAO (non-compulsory), IOTC and other bodies, yet chondrichthyan catches are seldom reported at species level, and the majority of chondrichthyan catches are reported in the general categories of 'Sharks, rays, skates etc. nei[115]' and 'Rays, stingrays, mantas nei', which impedes effective management and stock assessments.
- Observer coverage is inadequate in most countries, and even the IOTC observer coverage requirement of 5% of fishing effort gives a poor representation of true catches.
- Although small-scale fisheries monitoring has improved in many States in the past decade, chondrichthyans are rarely reported at species level and sometimes not at all, preventing accurate estimates of small-scale catch volumes.

[115] Nei refers to not elsewhere included, i.e., volumes of catches for species not specified at a more specific level

- Small-scale fisheries have limited discards with almost all chondrichthyans retained and utilized. However, there are known discards in certain commercial and industrial fisheries, particularly carcasses of low value species, yet these are often unreported, skewing total catch estimates.
- Most information on population status comes from South African fisheries, which may not fully represent stocks at the WIO level.
- Few formal stock assessments have been conducted on datasets from outside of South Africa. Stock assessments have been conducted by the IOTC for few pelagic shark species, and most of these are characterized by high levels of uncertainty due to inadequate species-level data, thus providing unclear management advice.
- Species-level identification remains a capacity challenge, and a limitation to accurate catch data recording and reporting for chondrichthyans.

Ecological and biological knowledge

- The SWIO (particularly the Mozambique Channel) is a global chondrichthyan biodiversity hotspot and a hotspot for threatened and endemic species; yet knowledge of chondrichthyan biodiversity and status in the WIO is limited.
- Relative to other important chondrichthyan regions, the WIO has been poorly studied, and there remain many gaps in the biological and ecological knowledge for many chondrichthyan species in the WIO, particularly WIO endemic species, hindering the development of effective management measures.
- Taxonomic uncertainties for chondrichthyans remain, particularly for batoids, chimaeras and deepwater sharks that have been relatively less studied than large, charismatic sharks and mobulid rays. Recent species descriptions suggest there may be undescribed deepwater chondrichthyan species in the WIO.
- Chondrichthyan species lists are not available for the WIO or most WIO countries. The current working regional chondrichthyan list (see Table 3.3) provides a foundation, confirming at least 224 species in the WIO, including 135 shark, 80 batoid, and nine chimaera species (~18% of known chondrichthyan species globally).
- Approximately 50 (22%) chondrichthyan species in the WIO are endemic to the region. At least 15 (~7%) are endemic to a single WIO country.
- South Africa (155 species, eastwards of East London), Mozambique (131) and Madagascar (108) have the highest chondrichthyan species richness of the WIO countries, as they share a global chondrichthyan biodiversity hotspot.

7.3.6 Capacity, resources and will

- Technical, financial and institutional capacity limitations are major constraints in the WIO, impacting the ability of government agencies to discharge their basic fishery management responsibilities. Inadequate funding limits data collection, capacity building, infrastructure, institutional capacity, MCS and other aspects.
- Capacity for species identification, data collection, fisheries statistical analyses, stock and biological assessments, catch inspections and vessel inspections are limited, largely due to limited access to appropriate training.
- Effective MCS is difficult as many fishing areas are remote and difficult to reach, most Nairobi Convention Member States have insufficient vessel infrastructure to monitor their vast EEZs adequately, chondrichthyan products are difficult to track and often transhipped or traded at sea, and illegal operators actively avoid interception by authorities. MCS of coastal artisanal fisheries is poor and urgently needs to be strengthened.
- Inadequate political interest and will have been key constraints to effective chondrichthyan management in parts of the WIO.
- Public support for effective chondrichthyan management tends to be poor where attitudes towards sharks are particularly negative – usually in places where shark attacks have been relatively common (La Réunion, Seychelles, South Africa), or where there is a high dependence on the resources and thus a lack of willingness to find alternative sources of protein or livelihoods.

7.4 Required and recommended actions in detail

KEY ACTION 1: Strengthen management and conservation measures

- Chondrichthyans in the WIO are heavily threatened, therefore the most urgent action is to **implement measures to reduce chondrichthyan mortality**, particularly for threatened species. These should follow the FAO Precautionary Approach to Capture Fisheries and the FAO Code of Conduct for Responsible Fisheries.
- Effective management must recognize that chondrichthyans are significant components of almost all fisheries in the WIO, many are of high value, and many are direct target species. Accordingly, strict regulatory limits need to be implemented on their take and those limits must be strictly enforced, to prevent further declines.
- Best practice models for eliminating targeted fishing or incidental catch of threatened chondrichthyans in small-scale fisheries should be developed and should be disseminated and replicated throughout the region.
- There is a need to move away from non-selective gears and set catch limits for acceptable levels of bycatch.
- Bycatch mitigation measures should be promoted, improved, standardized and their implementation enforced, particularly for nearshore/artisanal fisheries and non-selective gears, as well as through the IOTC.
- Improved management requires species-level measures, which may include full protection of certain species. However, high dependence on chondrichthyan resources (including valuable bycatch), means total prohibition of chondrichthyan exploitation is not feasible. Nairobi Convention Member States are encouraged to follow the principles laid out in the many global guiding documents, such as the *FAO's Conservation and management of sharks* (FAO 2000) guidelines, the model conservation plan presented as Annex 3[116] of the CMS Sharks-MOU (CMS 2012), and relevant publications on integrating societal needs into conservation (e.g., Booth et al. 2019).
- Species recovery plans should be developed and implemented for the most threatened chondrichthyan species in the WIO, particularly migratory species and those whose stocks are facing local extinction, and these plans should be integrated at national and regional levels. Such plans should be multilateral in coverage and developed in partnership with IUCN Species Survival Commission's Shark Specialist Group.
- The use of marine protected area no-take zones should be expanded to contribute to shark and ray conservation and management, with a focus on safeguarding threatened endemic species in the region. The Antongil Bay Shark Sanctuary in northeast Madagascar is the only specific sanctuary for sharks in the WIO and, if appropriately enforced, could provide significant protection for several chondrichthyan species. Further chondrichthyan sanctuaries should be implemented. The new Important Shark and Ray Area (ISRA)[117] initiative of the IUCN Species Survival Commission could support this process.
- Marine Spatial Planning is expanding in the WIO. Chondrichthyan conservation goals should be incorporated into the development of new MPAs, while the potential protective benefits of existing MPAs should be assessed, to identify how their contribution to chondrichthyan conservation could be improved (see WWF's *Practical Guide to Effective Design and Management of MPAs for Sharks and Rays* (Rigby et al. 2019)).
- Transboundary MPAs should be explored in the WIO for chondrichthyan conservation and management. The South Africa-Mozambique border provides a significant opportunity for a chondrichthyan transboundary MPA.
- Community co-management models that integrate chondrichthyan conservation goals should be developed and replicated throughout the WIO, particularly in countries where capacity for top-down monitoring and enforcement of national fisheries regulations is limited.
- Coordination among government and non-government agencies for chondrichthyan management issues (fisheries, trade, biodiversity conservation and enforcement) should be improved.

[116] https://www.cms.int/sharks/en/page/sharks-mou-text
[117] https://sharkrayareas.org/

- International agreements related to chondrichthyan conservation and management (e.g., CMS, CMS Sharks-MOU, see Chapter 5) should be better implemented, and ratified where not already ratified.
- CMS Appendix I species should be protected at national level in all Party States, while regional management plans should be developed for relevant CMS Appendix II species. Comoros is encouraged to accede to CMS.
- Species with retention bans imposed by IOTC must be prohibited within the permit conditions of the fisheries for tuna and tuna-like species under the IOTC area of competence and could be considered for full protection.
- States should require that all sharks and rays must be landed with fins naturally attached, in compliance with IOTC. Requirements to land whole carcasses are likely more feasible to enforce than fin-to-carcass ratios.
- In States with poor MCS, legislation focusing on trade controls for chondrichthyan parts and products may be more effective in reducing overfishing of these species than controls focused on fishing.
- Nairobi Convention Member States need to improve the implementation of CITES shark and ray measures (including non-detriment findings, permit issuance and appropriate reporting), for better trade control.
- Management decisions taken in the Nairobi Convention area should consider the total potential economic value of chondrichthyans, including direct consumptive and ecotourism values, but also the indirect use values which they add through their ecological roles, whilst taking measures to minimize stakeholder conflict.
- Regional IUCN Red List assessments could be considered for relevant WIO chondrichthyan species, with the support of the IUCN Shark Specialist Group, particularly for species not yet been evaluated (Not Evaluated) and those classified as Data Deficient, to confirm chondrichthyan species under threat at the regional level and identify priority conservation, management, and research actions to improve their conservation status.

KEY ACTION 2: Strengthen policy and legislation

- National legal frameworks and the extent to which they incorporate chondrichthyan species protection and management should be assessed and, where necessary, amended to **ensure that legal frameworks provide for adequate protection of chondrichthyan populations and effective management of fisheries that catch chondrichthyans**, and to ensure adequate national implementation of chondrichthyan management measures imposed by international agreements (particularly CMS, CITES and IOTC).
- National legislation for and policy on chondrichthyan product trade should be assessed and, where necessary, amended, to ensure that legal frameworks provide for adequate regulation of chondrichthyan products in trade and to ensure adequate national implementation of trade-related provisions of international agreements (i.e., CITES). Such legal reviews are underway in several Nairobi Convention Member States.
- States should consider development of national policy or legislation specific to chondrichthyans and their management. South Africa's Shark Biodiversity Management Plan[118] provides an example.
- The preparation of an NPOA-Sharks, which includes 1) a shark assessment report, 2) a risk assessment, 3) a set of priority objectives, and 4) a detailed implementation workplan, is a first step to identifying the issues and threats facing chondrichthyans at national level, and potential actions to be taken to achieve those objectives.
- Comoros should develop an NPOA-Sharks, by virtue of membership to FAO and in adherence with the binding requirement of the IOTC WPEB to do so. Kenya, Mozambique, Somalia and Tanzania should complete the ongoing processes to finalize their NPOA-Sharks. South Africa should finalize and implement its second NPOA-Sharks, while that of Seychelles was intended to cover the period up to 2020 and is now also due for revision. Madagascar and Mauritius should implement their already completed NPOA-Sharks.

[118] https://www.gov.za/documents/national-environmental-management-biodiversit-act-shark-biodiversity-management-plan-26

KEY ACTION 3: Improve compliance and enforcement

- **Existing national measures and those imposed by MEAs should be enforced** in all fishery or trade operations.
- Specific measures for chondrichthyans should be integrated into activities focused on tackling Illegal, unreported and unregulated (IUU) fishing.
- Community-led surveillance and control measures need to be improved in co-managed areas (e.g., through the use of SMART or similar systems), and existing effective models should be replicated in other communities.
- Capacity and infrastructure need to be improved, and long-term financial support secured, to facilitate more effective MCS operations and enforcement of regulations at national level.
- The PSMA and the measures and provisions defined therein should be implemented and enforced within signatory States. Comoros and Tanzania are encouraged to ratify and implement the PSMA.
- MCS training should be provided, such as vessel inspections, port inspections, use of new technologies (e.g., rapid genetic sequencers) and the legal frameworks for effective implementation of MEAs (e.g., CITES, PSMA).

KEY ACTION 4: Improve data collection, reporting and knowledge on chondrichthyans in the WIO

Fishery catch monitoring and reporting

- **Chondrichthyan catch data recording and reporting should be improved** in existing national fishery monitoring programs, with **particular emphasis on species-specific data**, including incidental catch. Catch monitoring should be conducted over the long term, to detect trends, and funding should be secured to ensure long-term persistence.
- National-level chondrichthyan fisheries monitoring programs should be expanded, particularly for small-scale, artisanal and sport fishing activities. Such programs should make use of available technology, such as smart phones or other electronic devices, to collect accurate, species-level catch, effort and biological data (animal size, sex, state of maturity), as well as photographic records and genetic samples to allow for species validation.
- In recent years, catch monitoring programs have developed in several WIO countries, such as Seychelles, Tanzania, Madagascar, Mozambique, Kenya and Somalia. Such programs contribute extensive information on coastal fisheries and could be replicated in other areas.
- Industrial and commercial fishery data collection must be improved. Reporting of catches (vessel logbooks) must be improved to meet requirements set in national permit conditions or fishing partnership agreements.
- Reporting requirements must be enforced and where relevant amended to ensure collection of useful information for management. Reporting requirements should call for species-level catch reporting and accurate positional data on each catch, for improved stock management and ecological knowledge.
- Reporting by States of catch data to IOTC and FAO requires improvement in most Nairobi Convention Member States, to ensure accurate catch reporting and adherence to reporting requirements.
- Observer coverage (including electronic monitoring) should be expanded to greater proportions of commercial and industrial fishing effort, particularly vessels that catch chondrichthyan species, whether target or bycatch.
- Methodical and repeated status and/or stock assessments should be conducted on threatened and keystone shark and ray species, starting with species that are most threatened, regulated under MEAs or under significant fishing pressure (e.g., Critically Endangered *Sphyrna lewini*, Vulnerable *Carcharhinus falciformis*).
- A WIO regional *Shark Assessment Report* under the FAO IPOA-Sharks could bring together dispersed data on chondrichthyan fisheries. Chondrichthyan data available for any fisheries or areas should be consolidated and analysed, and the findings used to inform improved management of chondrichthyans and their fisheries.

Trade monitoring and reporting

- National **chondrichthyan trade monitoring programs should be established or improved**, to monitor, guide and enforce chondrichthyan trade controls, including accurate reporting of trade volumes.
- Monitoring of reported trade data requires improvement, including comparative analysis of trade volumes to identify discrepancies and better traceability systems.
- Collection of Customs trade data on chondrichthyans requires improvement, through ensuring the use of correct and globally accepted Harmonized System (HS) codes by exporters, specific to the traded products.
- Where appropriate, more detailed HS codes/categories should be developed for shark and ray products in international trade and applied in the WIO.
- Improved knowledge is needed, through targeted research, of the socioeconomic importance of shark and ray fishing within small-scale fisheries, as well as of chondrichthyan product trade routes. Such surveys have been conducted at selected sites in several WIO countries, and such information should be shared widely to ensure its application to informing improved management.

Ecological, biological and biodiversity information

- **Further research is necessary to fill existing gaps in biological and ecological knowledge** on chondrichthyan species in the WIO. Research priorities and priority species (or species groups) for future research are detailed in section 3.4 in Chapter 3, and national priorities are detailed in individual country sections in Chapter 6.
- Research priorities include: stock assessments for chondrichthyan species known to be caught in fisheries; confirmation of species distributions; movement behaviour including migratory patterns, temporal movement patterns, fine-scale movements, habitat use and identification of critical chondrichthyan habitats (e.g., mating areas, breeding grounds, parturition/pupping grounds, nursery areas, aggregation sites and migration corridors); genetic connectivity; reproductive biology and ecology; and aspects of age and growth (age at maturity and maximum age in particular). Such information will help to elucidate critical habitats and hotspot areas for the most threatened chondrichthyan species, inform spatial and temporal protection measures such as closed areas and closed seasons, and provide the necessary information to determine reliable generation lengths which are used in assessments of conservation status.
- The clarification of taxonomic uncertainties should also be seen as a priority research focus, through taxonomic assessments, genetic assessments and through contributions made by citizen science.
- Studies should focus on priority data gaps of threatened species, which could support improved management measures (such as identifying nursery habitats).
- Studies should focus on improving knowledge particularly on batoids, deepwater shark species and chimaeras.
- Government agencies of Nairobi Convention Member States should participate in, support, encourage and facilitate research projects on chondrichthyans in the WIO. This includes supporting access to research permits, specific study areas and facilitating the sharing/export of biological samples for scientific purposes.
- Citizen science programs that report on chondrichthyan species observed by recreational divers and sport fishers should be supported. A centralized repository for such information should be established.
- All stakeholders should be encouraged to publish and support the publication of research findings and ensure that the data are made available to other stakeholders, for the purposes of improved conservation and management. Existing repositories such as the Nairobi Convention Clearinghouse mechanism could be used as a central repository through which relevant data and project metadata could be made accessible.

KEY ACTION 5: Strengthen national and regional capacity

- **National and regional capacity in the WIO region must be strengthened, to effectively implement research, conservation and management measures for chondrichthyans** that address the key issues facing chondrichthyans in the WIO.
- Key areas for capacity building include *inter alia* fishery data collection, biological and ecological data collection, life history assessments, stock assessments, genetic assessments, implementation of trade controls, MCS, enforcement and implementation of new technologies.
- National capacity for chondrichthyan research in Nairobi Convention Member States should be enhanced (e.g., through training in monitoring, archiving and data analysis, training and mentoring of local taxonomists, and providing support for national students for graduate studies, regional exchanges and mentoring).
- Training is required to ensure improved capacity to implement trade controls (e.g., species identification, CITES implementation, preparing NDFs, and enforcement measures such as rapid DNA barcoding tools).
- Training and technical support for fishers, fisheries officers, and customs staff should be expanded, for species identification and monitoring, using existing materials and guides (e.g., FAO SmartFish, CMS, CITES).
- New species identification guides (including local names) for all chondrichthyan species should be developed and disseminated, where not already available, and training on their use should be provided.
- Funding for capacity building and resource enhancement (infrastructure, vessels etc.) should be secured or facilitated (e.g., through the Nairobi Convention). Other avenues of revenue generation should also be explored, such as public-private partnerships.
- Regional and international assistance and resources (including funding opportunities) should be sought where necessary, to enhance national capacity for management and research.
- Greater regional and international cooperation should help to fill gaps at national level, in terms of capacity, financing and technical implementation.
- A regional approach that brings together individuals and agencies to share data and expertise, promotes regional discussions and provides opportunities to implement new or existing harmonized approaches, should be adopted to help build necessary capacity, and to provide ongoing technical support (such as advice, mentoring, organizing technical exchanges) for shark and ray conservation and management at all levels in the WIO. Platforms such as the Indian Ocean Commission (IOC), the Southwest Indian Ocean Fisheries Commission (SWIOFC), or a chondrichthyan Task Force established under the Nairobi Convention, may offer opportunities.

KEY ACTION 6: Improve awareness and communication

- **National and regional campaigns should be conducted that raise awareness of shark and ray conservation status, ecosystem functions and socioeconomic values,** among a broad range of stakeholders**.**
- Awareness should be raised/created among all fishery sectors, on the regulatory measures imposed thereon.
- Increased awareness amongst national and provincial governments in recent years has started to create the political will for improved management and conservation of chondrichthyans. This should continue.
- Awareness should be raised/created among governments and management agencies on the binding and voluntary commitments imposed on each State, by virtue of the relevant MEAs and instruments to which they are signatory, and on the numerous guiding and technical tools available for chondrichthyan management.
- Awareness and communication should be enhanced among researchers, conservationists and management agencies, of the socioeconomic importance of chondrichthyans and their fisheries, to ensure that the needs of the fishing communities are well understood and considered in the development of policy decisions.

7.5 Conclusions

This Regional Status Report presents detailed assessments of the biodiversity of chondrichthyan species in the WIO, including comprehensive national and regional species checklists, their current conservation status and recent trends therein (Chapter 3), fisheries for and trade in chondrichthyan products (Chapter 4), and the current status of policy and legislation for chondrichthyan species (particularly threatened species) (Chapter 5).

The Report highlights priority research areas (Chapter 3), provides recommendations for improved fisheries, fishery catch reporting and trade controls (Chapter 4) and highlights the required and recommended policy and legislative needs at national and regional levels (Chapters 5 and 7), as these relate to chondrichthyans in the WIO.

The Report is thereby intended to provide an assessment of the current knowledge base, raise awareness of current threats, identify priority aspects and taxa for research, and present recommendations to support improved management, both regionally across the WIO and at national level for the Nairobi Convention Member States.

The overarching finding is that chondrichthyan species in the WIO are under severe threat, particularly due to overfishing, in both directed and bycatch fisheries. The dire conservation status requires immediate action to reduce mortality of chondrichthyan species, particularly those threatened with extinction.

States are reminded of the many measures that they are bound to implement, and the many measures that they should voluntarily implement, by virtue of the various multilateral agreements to which each State is Party. Many such measures and many of the required and recommended actions presented in the current report also link directly to commitments made by States under the Aichi Biodiversity targets of the Convention on Biological Diversity, which include *inter alia* sustainable management and harvesting of all fish stocks, conserving at least 10% of coastal and marine (particularly biologically important) areas, and improving the conservation status of threatened species (United Nations 1992, CBD Secretariat 2010).

However, thousands of people in coastal communities are heavily dependent on fisheries, including those for chondrichthyans. Management measures and actions need to account for fisher needs, to ensure equitable access to resources, and to minimize or avoid impacts to such communities whilst ensuring the sustainability of coastal resources.

This delicate balance between human needs and ecological requirements is as much a social issue as it is ecological and represents a huge challenge for conservation and management authorities. However, the challenge is not specific to chondrichthyan species only and is applicable to all harvested marine resources. Effective chondrichthyan conservation and management thus requires inclusion and inputs from all stakeholders, to identify and urgently implement appropriate and timeous solutions.

REFERENCES

Abercrombie D, Jabado R 2022a. CITES Sharks and Rays - Implementing and Enforcing Listings: Volume III - Dried Product ID. Wildlife Conservation Society, New York, United States. 89 pp.

Abercrombie DL, Jabado RW 2022b. CITES Sharks and Rays - Implementing and Enforcing Listings: Volume II - Processed Carcass ID. Ministry of Marine Affairs and Fisheries (Indonesia), Cefas (UK). 62 pp.

Allen B, Cliff G 2000. Sharks caught in the protective gill nets off Kwazulu-Natal, South Africa. 9. The spinner shark *Carcharhinus brevipinna* (Müller and Henle). *African Journal of Marine Science* 22.

Allen B, Wintner S 2002. Age and growth of the spinner shark *Carcharhinus brevipinna* (Müller and Henle, 1839) off the KwaZulu-Natal coast, South Africa. *South African Journal of Marine Science* 24: 1–8.

Amandè M, Chassot E, Chavance P, Pianet R 2008. Silky shark (*Carcharhinus falciformis*) bycatch in the French tuna purse-seine fishery of the Indian Ocean.

Amandè MJ, Bez N, Konan N, Murua H, Delgado de Molina A, Chavance P, Dagorn L 2011. Areas with high bycatch of silky sharks (*Carcharhinus falciformis*) in the Western Indian Ocean purse seine fishery. *IOTC Proceedings IOTC–2011–WPEB, 7*.

Anam R, Mostarda E 2012. Field identification guide to the living marine resources of Kenya. *FAO Species Identification Guide for Fishery Purposes*. pp x–357.

Anderson J 2012. Options to reduce IUU fishing in Kenya, Tanzania, Uganda and Zanzibar. Mauritius.

Anderson R, Simpfendorfer C 2005. Indian Ocean. In: Fowler S, et al. (eds), *Sharks, Rays and Chimaeras: the status of the Chondrichthyan Fishes. Status Survey*. Gland, Switzerland and Cambridge: IUCN Species Survival Commission Shark Specialist Group. IUCN. pp 140–150.

Andreotti S, von der Heyden S, Henriques R, Rutzen M, Meÿer M, Oosthuizen H, Matthee CA 2016. New insights into the evolutionary history of white sharks, *Carcharodon carcharias*. *Journal of Biogeography* 43: 328–339.

Andrzejaczek S, Meeuwig J, Rowat D, Pierce S, Davies T, Fisher R, Meekan M 2016. The ecological connectivity of Whale Shark aggregations in the Indian ocean: A photo-identification approach. *Royal Society Open Science* 3.

Andrzejaczek S, Vély M, Jouannet D, Rowat D, Fossette S 2021. Regional movements of satellite-tagged whale sharks *Rhincodon typus* in the Gulf of Aden. *Ecology and Evolution* 11: 4920–4934.

Anon 1993. Agreement for the establishment of the Indian Ocean Tuna Commission. Accessed from https://www.iotc.org/sites/default/files/documents/2012/5/25/IOTC%20Agreement.pdf, 2021-11-10.

Anon 1996. Improvement of livestock export marketing in the north east region of Somalia: Report and recommendations. Nairobi, Kenya.

Anon 2006. Arrêté No. 06-2412/SG/DRCTCV réglementant la commercialisation de certaines especes de poissons marins tropicaux.

Anon 2007. Evaluation de la politique nationale du commerce des espèces sauvages - Madagascar. Accessed from http://www.cites.org/sites/default/files/common/prog/policy/madagascar_fr.pdf, 2021-11-11.

Anon 2009. Arrêté du 2 Décembre 2009, JORF n°0291 du 16 Décembre 2009, Texte n°37, NOR : AGRM0914820A.

Anon 2012. Plan de gestion du Parc naturel marin de Mayotte.

Anon 2013a. Arrêté préfectoral No. 000954 du 11 Junt 2013 fixant les conditions de marquarge des captures effectuees dans le cadre de la peche maritime de loisir dans les eaux maritimes de La Reunion.

Anon 2013b. Arrêté No. 37/UTM/2013 portant interdiction de peche des raies manta.

Anon 2015. Arrêté No. 08/UTM/2015 Relatif a la commercialisation de certaines especes de requins a Mayotte.

Anon 2017a. Sharks and People of Watamu MPA. Accessed from http://saveourseas.com/project/sharks-and-people-of-watamu-mpa/, 2021-11-10.

Anon 2017b. Requins de l'Ocean Indien et de La Réunion. Accessed from http://www.sharkcitizen.fr/requins-de-locean-indien-et-de-la-reunion/, 2021-11-12.

Anon 2017c. Baby sharks sharing space. Accessed from https://saveourseas.com/sosf-darros-research-centre/project/baby-sharks-sharing-space/, 2021-11-12.

Anon 2019. Arrêté préfectoral No. 3416 du 31 Oct 2019 portant réglementation des peches traditionalles exercées a titre do loisir l'interieur de la reserve naturelle nationale marine de La Réunion.

Anon 2021a. Annotated List of Wetlands of International Importance: Kenya. Accessed from https://rsis.ramsar.org/sites/default/files/rsiswp_search/exports/Ramsar-Sites-annotated-summary-Kenya.pdf?1634738571, 2021-11-11.

Anon 2021b. Arrêté No. 1742-2008 réglementant l'exerce de la peche maritime professionnelle dans les eaux du department de La Réunion.

Anon 2021c. Arrêté No. 1743-2008 réglementant l'exerce de la peche maritime de loisir dans les eaux du department de La Réunion.

Ardill D, Itano D, Gillet R 2013. A review of bycatch and discard issues in Indian Ocean tuna fisheries. SmartFish Programme for the implementation of a Regional Fisheries Strategy for the Eastern and Southern Africa and Indian Ocean Region.

Ardill J, Sanders M 1991. Review of the Marine Fishery Sub-Sector for Kenya. *Priorities for Fisheries Management and Development in the Southwest Indian Ocean. Proceedings of a seminar held 3-5 September 1991, Albion, Mauritius. FAO Fisheries Report No. 457*. Rome: Food and Agricultural Organization of the United Nations.

Asbury T, Bennett R, Price A, da Silva C, Bürgener M, Klein J, Maduna S, Sidat N, Fernando S, Bester-van der Merwe A 2021. Application of DNA mini-barcoding reveals illegal trade in endangered shark products in southern Africa. *African Journal of Marine Science* 43: 511–520.

ASCLME 2010. Coastal livelihoods in the Republic of Somalia. Accessed from https://iwlearn.net/resolveuid/58ce3a87-dd07-4511-bc0b-e0a88464e760, 2021-11-22.

ASCLME/SWIOFP 2012. Transboundary Diagnostic Analysis for the Western Indian Ocean. Volume 1: Baseline. Accessed from https://iwlearn.net/resolveuid/d24f1297-95b6-4e1b-9c9f-15e04c97948b, 2021-11-22.

AU-IBAR 2016. Status of Monitoring, Control and Surveillance Systems in Southern Africa - Strengthening National and Regional Capacities for Combating Illegal, Unreported and Unregulated Fishing. Nairobi.

Bach P, Sabarros S, le Foulgoc L, Richard E, Lamoureux J-P, Romanov E 2013. Self-reporting data collection project for the pelagic longline fishery based in La Réunion.

Bahadur J 2021. Fishy business: Illegal fishing in Somalia and the capture of state institutions. Accessed from https://globalinitiative.net/wp-content/uploads/2021/07/GITOC-ESAObs-Fishy-Business-Illegal-fishing-in-Somalia-and-the-capture-of-state-institutions.pdf, 2021-11-22.

Baissac J de B 1990. Checklist of the Marine Fishes of Mauritius. Regional project for the development and management of fisheries in the Southwest Indian Ocean.

Baker-Médard M, Faber J 2020. Fins and (Mis)fortunes: Managing shark populations for sustainability and food sovereignty. *Marine Policy* 113.

Bakun A, Claude R, Lluch-Cota S 1998. Coastal upwelling and other processes regulating ecosystem productivity and fish production in the western Indian Ocean. In: Sherman K, Okemwa E, Ntiba M (eds), *Large marine ecosystems of the Indian Ocean: assessment, sustainability and management*. Oxford, U.K.: Blackwell Science.

Bandeira SO, Silva RPE, Paula J, Macia A, Hernroth L, Guissamulo AT, Gove DZ 2002. Marine biological research in Mozambique: Past, present and future. *Ambio* 31: 606–609.

Bargain R 2001. Trends in the Seychelles Semi-Industrial Longline Fishery. *IOTC proceedings 4*. pp 110–119.

Barker MJ, Schluessel V 2005. Managing global shark fisheries: Suggestions for prioritizing management strategies. *Aquatic Conservation: Marine and Freshwater Ecosystems* 15: 325–347.

Barkley AN, Gollock M, Samoilys M, Llewellyn F, Shivji M, Wetherbee B, Hussey NE 2019. Complex transboundary movements of marine megafauna in the Western Indian Ocean. *Animal Conservation* 22: 420–431.

Barnes-Mauthe M, Oleson KLL, Zafindrasilivonona B 2013. The total economic value of small-scale fisheries with a characterization of post-landing trends: An application in Madagascar with global relevance. *Fisheries Research* 147: 175–185.

Barnett R 1997. The shark trade in mainland Tanzania and Zanzibar. *The trade in sharks and shark products in the Western Indian and Southeast Atlantic Oceans*. Nairobi: TRAFFIC East/Southern Africa. pp 39–66.

Barrowclift E, Temple AJ, Stead S, Jiddawi NS, Berggren P 2017. Social, economic and trade characteristics of the elasmobranch fishery on Unguja Island, Zanzibar, East Africa. *Marine Policy* 83: 128–136.

Bartholomew DC, Mangel JC, Alfaro-Shigueto J, Pingo S, Jimenez A, Godley BJ 2018. Remote electronic monitoring as a potential alternative to on-board observers in small-scale fisheries. *Biological Conservation* 219: 35–45.

Bass A 1970. Report on a shark survey at St. Brandon during November 1970. Durban.

Bass AJ, D'Aubrey JD, Kistnasamy N 1973. Sharks of the east coast of southern Africa. I. The genus *Carcharhinus* (Carcharhinidae). *Investigational Report. Oceanographic Research Institute, Durban* 33: 1–168.

Bass AJ, D'Aubrey JD, Kistnasamy N 1975a. Sharks of the east coast of southern Africa. V. The families Hexanchidae, Chlamydoselachidae, Heterodontidae, Pristiophoridae, and Squatinidae. *Investigational Report. Oceanographic Research Institute, Durban* 43: 1–50.

Bass AJ, D'Aubrey JD, Kistnasamy N 1975b. Sharks of the east coast of southern Africa. IV. The families Odontaspididae, Scapanorhynchidae, Isuridae, Cetorhinidae, Alopiidae, Orectolobidae and Rhiniodontidae. *Investigational Report. Oceanographic Research Institute, Durban* 39: 1–102.

Bass AJ, D'Aubrey JD, Kistnasamy N 1975c. Sharks of the east coast of southern Africa. III. The families Carcharhinidae (excluding *Mustelus* and *Carcharhinus*) and Sphyrnidae. *Investigational Report. Oceanographic Research Institute, Durban* 38: 1–100.

Bass AJ, D'Aubrey JD, Kistnasamy N 1975d. Sharks of the east coast of southern Africa. II. The families Scyliorhinidae and Pseudotriakidae. *Investigational Report. Oceanographic Research Institute, Durban* 37: 1–64.

Bass AJ, D'Aubrey JD, Kistnasamy N 1976. Sharks of the east coast of southern Africa. VI. The families Oxynotidae, Squalidae, Dalatiidae and Echinorhinidae. *Investigational Report. Oceanographic Research Institute, Durban* 45: 1–103.

Bassen V 2007. Conservation efforts of the East African Whale Shark Trust in Kenya. In: Irvine T, Keesing J (eds), *The First International Whale Shark Conference: Promoting International Collaboration in Whale Shark Conservation, Science and Management. Conference Overview, Abstracts and Supplementary Proceedings*. CSIRO Marine and Atmospheric Research, Australia.

Batt C, Fletham J, Becker D 2017. Enhancing the Detection, Investigation and Disruption of Illicit Financial Flows from Wildlife Crime.

Bauchot M-L, Bianchi G 1984. Guide des Poissons Commerciaux de Madagascar. Fiches FAO d'Identification des Espèces pour les Besoins de la Pêche. Rome.

Baum JK, Worm B 2009. Cascading top-down effects of changing oceanic predator abundances. *Journal of Animal Ecology* 78: 699–714.

Baust S, Teh L, Harper S, Zeller D 2015. South Africa's marine fisheries catches (1950–2010). In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2)*. Fisheries Centre, University of British Columbia.

Bayworld 2015. Response to questionnaire completed by R. Daly at Bayworld Centre for Research and Education and Rhodes University. Unpublished.

Beeharry S, Dhurmeea Z, Sooklall T 2013. An overview of the bycatch landed by national and foreign tuna longliners in Mauritius for the period 2009 to 2012.

Benkenstein A 2013. Small-Scale Fisheries in Mozambique. Governance of Africa's Resources Programme.

Bennett RH, Ebert DA, Sitoe JJ, Fernando S, Harris M, van Beuningen D, Davids A 2021. Range extension of the Critically Endangered shorttail nurse shark *Pseudoginglymostoma brevicaudatum* (Orectolobiformes: Ginglymostomatidae) to include Mozambique, with implications for management. *Marine Biodiversity* 51.

Bérard M 2011. Légitimité des normes environnementales dans la gestion locale de la forêt à Madagascar. *Canadian Journal of Law and Society/La Revue Canadienne Droit et Société* 26: 89–111.

Berbera Port Authority 2015. Response to questionnaire completed by Stephen Berbera. Unpublished.

Bester-van der Merwe AE, Bitalo D, Cuevas JM, Ovenden J, Hernández S, da Silva C, McCord M, Roodt-Wilding R 2017. Population genetics of Southern Hemisphere tope shark (*Galeorhinus galeus*): Intercontinental divergence and constrained gene flow at different geographical scales. *PLoS ONE* 12.

Biais G, Taquet M 1992. La pêche locale aux abords de La Réunion. Repères Océans 2. Plouzané (France).

Bianchi G 1985. Field guide: commercial marine and brackish water species of Tanzania. *FAO species identification sheets for fishery purposes* undefined-250.

Bihi A 1984. Somalia National Report. UNEP Regional Seas Reports and Studies.

Bijoux J 2021. Marine and coastal areas under protection: Seychelles. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 167–186.

Blaison A, Jaquemet S, Guyomard D, Vangrevelynghe G, Gazzo T, Cliff G, Cotel P, Soria M 2015. Seasonal variability of bull and tiger shark presence on the west coast of Reunion Island, western Indian Ocean. *African Journal of Marine Science* 37: 199–208.

Blue Ventures 2015. Response to questionnaire completed by F. Humber. Unpublished.

Blythe J 2013. Dynamics of fishers' responses to social-ecological change in coastal Mozambique: A resilience perspective. University of Victoria. Canada.

Bodiguel C, Clerkin P, Ebert D, Wallemacq F 2017. Report of the Workshops on Identification of Pelagic Sharks and Rays in the Western Indian Ocean Report/Rapport: SFFAO/2013/34. Ebène, Mauritius.

Boggio-Pasqua A, Flam AL, Marshall AD 2019. Spotting the '"small eyes"': Using photo-ID methodology to study a wild population of smalleye stingrays (*Megatrygon microps*) in southern Mozambique. *PeerJ* 2019.

Boistol L, Harper S, Booth S, Zeller D 2011. Reconstruction of marine fisheries catches for Mauritius and its outer islands. In: Harper S, Zeller D (eds), *Fisheries catch reconstructions: Islands, part II*. Vancouver: The Fisheries Centre. pp 39–62.

von Bonde C 1934. Shark fishing as an industry. *Fisheries and Marine Biology Division, Union of South Africa, Investigational Report 2* 1–19.

Booth A, Foulis A, Smale M 2010. Age validation, growth, mortality, and demographic modeling of spotted gulley shark (Triakis megalopterus) from the southeast coast of South Africa. *Fishery Bulletin* 019: 101–112.

Booth AJ, Foulis AJ, Smale MJ 2011. Age validation, growth, mortality, and demographic modelling of spotted gully shark (*Triakis megalopterus*) from the southeast coast of South Africa. *Fisheries Bulletin* 109: 101–112.

Booth H, Squires D, Milner-Gulland EJ 2019. The neglected complexities of shark fisheries, and priorities for holistic risk-based management. *Ocean & Coastal Management* 182: p.104994.

Bornatowski H, Braga RR, Vitule JRS 2013. Shark Mislabelling Threatens Biodiversity. *Science* 340.

Bouchard C 2009. Fisheries in the French Indian Ocean Territories. In: Rumley D, Sanjay C, Sakhuja V (eds), *Fisheries exploitation in the Indian Ocean — Threats and opportunities*. Singapore: Institute of Southeast Asian Studies.

le Bourg B, Kiszka JJ, Bustamante P, Heithaus MR, Jaquemet S, Humber F 2019. Effect of body length, trophic position and habitat use on mercury concentrations of sharks from contrasted ecosystems in the southwestern Indian Ocean. *Environmental Research* 169: 387–395.

Braulik G 2015. Response to questionnaire completed by G. Braulik. Unpublished.

Braulik G, Kasuga M, Majubwa G 2020. Local ecological knowledge demonstrates shifting baselines and the large-scale decline of sawfishes (Pristidae) in Tanzania. *African Journal of Marine Science* 42: 67–79.

Bräutigam A, Callow M, Campbell I, Cornish A, Dulvy N, Fordham S, Fowler S, Hood A, McClennen C, Reuter E, et al. 2015. Global Priorities for Conserving Sharks and Rays: A 2015–2025 Strategy.

Breuil C, Grima D 2014a. Baseline Report Comoros. SmartFish Programme of the Indian Ocean Commission, Fisheries Management FAO component. Ebene, Mauritius.

Breuil C, Grima D 2014b. Baseline Report Seychelles. SmartFish Programme of the Indian Ocean Commission, Fisheries Management FAO component. Ebene, Mauritius.

Breuil C, Grima D 2014c. Baseline Report Tanzania. SmartFish Programme of the Indian Ocean Commission, Fisheries Management FAO component. Ebene, Mauritius.

Brooks K, Rowat D, Pierce SJ, Jouannet D, Vely M 2010. Seeing Spots: Photo-identification as a Regional Tool for Whale Shark Identification.

Brunel T, Coelho R, Merino G, Ortiz De Urbina J, Rosa D, Santos C, Murua H, Bach P, Saber S, Macias D 2018. A preliminary stock assessment for the shortfin mako shark in the Indian Ocean using data-limited approaches.

de Bruyn P, Dudley SFJ, Cliff G, Smale MJ 2005. Sharks caught in the protective gill nets off KwaZulu-Natal, South Africa. 11. The scalloped hammerhead shark *Sphyrna lewini* (Griffith and Smith). *African Journal of Marine Science* 27: 517–528.

Bullock R, Ralph G, Stump E, al Abdali F, al Asfoor J, al Buwaiqi B, al Kindi A, Ambuali A, Birge T, Borsa P, et al. 2021. The conservation status of marine biodiversity of the Western Indian Ocean. Gland, Switzerland.

Bultel E, Doherty B, Herman A, Le Manach F, Zeller D 2015. An update of the reconstructed marine fisheries catches of Tanzania with taxonomic breakdown. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010*. pp 151–160

Butcher PA, Piddocke TP, Colefax AP, Hoade B, Peddemors VM, Borg L, Cullis BR 2019. Beach safety: Can drones provide a platform for sighting sharks? *Wildlife Research* 46: 701–712.

Cagua EF, Cochran JEM, Rohner CA, Prebble CEM, Sinclair-Taylor TH, Pierce SJ, Berumen ML 2015. Acoustic telemetry reveals cryptic residency of whale sharks. *Biology Letters* 11.

Cagua F, Cochran J, Rohner C, Igulu M, Rubens J, Pierce S, Berumen M 2013. Demographics and feeding ecology of whale sharks at Mafia Island, Tanzania.

Cailliet GM, Smith WD, Mollet HF, Goldman KJ 2006. Age and growth studies of chondrichthyan fishes: The need for consistency in terminology, verification, validation, and growth function fitting. *Environmental Biology of Fishes* 77: 211–228.

Cameron TC, Plaistow S, Mugabo M, Piertney SB, Benton TG 2014. Eco-evolutionary Dynamics: Experiments in a model system. *Advances in ecological research* 50: 171–206.

Cardeñosa D, Quinlan J, Shea KH, Chapman DD 2018. Multiplex real-time PCR assay to detect illegal trade of CITES-listed shark species. *Scientific Reports* 8(1): 1–10.

Carpenter KE, Miclat R, Albadejo V, Corpuz V 1981. The influence of substrate structure on the local abundance and diversity of Phillippine reef fish. *Proceedings of the Fourth International Coral Reef Symposium*. pp 497–502.

Cashion T, Glaser SM, Persson L, Roberts PM, Zeller D 2018. Fisheries in Somali waters: Reconstruction of domestic and foreign catches for 1950–2015. *Marine Policy* 87: 275–283.

Cayré P 1991. Behaviour of yellowfin tuna (*Thunnus albacares*) and skipjack tuna (*Katsuwonous pelamis*) around fish aggregating devices (FADs) in the Comoros Islands as determined by ultrasonic tagging. *Aquatic Living Resources 4* 4: 1–12.

CBD Secretariat 2010. The strategic plan for biodiversity 2011– 2020 and the Aichi biodiversity targets. Document UNEP/ CBD/COP/DEC/X/2. Secretariat of the Convention on Biological Diversity, Nagoya, Japan.

CEPAM 2015. Response to questionnaire completed by Sónia Ricardo Muando at Centro de Pesquisa do Ambiente Marinho e Costeiro. Unpublished.

Chabanet P, Tessier E, Durville P, Thierry M, René F 2002. Peuplement ichtyologique des bancs de Geyser et Zélée (Océan Indien Occidental). *Cybium* 26: 11–26.

Chacate O, Mutombene R 2015. Mozambique National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2015.

Christiansen HM, Campana SE, Fisk AT, Cliff G, Wintner SP, Dudley SFJ, Kerr LA, Hussey NE 2016. Using bomb radiocarbon to estimate age and growth of the white shark, *Carcharodon carcharias*, from the southwestern Indian Ocean. *Marine Biology* 163.

Chynel M, Munschy C, Bely N, Héas-Moisan K, Pollono C, Jaquemet S 2021. Legacy and emerging organic contaminants in two sympatric shark species from Reunion Island (Southwest Indian Ocean): Levels, profiles and maternal transfer. *Science of the Total Environment* 751.

Cinner JE, Daw TM, McClanahan TR, Muthiga N, Abunge C, Hamed S, Mwaka B, Rabearisoa A, Wamukota A, Fisher E, et al. 2012. Transitions toward co-management: The process of marine resource management devolution in three east African countries. *Global Environmental Change* 22: 651–658.

Cisneros-Montemayor AM, Barnes-Mauthe M, Al-Abdulrazzak D, Navarro-Holm E, Sumaila UR 2013. Global economic value of shark ecotourism: Implications for conservation. *ORYX* 47: 381–388.

CITES 1994. Conf. 9.17 Status of International Trade in Shark Species. Accessed from https://www.cites.org/eng/res/all/09/E09-17.pdf, 2021-11-10.

CITES 1997. Biological and trade status of sharks. Doc. 10.51. Accessed from https://cites.org/sites/default/files/eng/cop/10/doc/E10-51.pdf, 2021-11-10.

CITES 2013. A guide to using the CITES Trade Database. Accessed from www.cites.org.

CITES 2016. Resolution Conf. 12.6 (Rev. CoP17). Conservation and management of sharks (Class Chondrichthyes). Accessed from https://cites.org/res/12/12-06R16.php, 2021-11-10.

CITES 2021. Status of Legislative Progress for Implementing CITES (updated August 2021).

Clarke C, Lea J, Ormond R 2012. Comparative abundance of reef sharks in the Western Indian Ocean. *Proceedings of the 12th International Coral Reef Symposium*. Cairns, Australia.

Clarke S, Milner-Gulland E, Cemare T 2007. Perspectives Social, Economic, and Regulatory Drivers of the Shark Fin Trade.

Clarke SC, McAllister MK, Milner-Gulland EJ, Kirkwood GP, Michielsens CGJ, Agnew DJ, Pikitch EK, Nakano H, Shivji MS 2006. Global estimates of shark catches using trade records from commercial markets. *Ecology Letters* 9.

Claus S, de Hauwere N, Vanhoorne B, Deckers P, Souza Dias F, Hernandez F, Mees J 2014. Marine Regions: Towards a Global Standard for Georeferenced Marine Names and Boundaries. *Marine Geodesy* 37.

Clerkin PJ, Ebert DA, Kemper JM 2017. New species of Chimaera (Chondrichthyes: Holocephali: Chimaeriformes: Chimaeridae) from the Southwestern Indian Ocean. *Zootaxa* 4312: 1.

Cliff G, Dudley SFJ 1991. Sharks caught in the protective gill nets off Natal, South Africa. 4. The bull shark *Carcharhinus leucas* Valenciennes. *South African Journal of Marine Science* 10: 253–270.

Cliff G, Dudley SFJ 1992. Sharks caught in the protective gill nets off Natal, South Africa. 6. The copper shark *Carcharhinus brachyurus* (Günther). *South African Journal of Marine Science* 12: 663–674.

Cliff G, Dudley SFJ 2011. Reducing the environmental impact of shark-control programs: A case study from KwaZulu-Natal, South Africa. *Marine and Freshwater Research* (62 vol.). pp 700–709.

Cliff G, Anderson-Reade MD, Aitken AP, Charter GE, Peddemors VM 2007. Aerial census of whale sharks (*Rhincodon typus*) on the northern KwaZulu-Natal coast, South Africa. *Fisheries Research* 84: 41–46.

Cliff G, Compagno L, Smale M, van der Elst R, Wintner S 2000. First records of white sharks, *Carcharodon carcharias*, from Mauritius, Zanzibar, Madagascar and Kenya. *South African Joumal of Science* 96: 365–367.

Clua E, Buray N, Legendre P, Mourier J, Planes S 2011. Business partner or simple catch? The economic value of the sicklefin lemon shark in French Polynesia. *Marine and Freshwater Research* 62.

CMS 2012. Annex 3 to the MOU: Conservation Plan. Accessed from http://www.cms.int/sharks/sites/default/files/document/Outcome_1_2_Annex3_to_MoU_Conservation_Plan_E_0.pdf, 2021-11-10.

CMS 2018. Memorandum of understanding on the conservation and management of migratory sharks. *(As amended by the Signatories at their 3rd Meeting, Monaco, December 2018)*.

Colman JG 1997. A review of the biology and ecology of the whale shark. *Journal of Fish Biology* 51: 1219–1234.

COM 2009. On a European Community Action Plan for the Conservation and Management of Sharks. Communication from the Commission to the European Parliament and the Council. Brussels.

Compagno L 1984. Sharks of the World. An annotated and illustrated catalogue of shark species to date. Part II (Carcharhiniformes). Rome.

Compagno L 1988. *Sharks of the order Carcharhiniformes*. Princeton: Princeton University Press.

Compagno L 2001. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Vol. 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). FAO species catalogue for fisheries purposes. No. 1. Vol. 2. Rome.

Compagno L, Heemstra P 2007. Electrolux addisoni, a new genus and species of electric ray from the east coast of South Africa (Rajiformes: Torpedinoidei: Narkidae), with a review of torpedinoid taxonomy. *Smithiana Bulletin* 7: 15–49.

Compagno LJ v., Ebert DA 2007. Southern African skate biodiversity and distribution. *Environmental Biology of Fishes* 80.

Compagno LJV 1986. Families Pristidae, Narkidae, Rhinobatidae, Myliobatidae, Mobulidae, Dasyatidae, Chimaeridae, Rhinochimaeridae, Callorhinchidae. In: Smith MM, Heemstra PC (eds), *Smith's Sea Fishes*. Johannesburg: Macmillan. pp 110–147.

Compagno LJV 1999. An overview of chondrichthyan systematics and biodiversity in southern Africa. *Transactions of the Royal Society of South Africa* 54: 75–120.

Compagno LJV, Cavanagh RD, Smale MJ, Dudley SFJ, Cook SF, Cooke A, Sauer W, Holtzhausen H 2005. Sub-equatorial Africa. In: Fowler SL, Cavanagh RD, Camhi M, et al. (eds), *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey*. Gland: IUCN SSC Shark Specialist Group.

Compagno LJV, Ebert DA, Smale MJ 1989. *Guide to the Sharks and Rays of Southern Africa*. Cape Town: Struik Publishers.

Conand C 2002. Marine ecology of La Réunion: an overview of recent research. *Ambio* 31: 602–605.

Cooke A, Jonahson M, Doukakis P, Smale M, du Feu T, Rasolonjatovo V, Healey T, Robinson L 2003. Shark fisheries and shark fin trade in Madagascar - review and analysis, with suggestions for action – Version 12 (Sept 2003) corrected Nov 2005.

Cooke AJ 1997. Survey of Elasmobranch Fisheries and Trade in Madagascar. In: Marshall NT, Barnett R (eds), *The trade in sharks and shark products in the Western Indian and Southeast Atlantic Oceans*. Nairobi: TRAFFIC East/Southern Africa. pp 101–130.

Cordova J, Ebert D 2021. *Apristurus manocheriani* (Carcharhiniformes: Pentanchidae), a new species of catshark from the Southwest Indian Ocean. *Journal of the Ocean Science Foundation* 38: 13–26.

Corrigan S, Lowther AD, Beheregaray LB, Bruce BD, Cliff G, Duffy CA, Foulis A, Francis MP, Goldsworthy SD, Hyde JR, et al. 2018. Population connectivity of the highly migratory shortfin mako (*Isurus oxyrinchus* Rafinesque 1810) and implications for management in the Southern Hemisphere. *Frontiers in Ecology and Evolution* 6.

Cortés E 2000. Life History Patterns and Correlations in Sharks. *Reviews in Fisheries Science* 8: 299–344.

Costa Pires A 2014. Analysis of fisheries policy and legislation for development of shark regulations in Mozambique. TRAFFIC. 22 pp.

Cowley PD, Bennett RH, Childs AR, Murray TS 2017. Reflection on the first five years of South Africa's Acoustic Tracking Array Platform (ATAP): status, challenges and opportunities. *African Journal of Marine Science* 39: 363–372.

Cripps G 2010. Feasibility study on the protection and management of the Barren Isles ecosystem, Madagascar. Blue Ventures Conservation Report (2009), for WWF and the "Réseau interdisciplinaire pour une gestion durable de la biodiversité marine: diagnostic environnemental et social autour des tortues marines dans le sud-ouest de l'Océan Indien.

Cripps G, Gardner CJ 2016. Human migration and marine protected areas: Insights from Vezo fishers in Madagascar. *Geoforum* 74: 49–62.

Cripps G, Harris A, Humber F, Harding S, Thomas T 2015. A preliminary value chain analysis of shark fisheries in Madagascar. *Programme for the implementation of a Regional Fisheries Strategy for the Eastern and Southern Africa—Indian Ocean Region vol SF/2015/34. Indian Ocean Commission, Ebene, Mauritius* 82 pp.

Curnick DJ, Andrzejaczek S, Jacoby DMP, Coffey DM, Carlisle AB, Chapple TK, Ferretti F, Schallert RJ, White T, Block BA, et al. 2020. Behavior and Ecology of Silky Sharks Around the Chagos Archipelago and Evidence of Indian Ocean Wide Movement. *Frontiers in Marine Science* 7.

Currie JC, Thorson JT, Sink KJ, Atkinson LJ, Fairweather TP, Winker H 2019. A novel approach to assess distribution trends from fisheries survey data. *Fisheries Research* 214: 98–109.

DAFF 2013. National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks) South Africa. South African Department of Agriculture, Forestry and Fisheries, South Africa.

DAFF 2015a. Policy on the Allocation and Management of Commercial Fishing Rights in the Large Pelagic Longline Fishery: 2015.

DAFF 2015b. Response to questionnaire completed by C. da Silva. Unpublished.

DAFF 2015c. Chondrichthyans of South Africa - Fisheries Identification Guide.

Dalton W, Porter S, Livingstone T-C, Mann B 2021. Demersal fish communities in KwaZulu-Natal, South Africa, indicate partial congruence with proposed conservation biozones. *African Journal of Marine Science* 43.

Daly R, le Noury P, Hempson TN, Ziembicki M, Olbers JM, Brokensha GM, Mann BQ 2021. Bull shark *Carcharhinus leucas* recruitment into the St Lucia Estuary, South Africa, after prolonged mouth closure, and the first observation of a neonate bull shark preyed on by a Nile crocodile Crocodylus niloticus. *African Journal of Marine Science* 43: 417–421.

Daly R, Parker D, Cliff G, Jordaan GL, Nomfundo N, Bennett RH, Mann BQ 2020. Long-term catch trends and risk assessment of the Critically Endangered white-spotted wedgefish (*Rhynchobatus djiddensis*) from South Africa. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31: 1–12.

Daly R, Smale MJ, Cowley PD, Froneman PW 2014. Residency patterns and migration dynamics of adult bull sharks (*Carcharhinus leucas*) on the east coast of Southern Africa. *PLoS ONE* 9.

Daly R, Smale MJ, Singh S, Anders D, Shivji M, Clare CA, Lea JSE, Sousa LL, Wetherbee BM, Fitzpatrick R, et al. 2018. Refuges and risks: Evaluating the benefits of an expanded MPA network for mobile apex predators. *Diversity and Distributions* 24: 1217–1230.

D'Anastasi B, Simpfendorfer C, van Herwerden L 2013. *Anoxypristis cuspidata*. The IUCN Red List of Threatened Species. e. T39389A18620409. https://doi.org/10, 2305.

d'Aubrey JD 1964. Preliminary guide to the sharks found off the east coast of southern Africa.

Davidson LNK, Dulvy NK 2017. Global marine protected areas to prevent extinctions. *Nature Ecology and Evolution* 1.

Davidson LNK, Krawchuk MA, Dulvy NK 2016. Why have global shark and ray landings declined: Improved management or overfishing? *Fish and Fisheries* 17: 438–458.

Davies S, Manning P, Cacaud P 2014. Ex-ante evaluation of a possible future fisheries partnership agreement and protocol between the European Union and the United Republic of Tanzania MARE/2011/01 – Lot 3, specific contract 7. Brussels, Belgium.

Davis D, Tisdell CA 1999. Tourist Levies and Willingness to Pay for a Whale Shark Experience. *Tourism Economics* 5.

DEFF 2020. Review of the South African National Plan of Action for the Conservation and Management of Sharks.

Dent F, Clarke S 2015. State of the global market for shark products. *FAO Fisheries and Aquaculture Technical Paper No. 590*.

Derrick DH, Cheok J, Dulvy NK 2020. Spatially congruent sites of importance for global shark and ray biodiversity. *PLoS ONE* 15.

Desbiens AA, Roff G, Robbins WD, Taylor BM, Castro-Sanguino C, Dempsey A, Mumby PJ 2021. Revisiting the paradigm of shark-driven trophic cascades in coral reef ecosystems. *Ecology* 102.

DFFE 2022. South Africa's second National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks II). South African Department of Forestry, Fisheries and the Environment

Diamant S, Rohner CA, Kiszka JJ, d'Echon AG, d'Echon TG, Sourisseau E, Pierce SJ 2018. Movements and habitat use of satellite-tagged whale sharks off western Madagascar. *Endangered Species Research* 36: 49–58.

Dias N, Afonso P 2011. Overview of fisheries and data information. ndiSeas — SWIOFP Meeting/Workshop, January 18–19, 2011, Cape Town (South Africa).

Dicken M, Smale M, Booth A 2006. Spatial and seasonal distribution patterns of the ragged-tooth shark *Carcharias taurus* along the coast of South Africa. *African Journal of Marine Science* 28.

Dicken ML, Hosking SG 2009. Socio-economic aspects of the tiger shark diving industry within the Aliwal Shoal Marine Protected Area, South Africa. *African Journal of Marine Science* 31.

Dicken ML, Booth AJ, Smale MJ 2008. Estimates of juvenile and adult raggedtooth shark (*Carcharias taurus*) abundance along the east coast of South Africa. *Canadian Journal of Fisheries and Aquatic Sciences* 65.

Dicken ML, Cliff G, Winker H 2016. Sharks caught in the KwaZulu-Natal bather protection programme, South Africa. 13. The tiger shark *Galeocerdo cuvier*. *African Journal of Marine Science* 38: 285–301.

Dicken ML, Winker H, Smale MJ, Cliff G 2018. Sharks caught in the KwaZulu-Natal bather protection programme, South Africa. 14. The smooth hammerhead shark *Sphyrna zygaena* (Linnaeus). *African Journal of Marine Science* 40: 157–174.

Diemer KM, Mann BQ, Hussey NE 2011. Distribution and movement of scalloped hammerhead *Sphyrna lewini* and smooth hammerhead *Sphyrna zygaena* sharks along the east coast of Southern Africa. *African Journal of Marine Science* 33: 229–238.

Doboš B 2016. Shapeshifter of Somalia: Evolution of the Political Territoriality of Al-Shabaab. *Small Wars & Insurgencies* 27: 937–957.

Doherty B, Hauzer M, Le Manach F 2015a. Reconstructing catches for the Union of the Comoros: uniting historical sources of catch data for Ngazidja, Ndzuwani and Mwali from 1950–2010. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2)*. Fisheries Centre, University of British Columbia. pp 1–11.

Doherty B, Herfaut J, Le Manach F, Harper S, Zeller D 2015b. Reconstructing domestic marine fisheries in Mayotte from 1950–2010. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010*. pp 53–65.

Doherty B, McBride M, Brito A, Le Manach F, Sousa L, Chauca I, Zeller D 2015c. Marine fisheries in Mozambique: catches updated to 2010 and taxonomic disaggregation. *Fisheries Centre Research Reports* 23: 67–81.

Doukakis P, Hanner R, Shivji M, Bartholomew C, Chapman D, Wong E, Amato G 2011. Applying genetic techniques to study remote shark fisheries in northeastern Madagascar. *Mitochondrial DNA* 22: 15–20.

Doukakis P, Jonahson M, Ramahery V, de Dieu Randriamanantsoa BJ, Harding S 2007. Traditional fisheries of Antongil Bay, Madagascar. *Western Indian Ocean J. Mar. Sci* 6: 175–181.

Ducatez S 2019. Which sharks attract research? Analyses of the distribution of research effort in sharks reveal significant non-random knowledge biases. *Reviews in Fish Biology and Fisheries* 29: 355–367.

Dudley S, Cavanagh R 2006. *Rhynchobatus djiddensis*.

Dudley S, Cliff G, Zungu M, Smale M 2005. Sharks caught in the protective gill nets off KwaZulu-Natal, South Africa. 10. The dusky shark *Carcharhinus obscurus* (Lesueur 1818). *African Journal of Marine Science* 27: 107–127.

Dudley SF, Cliff G 1993. Sharks caught in the protective gill nets off Natal, South Africa. 7. the blacktip shark *Carcharhinus limbatus* (Valenciennes). *South African Journal of Marine Science* 13: 237–254.

Dudley SFJ 1997. A comparison of the shark control programs of New South Wales and Queensland (Australia) and KwaZulu-Natal (South Africa).

Dudley SFJ 2012. A review of research on the white shark, *Carcharodon carcharias* (Linnaeus). Southern Africa. In: Domeier ML (ed.), *Global Perspectives on the Biology and Life History of the White Shark*. CRC Press. pp 511–532.

Dudley SFJ, Cliff G 2010. Influence of the annual sardine run on catches of large sharks in the protective gillnets off KwaZulu-Natal, South Africa, and the occurrence of sardine in shark diet. *African Journal of Marine Science* 32: 383–397.

Dudley SFJ, Simpfendorfer CA 2006. Population status of 14 shark species caught in the protective gillnets off KwaZulu- Natal beaches, South Africa, 1978 - 2003. *Marine and Freshwater Research* 57.

Dulvy NK, Davidson LNK, Kyne PM, Simpfendorfer CA, Harrison LR, Carlson JK, Fordham S v. 2016. Ghosts of the coast: Global extinction risk and conservation of sawfishes. *Aquatic Conservation: Marine and Freshwater Ecosystems* 26: 134–153.

Dulvy NK, Fowler SL, Musick JA, Cavanagh RD, Kyne PM, Harrison LR, Carlson JK, Davidson LN, Fordham S v, Francis MP, et al. 2014. Extinction risk and conservation of the world's sharks and rays. *eLife* 3.

Dulvy NK, Pacoureau N, Rigby CL, Pollom RA, Jabado RW, Ebert DA, Finucci B, Pollock CM, Cheok J, Derrick DH, et al. 2021. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology*.

Dulvy NK, Simpfendorfer CA, Davidson LNK, Fordham S v., Bräutigam A, Sant G, Welch DJ 2017. Challenges and Priorities in Shark and Ray Conservation. *Current Biology* 27: R565–R572.

Dunlop S 2013a. Honeycomb stingray (*Himantura uarnak*). In: Mann B (ed.), *Southern African Marine Linefish Species Profiles*. Durban: Special Publication, Oceanographic Research Institute. pp 179–180.

Dunlop S 2013b. Giant guitarfish (*Rhynchobatus djiddensis*). In: Mann B (ed.), *Southern African Marine Linefish Species Profiles*. Durban: Special Publication, Oceanographic Research Institute. pp 179–180.

Dunlop S, Mann B, van der Elst R 2013. A review of the Oceanographic Research Institute's Cooperative Fish Tagging Project: 27 years down the line. *African Journal of Marine Science* 35: 209–221.

Durbin J 2007. Madagascar's new system of protected areas - Implementing the "Durban Vision."

Ebert D, Compagno L, de Vries M 2011. A New Lanternshark (Squaliformes: Etmopteridae: *Etmopterus*) from Southern Africa. *Copeia* 2011.

Ebert DA 2013. Deep–sea Cartilaginous Fishes of the Indian Ocean. Volume 1. Sharks. *FAO Species Catalogue for Fishery Purposes No. 8* 1: 1–256.

Ebert DA 2014a. Deep–sea Cartilaginous Fishes of the Indian Ocean. Volume 2. Batoids and Chimaeras. *FAO Species Catalogue for Fishery Purposes No. 8* 2: 1–129.

Ebert DA 2014b. On Board Guide for the Identification of Pelagic Sharks and Rays of the Western Indian Ocean.

Ebert DA, Cailliet GM 2011. *Pristiophorus Nancyae,* a New Species of Sawshark (Chondrichthyes: Pristiophoridae) from Southern Africa. *Bulletin of Marine Science* 87.

Ebert DA, Clerkin PJ 2015. A new species of deep-sea catshark (Scyliorhinidae: *Bythaelurus*) from the southwestern Indian Ocean. *Journal of the Ocean Science Foundation* 15: 53–63.

Ebert DA, Gon O 2017. *Rhinobatos austini* n. sp., a new species of guitarfish (Rhinopristiformes: Rhinobatidae) from the Southwestern Indian Ocean. *Zootaxa* 4276: 204–214.

Ebert DA, van Hees KE 2015. Beyond Jaws: rediscovering the 'lost sharks' of southern Africa. *African Journal of Marine Science* 37: 141–156.

Ebert DA, Knuckey DS n.d. Coastal Chondrichthyans of the Western Indian Ocean. In: Heemstra P, Heemstra E, Ebert D, Holleman W, Randall J (eds), *Coastal Fishes of the Western Indian Ocean* (1 vol.) (edn). NRF/SAIAB. pp 8–11.

Ebert DA, Leslie RW 2019. *Leucoraja elaineae* sp. nov., a new rough skate (Rajiformes: Rajidae) from the Western Indian Ocean. *Zootaxa* 4691: 225–234.

Ebert DA, Dando M, Fowler S 2021a. *Sharks of the World*. Princeton University Press.

Ebert DA, Fowler S, Compagno L 2013. *Sharks of the world*. Wild Nature Press.

Ebert DA, Leslie RW, Weigmann S 2021b. *Etmopterus brosei* sp. nov.: a new lanternshark (Squaliformes: Etmopteridae) from the southeastern Atlantic and southwestern Indian oceans, with a revised key to the *Etmopterus lucifer* clade. *Marine Biodiversity* 51.

Ebert DA, Straube N, Leslie RW, Weigmann S 2016. *Etmopterus alphus* n. sp.: a new lanternshark (Squaliformes: Etmopteridae) from the south-western Indian Ocean. *African Journal of Marine Science* 38: 329–340.

Ebert DA, Wintner SP, Kyne PM 2021c. An annotated checklist of the chondrichthyans of South Africa. *Zootaxa* 4947: 1–127.

EJF 2009. Lowering the flag: Ending the use of flags of convenience by pirate fishing vessels.

Ellis JR, Phillips SRM, Poisson F 2017. A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology* 90: 653–722.

van der Elst R 1993. *A guide to the common sea fishes of southern Africa*. Cape Town, South Africa: Struik Publishers.

van der Elst R, Everett B 2015. *Offshore fisheries of the southwest Indian Ocean: their status and the impact on vulnerable species*. R van der Elst and B Everett (eds). Oceanographic Research Institute and Western Indian Ocean Marine Science Association.

van der Elst R, Everett B, Jiddawi N, Mwatha G, Afonso PS, Boulle D 2005. Fish, fishers and fisheries of the Western Indian Ocean: their diversity and status. A preliminary assessment. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 363: 263–284.

van der Elst R, Fennessy S, Everett B, Mackay F, Floros C, Schleyer M, Kiszka J, Bourjea J, Wanless R 2012. Mainstreaming biodiversity in fisheries management: a retrospective analysis of existing data on vulnerable organisms in the South West Indian Ocean.

Elston C, von Brandis RG, Cowley PD 2017. Dietary composition and prey selectivity of juvenile porcupine rays *Urogymnus asperrimus*. *Journal of Fish Biology* 91: 429–442.

Elston C, Cowley PD, von Brandis RG 2019. Movement patterns of juvenile porcupine rays *Urogymnus asperrimus* at a remote atoll: a potential nursery ground within a proposed marine protected area. *Environmental Biology of Fishes* 102: 1485–1498.

Elston C, Cowley PD, von Brandis RG, Fisk A 2020. Dietary niche differentiation in a mesopredatory dasyatid assemblage. *Marine Biology* 167.

Elston C, Cowley P, von Brandis R, Lea J 2021. Residency and habitat use patterns by sympatric stingrays at a remote atoll in the Western Indian Ocean. *Marine Ecology Progress Series* 662: 97–114.

Engelbrecht T, Kock A, Waries S, O'Riain MJ 2017. Shark Spotters: Successfully reducing spatial overlap between white sharks (*Carcharodon carcharias*) and recreational water users in False Bay, South Africa. *PLoS ONE* 12.

Eriksson H, Clarke S 2015. Chinese market responses to overexploitation of sharks and sea cucumbers. *Biological Conservation* 184: 163–173.

Escalle L, Gaertner D, Chavance P, de Molina A, Ariz J, Merigot B 2016. Consequences of fishing moratoria on catch and bycatch: the case of tropical tuna purse-seiners and whale and whale shark associated sets. *Biodiversity and conservation, 25(9), pp.1637-1659.*

EU 2003. Council regulation (EC) No 1185/2003 of 26 June 2003 on the removal of fins of sharks on board vessels. *Official Journal of the European Union*.

EU 2007a. Fisheries Partnership Agreement between the Republic of Madagascar and the European Community. *Official Journal of the European Union*.

EU 2007b. Fisheries Partnership Agreement Between the European Union and Mozambique. *Official Journal of the European Union*.

EU 2013a. Protocol between the European Union and the Union of the Comoros setting out the fishing opportunities and financial contribution provided for in the Fisheries Partnership Agreement between the two parties currently in force. *Official Journal of the European Union*.

EU 2013b. Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. *Official Journal of the European Union*.

EU 2013c. Regulation (EU) No 605/2013 of the European Parliament and of the Council of 12 June 2013 amending Council Regulation (EC) No 1185/2003 on the removal of fins of sharks on board vessels. *Official Journal of the European Union*.

EU 2014a. Protocol setting out the fishing opportunities and the financial contribution provided for by the Fisheries Partnership Agreement between the Republic of Madagascar and the European Community. *Official Journal of the European Union*.

EU 2014b. Agreement between the European Union and the Republic of the Seychelles on access for fishing vessels flying the flag of the Seychelles to waters and marine biological resources of Mayotte, under the jurisdiction of the European Union. *Official Journal of the European Union*.

EU 2016. COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 fixing for 2016 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2015/104.

EU 2018. Council decision (EU) 2018/754 of 14 May 2018 on the conclusion of the Protocol setting out the fishing opportunities and the financial contribution provided for by the Fisheries Partnership Agreement between the European Union and the Republic of Mauritius. *Official Journal of the European Union*.

EU 2020. EU Sustainable Fisheries Partnership Agreements. A transparent, coherent and mutually beneficial tool that enhances fisheries governance for sustainable exploitation, fish supply and development of the fisheries sector with partner countries.

EU Commission 2018. Council Decision (EU) 2018/757 of 14 May 2018 denouncing the Partnership Agreement in the fisheries sector between the European Community and the Union of the Comoros. *Official Journal of the European Union. L 128/13*.

European Commission 2020. EU Sustainable Fisheries Partnership Agreements: A transparent, coherent and mutually beneficial tool that enhances fisheries governance for sustainable exploitation, fish supply and development of the fisheries sector with partner countries.

Everett B, van der Elst R, Schleyer M 2008. A natural history of the Bazaruto Archipelago, Mozambique.

Everett B, Jiddawi N, Wambiji N, Boinali K, Randriambola T, Jeetah S, Chauca I, Assan C 2017. WIOFish database: A catalogue of small-scale fisheries of the Western Indian Ocean: Biennial Report for 2016 and 2017.

Everett BI, Cliff G, Dudley SFJ, Wintner SP, van der Elst RP 2015. Do sawfish *Pristis* spp. represent South Africa's first local extirpation of marine elasmobranchs in the modern era? *African Journal of Marine Science* 37: 275–284.

Fabing P 2014. Impact économique de la crise requin à la Réunion. Saint-Denis, La Réunion.

FAO 1990. Frame survey of artisanal fisheries of the Sofala Province (Mozambique). Victoria, Seychelles.

FAO 1995. Code of conduct for responsible fisheries. Rome.

FAO 1999. *International Plan of Action for the Conservation and Management of Sharks*. Rome: FAO.

FAO 2000. *Fisheries management. 1. Conservation and management of sharks. FAO Technical Guidelines for Responsible Fisheries* (Suppl. 1. edn). Rome: FAO.

FAO 2003. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome.

FAO 2005. South West Indian Ocean Fisheries Commission. First Session; Resolution and Statutes of the South West Indian Ocean Fisheries Commission. SAFR/DM/SWIOFC/05/INF 4 E.

FAO 2007. Fishery Country Profile: Mozambique. Rome.

FAO 2010. Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. Rome.

FAO 2011. Review of the state of world marine fishery resources. Rome.

FAO 2016a. Country profile - South Africa. FAO AQUASTAT Reports. Accessed from https://www.fao.org/publications/card/en/c/I9821EN/, 2021-11-22.

FAO 2016b. Country profile – United Republic of Tanzania. FAO AQUASTAT Reports. Accessed from https://www.fao.org/publications/card/en/c/I9836EN/, 2021-11-22.

FAO 2018. The Republic of South Africa. FAO Fishery and Aquaculture Profiles. Accessed from https://www.fao.org/fishery/facp/zaf/en, 2021-11-22.

FAO 2019. Fishery and Aquaculture Country Profiles: The Republic of Mauritius. Accessed from https://www.fao.org/fishery/facp/MUS/en, 2021-11-11.

FAO 2021. Fishery and Aquaculture Statistics. Global capture production 1950-2019 (FishStatJ). *FAO Fisheries Division [online]. Rome. Updated 2021*.

Faria V, McDavitt M, Charvet P, Wiley T, Simpfendorfer C, Naylor G 2013. Species delineation and global population structure of Critically Endangered sawfishes (Pristidae). *Zoological Journal of the Linnean Society* 167: 136–164.

Fennessy S, Everett B 2015. Fisheries' bycatch. In: van der Elst R, Everett B (eds), *Offshore fisheries of the Southwest Indian Ocean: their status and the impact on vulnerable species*. Oceanographic Research Institute: Special Publication 10. p undefined-448.

Fennessy S, Isaksen B 2007. Can bycatch reduction devices be implemented successfully on prawn trawlers in the Western Indian Ocean? *African Journal of Marine Science* 29: 453–463.

Fennessy S, Everett B, Kaguru B, Mwakosya C, Munga C, Sitoe S, da Conceicao K, Razafindrakoto H, Brito A 2015. Report of a workshop on the analysis of existing data from prawn trawl nets with Turtle Excluder Device (TED) and without TED (non-TED) in the Western Indian Ocean.

Fennessy ST 1994. Incidental capture of elasmobranchs by commercial prawn trawlers on the Tugela Bank, Natal, South Africa. *South African Journal of Marine Science* 14: 287–296.

Fennessy ST, Vincent X, Budeba Y, Mueni EM, Gove DZ 2008. An update on initiatives to reduce prawn trawl bycatch in the Western Indian Ocean. *Western Indian Ocean J. Mar. Sci* 7: 217–222.

Fielding P 2021. Marine and coastal areas under protection: Republic of South Africa. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western*

Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets. Nairobi: UNEP and WIOMSA. pp 133–166.

Fields AT, Fischer GA, Shea SKH, Zhang H, Abercrombie DL, Feldheim KA, Babcock EA, Chapman DD 2018. Species composition of the international shark fin trade assessed through a retail-market survey in Hong Kong. *Conservation Biology* 32: 376–389.

Fields AT, Fischer GA, Shea SKH, Zhang H, Feldheim KA, Chapman DD 2020. DNA Zip-coding: identifying the source populations supplying the international trade of a critically endangered coastal shark. *Animal Conservation* 23: 670–678.

Filmalter J, Dagorn L, Cowley P 2013a. Spatial behaviour and site fidelity of the sicklefin lemon shark *Negaprion acutidens* in a remote Indian Ocean atoll. *Mar Biol* 160: 2425–2436.

Filmalter JD, Bauer RK, Forget F, Cowley PD, Dagorn L 2021. Movement behaviour and fishery interaction of silky sharks (*Carcharhinus falciformis*) in the tropical tuna purse seine fishery in the Western Indian Ocean. *ICES Journal of Marine Science* 78: 2474–2485.

Filmalter JD, Capello M, Deneubourg JL, Cowley PD, Dagorn L 2013b. Looking behind the curtain: Quantifying massive shark mortality in fish aggregating devices. *Frontiers in Ecology and the Environment* 11: 291–296.

Filmalter JD, Cowley PD, Potier M, Ménard F, Smale MJ, Cherel Y, Dagorn L 2017. Feeding ecology of silky sharks *Carcharhinus falciformis* associated with floating objects in the western Indian Ocean. *Journal of Fish Biology* 90: 1321–1337.

Fischer J, Erikstein K, D'Offay B, Guggisberg S, Barone M 2012. Review of the Implementation of the International Plan of Action for the Conservation and Management of Sharks. Rome.

Fischer W, Sousa IM, Silva C, de Freitas A, Poutiers JM 1990. Guia de campo das espécies comerciais marinhas e de águas salobras de Moçambique. *Fichas FAO de identificação de espécies para actividades de pesca*.

Fisheries Development Division 2009. Guidelines for Establishing Community Based Collaborative Fisheries Management in Marine Waters of Tanzania. Dar es Salaam, Tanzania.

Forget F, Muir J, Hutchinson M, Itano D, Sancristobal I, Leroy B, Filmalter J, Martinez U, Holland K, Restrepo V, et al. 2021. Quantifying the accuracy of shark bycatch estimations in tuna purse seine fisheries. *Ocean and Coastal Management* 210.

Fourmanoir P 1954. Ichthyologie et pêche aux Comoros. *Ichthyologie et pêche aux Comores. Mémoires de l'Institut Scientifique de Madagascar. Série A: Biologie Animale* 9: 187–239.

Fourmanoir P 1961. Requins de la côte ouest de Madagascar. *Mémoires de l'Institut Scientifique de Madagascar. Série F: Océanographie* 4: 3–84.

Fourmanoir P 1963. Raies et requins-scie de la cote ouest de Madagascar (ordre des Batoidei). *Cahiers ORSTOM. Série Océanographie* 6: 33–58.

Fowler HW 1934. Natal fishes obtained by Mr. H. W. Bell-Marley. *Annals of the Natal Museum* 7: 403–433.

Fowler S 2014. The conservation status of migratory sharks. Bonn, Germany.

Fowler S, Bräutigam A, Okes N, Sant G 2021. Conservation, Fisheries, Trade and Management Status of CITES-Listed Sharks.

Fowler S, Reed T, Dipper F 2002. *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997*. S Fowler, T Reed, and F Dipper (eds). Gland, Switzerland and Cambridge: IUCN Species Survival Commission Shark Specialist Group.

Fowler SL, Cavanagh RD, Camhi M, Burgess GH, Cailliet GM, Fordham SV, Simpfendorfer CA, Musick JA 2005. *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey*. Gland, Switzerland and Cambridge, UK: IUCN/SSC Shark Specialist Group. IUCN.

Fricke R 1999. *Fishes of the Mascarene Islands (Reunion, Mauritius, Rodriguez)*. Königstein: Koeltz Scientific Books.

Fricke R, Chabanet P, Mulochau T, Durville P, Tessier E, Letourneur Y 2009. Annotated checklist of the fish species (Pisces) of La Réunion, including a Red List of threatened and declining species. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 2: 1–168.

Fricke R, Durville P, Bernardi G, Borsa P, Mou-Tham G, Chabanet P 2013. Checklist of the shore fishes of Europa Island, Mozambique Channel, southwestern Indian Ocean, including 302 new records. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 6: 247–276.

Fricke R, Eschmeyer WN, van der Laan R 2021. Eschmeyer's Catalog of Fishes: Genera, species, references. Accessed from http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp, 2021-11-9.

Fricke R, Mahafina J, Behivoke F, Henitsoa J, Léopold M, Ponton D 2018. Annotated checklist of the fishes of Madagascar, southwestern Indian Ocean, with 158 new records. *FishTaxa* 3: 1–432.

Froese R, Pauly D 2021. FishBase. World Wide Web electronic publication. Version (08/2021). Accessed from www.fishbase.org, 2021-11-9.

Gallagher AJ, Hammerschlag N 2011. Global shark currency: the distribution, frequency, and economic value of shark ecotourism. *Current Issues in Tourism* 14.

Gamoyo M, Obura D, Reason CJC 2019. Estimating Connectivity Through Larval Dispersal in the Western Indian Ocean. *Journal of Geophysical Research: Biogeosciences* 124.

Garcia A, Herrera M 2018. Assessing the Contribution of Purse Seine Fisheries to Overall Levels of Bycatch in the Indian Ocean.

Gardner CJ 2011. IUCN management categories fail to represent new, multiple-use protected areas in Madagascar. *Oryx* 45: 336–346.

Gardner CJ, Nicoll ME, Birkinshaw C, Harris A, Lewis RE, Rakotomalala D, Ratsifandrihamanana AN 2018. The rapid expansion of Madagascar's protected area system. *Biological Conservation* 220: 29–36.

Gastrow P 2001. Triad societies and Chinese organised crime in South Africa. Occasional Paper 48. South Africa.

Gates Andrew 2016. *Deep-sea life of Tanzania*. Southampton: National Oceanography Centre.

Gauthier ARG, Chateauminois E, Hoarau MG, Gadenne J, Hoarau E, Jaquemet S, Whitmarsh SK, Huveneers C 2020. Variable response to electric shark deterrents in bull sharks, *Carcharhinus leucas*. *Scientific Reports* 10.

Gianni M, Simpson W 2005. The Changing Nature of High Seas Fishing:How flags of convenience provide cover for illegal, unreported and unregulated fishing.

Gilchrist JDF 1902. Catalogue of fishes recorded from South Africa. Cape of Good Hope, Department of Agriculture. *Marine Investigations in South Africa* 1: 97–179.

Gilchrist JDF 1913. Description of a new species of sting-ray (*Trygon*) from South Africa. *Transactions of the Royal Society of South Africa* 3.

Gilchrist JDF 1921. Fisheries and Marine Biological Survey. Report no. 1 for the Year 1920. Annexure A. List of Fishes, etc., procured; Annexure B., List of stations of SS "Pickle"; Annexure C., Journal of SS "Pickle".

Gilchrist JDF 1922a. Deep-sea fishes procured by the S.A. "Pickle" (Part I.). Special Report (3).

Gilchrist JDF 1922b. Fisheries and Marine Biological Survey. Report no. 2 for the Year 1921. Annexure A. List of Fishes, etc., procured; Annexure B., List of stations of SS "Pickle"; Annexure C., Journal of SS "Pickle."

Gilchrist JDF, von Bonde C 1924. Deep-sea fishes procured by the S.S. "Pickle" (Part II).

Gilchrist JDF, Thompson WW 1916. A catalogue of the sea fishes recorded from Natal. Part I. *Annals of the Durban Museum* 1: 255–290.

Glaser S, Roberts P, Mazurek R, Hurlburt K, Kane-Hartnet L 2015. Securing Somali Fisheries. Broomfield, Colorado.

Glaser SM, Roberts PM, Hurlburt KJ 2019. Foreign Illegal, Unreported, and Unregulated Fishing in Somali Waters Perpetuates Conflict. *Frontiers in Marine Science* 6.

Govan H, Aalbersberg W, Tawake A, Parks J 2008. Locally-Managed Marine Areas: A Guide for Practitioners. The Locally-Managed Marine Area Network. Suva, Fiji.

Gove 2011. Mozambique National Policy and Governance Assessment for Management of Marine and Coastal Resources.

Gove D, Pacule H, Goncalves M 2001. The impact of Sofala Bank (central Mozambique) shallow water shrimp fishery on marine turtles and the effects of introducing TED (Turtle Excluder Device) on shrimp fishery. Maputo, Mozambique.

Government of Kenya 2013. The Wildlife Conservation and Management Act, 2013.

Government of Mauritius 2015. National Plan of Action for Conservation and Management of Sharks (NPOA-Sharks, Mauritius). Port Louis.

Government of Mauritius 2018. Performance audit report: Moving towards sustainable artisanal fishery in Mauritius.

Government of Somalia 1959. Maritime Code (Legislative Decree 1 of 21 Feb 1959.

Government of Somalia 1985a. Somali Democratic Republic Fishery Law No. 23 of 30 November 1985. (1985, November 30).

Government of Somalia 1985b. Guidelines for fisheries joint venture with foreign partners.

Government of Somalia 2014. A Review of the Somali Fisheries Law (Law No. 23 of November 30, 1985), in accordance with Article 79, paragraph (d) of the Federal Constitution of Somalia.

Government of Somalia 2016. A Review of the Somali Fisheries Law (Law No. 23 of November 30, 1985), in accordance with Article 79, Paragraph (d) of the Federal Constitution of Somalia.

Government of Somaliland 1995. Fisheries Regulations of Somaliland Law No. 24 of 27 November 1995.

Granek EF, Brown MA 2005. Co-Management Approach to Marine Conservation in Mohéli, Comoros Islands. *Conservation Biology* 19.

van Grevelynghe G 1999. Attaques de requins à l'Île de La Réunion (sud-ouest de L'Ocean Indien). In: Seret B, Sire J-Y (eds), *Proceedings of the 3rd European Elasmobranch Association Meeting*. Boulogne-sur-Mer: Soc. Fr. lchtyol. & IRD.

Griffiths C 2005. Coastal marine biodiversity in East Africa. *Indian Journal of Marine Sciences* 34: 35–41.

Groeneveld J 2015. The Western Indian Ocean as a Source of Food. In: UNEP-Nairobi Convention, WIOMSA (eds), *Regional State of the Coast Report: Western Indian Ocean*. Nairobi: UNEP and WIOMSA. pp 261–270.

Groeneveld JC, Cliff G, Dudley SFJ, Foulis AJ, Santos J, Wintner SP 2014. Population structure and biology of shortfin mako, *Isurus oxyrinchus*, in the south-west Indian Ocean. *Marine and Freshwater Research* 65: 1045–1058.

Grubbs RD, Carlson JK, Romine JG, Curtis TH, McElroy WD, McCandless CT, Cotton CF, Musick JA 2016. Critical assessment and ramifications of a purported marine trophic cascade. *Scientific Reports* 6.

Guard M, Masaiganah M 1997. Dynamite fishing in southern Tanzania, geographical variation, intensity of use and possible solutions. *Marine Pollution Bulletin* 34: 758–762.

Guerreiro J, Chircop A, Dzidzornu D, Grilo C, Ribeiro R, van der Elst R, Viras A 2011. The role of international environmental instruments in enhancing transboundary marine protected areas: An approach in East Africa. *Marine Policy* 35.

Guézel R, Quartararo A, Aboutoihi L, Saindou K, Salaün P, Ybrahim B, Arnaud J 2009. Richesses de Mayotte — Parc naturel marin de Mayotte — Les hommes et l'océan — Mission d'étude pour la création d'un parc naturel marin à Mayotte. Mamoudzou (Mayotte).

Gulaid A 2004. Feasibility report on the fisheries sector in Somaliland: Current status, opportunities and constraints.

Guyomard D, Hohmann S, Fleury P, Bissery C 2012. Etude technico-économique sur les DCP ancrés de La Réunion — Rapport final. Comité Régional des Pêches Maritimes et des Elevages Marins de La Réunion, Le Port (France).

Guyomard D, Lee KA, Perry C, Jaquemet S, Cliff G 2020. SMART drumlines at Réunion Island do not attract bull sharks *Carcharhinus leucas* into nearshore waters: Evidence from acoustic monitoring. *Fisheries Research* 225.

Guyomard D, Perry C, Tournoux PU, Cliff G, Peddemors V, Jaquemet S 2019. An innovative fishing gear to enhance the release of non-target species in coastal shark-control programs: The SMART (shark management alert in real-time) drumline. *Fisheries Research* 216: 6–17.

Guyomard D, Poisson F, Stretta JM 2006. Synopsis de la pêche palangrière réunionnaise. In: Petit M, Huynh F (eds), *Halieutique et environnement océanique: le cas de la pêche palangrière à l'espadon depuis l'île de la Réunion*. Paris, France: Institut de Recherche pour le Développement. pp 79–91.

Haas AR, Fedler T, Brooks EJ 2017. The contemporary economic value of elasmobranchs in The Bahamas: Reaping the rewards of 25 years of stewardship and conservation. *Biological Conservation* 207.

Hadi S, Andayani N, Muttaqin E, Simeon BM, Ichsan M, Subhan B, Madduppa H 2020. Genetic connectivity of the scalloped hammerhead shark *Sphyrna lewini* across Indonesia and the Western Indian Ocean. *PLoS ONE* 15.

Hamada O 2010. Captures accidentelles et utilisation des requins par la pêcherie artisanale de Mayotte.

Hansen S 2008. Private security & local politics in Somalia. *Review of African Political Economy* 118: 585–598.

Harley S, Pilling G 2016. Potential implications of the choice of longline mitigation approach allowed within CMM 2014-05.

Harris A, Gove D 2015. SWIOFC: Ten Years Promoting and Strengthening Regional Cooperation for Securing Sustainable Fisheries in South West Indian Ocean (SWIO) Region.

Harrison LR, Dulvy NK 2014. Sawfish: A Global Strategy for Conservation. Vancouver, Canada.

Haskell PJ, McGowan A, Westling A, Méndez-Jiménez A, Rohner CA, Collins K, Rosero-Caicedo M, Salmond J, Monadjem A, Marshall AD, et al. 2015. Monitoring the effects of tourism on whale shark *Rhincodon typus* behaviour in Mozambique. *ORYX* 49: 492–499.

Hassan K 2011. A Review of Somalia's (& Semi-Autonomous Regions) Fisheries Legislation & Management.

Hauzer M, Dearden P, Murray G 2013. The fisherwomen of Ngazidja island, Comoros: fisheries livelihoods, impacts, and implications for management. *Fisheries Research* 140: 28–35.

Hauzer M, Poonian C, Iboura C 2008. Mohéli Marine Park, Comoros: successes and challenges of the co-management approach. In: Obura D, Tamelander J, Linden O (eds), *Ten years after bleaching - facing the consequences of climate change in the Indian Ocean. CORDIO Status Report*. Mombasa: Coastal Oceans Research and Development in the Indian Ocean/Sida-SAREC.

Hazin FH v, Burgess GH, Carvalho FC 2008. A Shark attack outbreak off Recife, Pernambuco, Brazil: 1992-2006.

Heemstra E, Heemstra P, Smale M, Hooper T, Pelicier D 2004. Preliminary checklist of coastal fishes from the Mauritian island of Rodrigues. *Journal of Natural History* (38 vol.). Taylor and Francis Ltd. pp 3315–3350.

Heemstra PC, Hissmann K, Fricke H, Smale MJ, Schauer J 2006. Fishes of the deep demersal habitat at Ngazidja (Grand Comoro) Island, Western Indian Ocean. *South African Journal of Science* 102: 444–460.

Hefley TJ, Hooten MB 2016. Hierarchical Species Distribution Models. *Current Landscape Ecology Reports* 1: 87–97.

Heileman S, Scott LEP n.d. II-5 Somali Coastal Current: LME #31.

Heinrichs S, O'Malley M, Medd H, Hilton P 2011. Manta ray of hope: global threat to manta and mobula rays.

Heithaus MR, Frid A, Wirsing AJ, Worm B 2008. Predicting ecological consequences of marine top predator declines. *Trends in Ecology and Evolution* 23: 202–210.

Heithaus MR, Wirsing AJ, Dill LM 2012. The ecological importance of intact top-predator populations: A synthesis of 15 years of research in a seagrass ecosystem. *Marine and Freshwater Research* 63: 1039–1050.

Herfaut J 2004. Suivi statistique de la pêcherie artisanale Mahoraise: évaluation de l'effort de pêche, des captures et des CPUE de 1997 à 2003.

Herfaut J 2005a. Evaluation de la rentabilité économique de l'exploitation des bancs éloignés (Geyzer, Zelée, Castor...) par la pêcherie artisanale mahorais. Mamoudzou (Mayotte).

Herfaut J 2005b. Suivie statistique de la pêcherie artisanale mahoraise: Effort de pêche, captures et CPUE en 2004.

Herfaut J 2006. Suivi statistique de la pêcherie artisanale Mahoraise: effort de pêche, capture et CPUE en 2005.

Heupel MR, Kanno S, Martins APB, Simpfendorfer CA 2018. Advances in understanding the roles and benefits of nursery areas for elasmobranch populations. *Marine and Freshwater Research* 70: 897–907.

Hill N 2005. *Livelihoods in an artisanal fishing community and the effect of ecotourism*. MSc Thesi, Imperial College London, London.

Hill NAO, Davidson J, Silva I, Mucave S, Muaves L, Guissamulo A, Debney A, Garnier J 2009. Coral and Reef Fish in the Northern Quirimbas Archipelago, Mozambique-A First Assessment.

Ho HM, Huang CY, Cheng YJ, Shen KY, Tzeng TT, Liu SJ, Chen HW, Huang CH, Huang MH 2021. Assessment of adjuvantation strategy of lipid squalene nanoparticles for enhancing the immunogenicity of a SARS-CoV-2 spike subunit protein against COVID-19. *International Journal of Pharmaceutics* 607.

Hoarau F, Darnaude A, Poirout T, Jannel LA, Labonne M, Jaquemet S 2021. Age and growth of the bull shark (*Carcharhinus leucas*) around Reunion Island, South West Indian Ocean. *Journal of Fish Biology* 99: 1087–1099.

Hong Kong Census and Statistics Department 2021. Hong Kong Statistics. Government of Hong Kong (SAR of China). Accessed from http://www.censtatd.gov.hk/hkstat/, 2021-11-9.

Hosegood J 2020. *Genomic Tools for Conservation and Management of Manta and Devil Rays (*Mobula *spp.)*. Doctor of Philosophy, Bangor University.

Houssoyni H 2021. Marine and coastal areas under protection: Comoros. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 25–40.

HSI 2019. National laws, multi-lateral agreements, regional and global regulations on shark protection and shark finning. As of October 2019.

Hulley PA 1966. The validity of *Raja rhizacanthus* Regan and *Raja pullopunctata* Smith, based on a study of the clasper. *Annals of the South African Museum* 48: 497–514.

Hulley PA 1969. The relationship between *Raja miraletus* Linnaeus and *Raja ocellifera* Regan based on a study of the clasper. *Annals of the South African Museum* 52: 137–147.

Hulley PA 1970. An investigation of the Rajidae of the west and south coasts of southern Africa. *Annals of the South African Museum* 55: 151–220.

Hulley PA 1971. *Centrophorus squamosus* (Bonnaterre) (Chondrichthyes, Squalidae) in the eastern south Atlantic. *Annals of the South African Museum* 57: 265–270.

Hulley PA 1972a. A new species of southern African brevirajid skate (Chondrichthyes, Batoidei, Rajidae). *Annals of the South African Museum* 60: 253–263.

Hulley PA 1972b. The origin, interrelationships and distribution of southern African Rajidae (Chondrichthyes, Batoidei). *Annals of the South African Museum* 60: 1–103.

Hulley PA 1973. Interrelationships within the Anacanthobatidae (Chondrichthyes, Rajoidea), with a description of the lectotype of *Anacanthobatis marmoratus* von Bonde & Swart, 1923. *Annals of the South African Museum* 62: 131–158.

Hulley PA, Penrith MJ 1966. *Euprotomicroides zantedeschia*, a new genus and species of pigmy dalatiid shark from South Africa. *Bulletin of Marine Science* 16: 222–229.

Hulley PA, Stehmann M 1977. The validity of *Malacoraja* Stehmann, 1970 (Chondrichthyes; Batoidei, Rajidae) and its phylogenetic significance. *Annals of the South African Museum* 72: 227–237.

Human BA 2006. A taxonomic revision of the catshark genus Holohalaelurus Fowler 1934 (Chondrichthyes: Carcharhiniformes: Scyliorhinidae), with descriptions of two new species. *Zootaxa* 1315: 1–56.

Humber F, Andriamahaino ET, Beriziny T, Botosoamananto R, Godley BJ, Gough C, Pedron S, Ramahery V, Broderick AC 2017. Assessing the small-scale shark fishery of Madagascar through community-based monitoring and knowledge. *Fisheries Research* 186: 131–143.

Humber F, Andriamahefazafy M, Godley BJ, Broderick AC 2015. Endangered, essential and exploited: How extant laws are not enough to protect marine megafauna in Madagascar. *Marine Policy* 60: 70–83.

Hussey NE, Kessel ST, Aarestrup K, Cooke SJ, Cowley PD, Fisk AT, Harcourt RG, Holland KN, Iverson SJ, Kocik JF, et al. 2015. Aquatic animal telemetry: A panoramic window into the underwater world. *Science* 348.

Hussey NE, McCarthy ID, Dudley SFJ, Mann BQ 2009. Nursery grounds, movement patterns and growth rates of dusky sharks, *Carcharhinus obscurus*: a long-term tag and release study in South African waters. *Marine and Freshwater Research* 60: 571.

IDPPE 2013. Support to the Fisheries Sector of Mozambique 2013-2017.

IEDOM 2006. Mayotte en 2005. Institut d'Émission des Départements d'Outre-Mer (IEDOM).

Iglésias SP, Toulhoat L, Sellos DY 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20.

IHO 1953. Limits of oceans and seas. *International Hydrographic Organization* 23: 1–42.

IIP 2015. Relatório Anual 2014. Instituto Nacional de Investigação Pesqueira.

IMF 2021. IMF Data. Accessed from https://www.imf.org/en/Data, 2021-11-10.

Inacio A 2017. Dinamica populacional na pescaria do tubarao de profundidade "peixe gata" no canal de Moçanbique. Sofala.

IOC-SmartFish 2016. The shark fin trade in Mombasa, Kenya as an indicator of port State measures implementation: challenges and recommendations for improvement. Gaborone.

IOTC 2005. Information on shark finning fisheries (submitted by Japan). Victoria, Seychelles.

IOTC 2011. Resolution 11/04 on a regional observer scheme.

IOTC 2012a. Resolution 10/12 On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC agreement area.

IOTC 2012b. Resolution 12/12 To prohibit the use of large-scale driftnets on the high seas in the IOTC area.

IOTC 2013a. Resolution 13/05 on the conservation of whale sharks (*Rhincodon typus*).

IOTC 2013b. Resolution 13/06 on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries.

IOTC 2013c. Examination of the effects of piracy on fleet operations and subsequent catch and effort trends.

IOTC 2015a. Resolution 15/01 On the recording of catch and effort data by fishing vessels in the IOTC area of competence.

IOTC 2015b. The Seychelles NPOA for Sharks 2007-2010 Review. 11th Working Party on Ecosystems and Bycatch.

IOTC 2016. Resolution 16/11 on Port State Measures to prevent, deter and eliminate illegal, unreported and unregulated fishing.

IOTC 2017. Resolution 17/05 on the conservation of sharks caught in association with fisheries managed by IOT.

IOTC 2018a. Report of the 14th Session of the IOTC Working Party on Ecosystems and Bycatch. Cape Town, South Africa 10 – 14 September 2018.

IOTC 2018b. Resolution 18/02 on management measures for the conservation of blue shark caught in association with IOTC fisheries.

IOTC 2019a. Executive summary: scalloped hammerhead shark - Status of the Indian Ocean Scalloped Hammerhead Shark (SPL: *Sphyrna lewini*).

IOTC 2019b. Executive summary: silky shark - Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*).

IOTC 2019c. Compendium of active conservation and management measures for the Indian Ocean Tuna Commission. Victoria, Mahé.

IOTC 2019d. Resolution 19/02 procedures on a fish aggregating devices (FADs) management plan.

IOTC 2019e. Resolution 19/03 on the conservation of mobulid rays caught in association with fisheries in the IOTC Area of Competence.

IOTC 2019f. Resolution 19/06 on establishing a programme for transhipment by large-scale fishing vessels.

IOTC 2020. Status of implementation of National Plans of Action (NPOA) for sharks and seabirds and implementation of the FAO Guidelines to Reduce Marine Turtle Mortality in Fisheries Operations.

IOTC 2021a. Report of the 17th Session of the IOTC Working Party on Ecosystems and Bycatch.

IOTC 2021b. Status of development and implementation of National Plans of Action (NPOA) for seabirds and sharks and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations.

IOTC Secretariat 2015a. IOTC Compliance Report for: Comoros. IOTC-2015-CoC12-CR04 [E].

IOTC Secretariat 2015b. IOTC Compliance Report for: France (Territories). IOTC-2015-CoC12-CR07 [E].

IOTC Secretariat 2015c. IOTC Compliance Report for: South Africa. IOTC-2015-CoC12-CR35 [E].

IOTC Secretariat 2015d. IOTC Compliance Report for: Tanzania. IOTC-2015-CoC12-CR28.

IOTC Secretariat 2020a. IOTC Compliance Report for: Comoros. IOTC-2020-CoC17-CR04 [E/F].

IOTC Secretariat 2020b. IOTC Compliance Report for: European Union. IOTC-2020-CoC17-CR06.

IOTC Secretariat 2020c. IOTC Compliance Report for: France. IOTC-2020-CoC17-IR07.

IOTC Secretariat 2020d. IOTC Compliance Report for: Seychelles. IOTC-2020-CoC17-CR22 [E/F].

IOTC Secretariat 2021a. IOTC Compliance Report for: Comoros. IOTC-2021-CoC18-CR04 [E/F].

IOTC Secretariat 2021b. IOTC Compliance Report for: Kenya. KE IOTC-2021-CoC18-CR12 [E/F].

IOTC Secretariat 2021c. IOTC Compliance Report for: Madagascar. IOTC-2021-CoC18-CR14 [E/F].

IOTC Secretariat 2021d. IOTC Compliance Report for: Mauritius. IOTC-2021-CoC18-CR17 [E/F].

IOTC Secretariat 2021e. IOTC Compliance Report for: Mozambique. IOTC-2021-CoC18-CR18 [E/F].

IOTC Secretariat 2021f. IOTC Compliance Report for: France (OT). IOTC-2021-CoC18-CR07 [E/F].

IOTC Secretariat 2021g. IOTC Compliance Report for: European Union. IOTC-2021-CoC18-CR06_Rev1 [E/F].

IOTC Secretariat 2021h. IOTC Compliance Report for: Seychelles. IOTC-2021-CoC18-CR22 [E/F].

IOTC Secretariat 2021i. IOTC Compliance Report for: Somalia. IOTC-2021-CoC18-CR23 [E/F].

IOTC Secretariat 2021j. IOTC Compliance Report for: South Africa. IOTC-2021-CoC18-CR24 [E/F] .

IOTC Secretariat 2021k. IOTC Compliance Report for: Tanzania. IOTC-2021-CoC18-CR27 [E/F].

ITF 2021. Current registries listed as FOCs. Accessed from http://www.itfseafarers.org/foc-registries.cfm, 2021-11-10.

IUCN 2017. The Promise of Sydney: Our Commitment to Action for the Promise of Sydney.

IUCN 2019. Guidelines for Using the IUCN Red List Categories and Criteria. Version 14.

IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-2. Accessed from https://www.iucnredlist.org, 2021-11-8.

IUCN/TRAFFIC 2002. Report on implementation of the International Plan of Action for Sharks (IPOA-SHARKS): AC18 DOC. 19.2. Eighteenth meeting of the Animals Committee, San José (Costa Rica), 8-12 April 2002.

Jabado R, Abercrombie L 2022. CITES Sharks and Rays - Implementing and Enforcing Listings: Volume I - Full Carcass ID. Wildlife Conservation Society, New York, United States. 79 pp.

Jabado R, Kyne P, Pollom R, Ebert D, Simpfendorfer C, Ralph G, Dulvy N 2017. *The Conservation Status of Sharks, Rays, and Chimaeras in the Arabian Sea and Adjacent Waters.* Vancouver, Canada: Environment Agency – Abu Dhabi, UAE and IUCN Species Survival Commission Shark Specialist Group.

Jabado RW, Ebert DA 2015. *Sharks of the Arabian Seas: an identification guide*. Dubai, UAE: The International Fund for Animal Welfare.

Jaccoud A 2014. Mieux comprendre pour mieux agir. Approche sociale de la crise requin. Saint-Denis, La Réunion.

Jacquet J, Zeller D 2007a. National conflict and fisheries: Reconstructing marine fisheries catches for Mozambique. *Fisheries Centre Research Reports* 15: 35–47.

Jacquet J, Zeller D 2007b. Putting the 'United' in the United Republic of Tanzania: Reconstructing marine fisheries catches. *Fisheries Centre Research Reports* 15: 49–60.

Jacquet J, Fox H, Motta H, Ngusaru A, Zeller D 2010a. Few data but many fish: Marine small-scale fisheries catches for Mozambique and Tanzania. *African Journal of Marine Science* 32: 197–206.

Jacquet J, Fox H, Motta H, Ngusaru A, Zeller D 2010b. Few data but many fish: Marine small-scale fisheries catches for Mozambique and Tanzania. *African Journal of Marine Science* 32: 197–206.

James J 1988. Summary of the fisheries and resources information for the Comoros. In: Sanders M, Sparre P, Venema S (eds), *Proceedings of the workshop on the assessment of the fishery resources in the southwest Indian Ocean*. Albion: RAF/79/065/WP/41/88/E. FAO/UNDP.

Jamon A, Wickel J, Kiszka J, Layssac K, Seret B 2010. Synthèse des connaissances actuelles sur l'inventaire des élasmobranches de Mayotte (Océan Indien).

Janse M, Zimmerman B, Geerlings L, Brown C, Nagelkerke LAJ 2017. Sustainable species management of the elasmobranch populations within European aquariums: a conservation challenge. *Journal of Zoo and Aquarium Research* 5: 172–181.

Jaquemet S, Gyomard D, Evgeny R 2015. Response to questionnaire completed by Sebastien Jaquemet (Université de la Réunion), David Guyomard (CRPMEM) and Evgeny Romano. Unpublished.

Jaquemet S, Smale M, Blaison A, Guyomard D, Soria M 2012. First Observation of a Pregnant Tiger Shark (*Galeocerdo cuvier*) at Reunion Island, Western Indian Ocean. *Western Indian Ocean Journal of Marine Science* 11: 205–207.

Jeffers VF, Humber F, Nohasiarivelo T, Botosoamananto R, Anderson LG 2019. Trialling the use of smartphones as a tool to address gaps in small-scale fisheries catch data in southwest Madagascar. *Marine Policy* 99: 267–274.

Jennings T 1998. *Marine living resource governance in the absence of a central authority: A study of Somalia*. (Master's thesis), University of Washington, Seattle, Washington.

Jennings T 2001. Controlling access in the absence of a central government: the Somali dilemma. In: Mann Borgese E, Chircop A, McConnell M (eds), *Ocean Yearbook 15*. Chicago, IL (USA): The University of Chicago Press. pp 403–427.

Jewell OJD, Wcisel MA, Towner A v., Chivell W, van der Merwe L, Bester MN 2014. Core habitat use of an apex predator in a complex marine landscape. *Marine Ecology Progress Series* 506: 231–242.

Jiddawi N 2015. Response to questionnaire completed by N.S. Jiddawi, Institute of Marine Sciences, University of Dar Es Salaam. Unpublished.

Jiddawi NS, Öhman MC 2002. Marine Fisheries in Tanzania. *AMBIO: A Journal of the Human Environment* 31: 518.

Jiddawi NS, Stanley RD 1999. A study of the artisanal fishery landings in the villages of Matemwe and Mkokotoni, Zanzibar.

Joachim D, Razafimandimby D 2015. Shark catch characteristics by national longliner fleets in Madagascar (2010-2014). 11th Working Party on Ecosystems and Bycatch. IOTC-2015-WPEB11-21 Rev_1.

Johnstone G 2004. Artisanal fisheries co-management in Mozambique: Quirimbas Archipelago. Working Paper No. 22. Windhoek, Namibia.

Jolly K, da Silva C, Jarre A, Atwood C 2011. Spatial and temporal patterns in blue shark (*Prionace glauca*) catch in South African longline fisheries.

Jonahson M, Harding S 2007. Occurrence of whale sharks (*Rhincodon typus*) in Madagascar. *Fisheries Research* 84: 132–135.

Jordaan GL, Mann BQ, Daly R, Dunlop SW, Cowley PD 2021. Movement patterns and growth rate of the whitespotted wedgefish *Rhynchobatus djiddensis* in southern Africa based on tag-recapture data. *African Journal of Marine Science* 43: 201–213.

Jorgensen SJ, Micheli F, White TD, Van Houtan KS, Alfaro-Shigueto J, Andrzejaczek S, Arnoldi NS, Baum JK, Block B, Britten GL, Butner C 2022. Emergent research and priorities for shark and ray conservation. *Endangered Species Research* 47: 171–203.

Kaschner CJ, Weigmann S, Thiel R 2015. *Bythaelurus tenuicephalus* n. sp., a new deep-water catshark (Carcharhiniformes, Scyliorhinidae) from the western Indian Ocean. *Zootaxa* 4013: 120–138.

Kaunda-Arara B 2016. Ecology and Fishery of the Scalloped Hammerhead Shark (*Sphyrna lewini*) on the north coast of Kenya.

KBA Partnership 2020. KBA Programme Annual Report 2019.

KCDP 2013. Catch Assessment Survey of Marine and Coastal Fisheries in Kenya: Standard Operating Procedures 2013/2016.

Kelleher K 1998. Approaches to marine fisheries governance in Somalia. Draft report, the protection and sustainable development of Somalia marine environment, seaports and coastal areas.

Kelleher K 2002. Planning cost-effective fisheries monitoring, control and surveillance in Mozambique.

Kenya National Bureau of Statistics 2019. 2019 Kenya population and housing census. Vol 1: Population by county and sub-county.

Kiilu BK 2016. Growth, mortality and exploitation rates of shark species caught as bycatch in small-scale tuna fisheries in coastal Kenya. Mombasa.

Kiilu BK, Ndegwa S 2013. Shark bycatch - small-scale tuna fishery interactions along the Kenyan coast.

Kiilu BK, Kaunda-Arara B, Oddenyo RM, Thoya P, Njiru JM 2019. Spatial distribution, seasonal abundance and exploitation status of shark species in Kenyan coastal waters. *African Journal of Marine Science* 41: 191–201.

Kimani EN, Okemwa GM, Kazungu JM 2019. Fisheries in the Southwest Indian Ocean: Trends and Governance Challenges.

Kiszka J 2012. Bycatch assessment of vulnerable megafauna in coastal artisanal fisheries in the southwest Indian Ocean.

Kiszka J, van der Elst RP 2015. Elasmobranchs (sharks and rays). In: van der Elst R.P., Everett BI (eds), *Offshore fisheries of the Southwest Indian Ocean: their status and the impact on vulnerable species*. Durban, South Africa: Oceanographic Research Institute Special Publication 10. p undefined-448.

Kiszka J, Bein A, Bach P, Jamon A, Layssac K, Labart S, Wickel J 2010. Catch and bycatch in the pelagic longline fishery around Mayotte (NE Mozambique Channel), July 2009-September 2010.

Kiszka J, Jamon A, Wickel J, Pusineri C 2008. Raie manta: ce visiteur hivernal du lagon.

Kiszka J, Jamon A, Wickel J, Sauvignet H 2009. Les requins dans les îles de l'océan Indien occidental-Biodiversité, distribution et interactions avec les activités humaines Pour le compte du WWF France.

Klein JD, der Merwe AEB van, Dicken ML, Emami-Khoyi A, Mmonwa KL, Teske PR 2020. A globally threatened shark, *Carcharias taurus*, shows no population decline in South Africa. *Scientific Reports* 10.

Kock A, O'Riain MJ, Mauff K, Meÿer M, Kotze D, Griffiths C 2013. Residency, Habitat Use and Sexual Segregation of White Sharks, *Carcharodon carcharias* in False Bay, South Africa. *PLoS ONE* 8: e55048.

Kroese M, Sauer W 1998. Elasmobranch exploitation in Africa. *Marine and Freshwater Research* 49: 573–577.

Kuang HK 1999. Non-food use of sharks. In: Vannuccini S (ed.), *Shark utilization, marketing and trade*. Rome: FAO Fisheries Technical Paper No. 389. pp 285–294.

Kuguru G, Gennari E, Wintner S, Dicken ML, Klein JD, Rhode C, Bester-van der Merwe AE 2019. Spatio-temporal genetic variation of juvenile smooth hammerhead sharks in South Africa. *Marine Biology Research* 15: 568–579.

Kulmiye AJ 2010. Assessment of the status of the artisanal fisheries in Puntland through value chain analysis.

Kyne PM, Jabado RW 2019. *Glaucostegus halavi*. The IUCN Red List of Threatened Species.

Kyne PM, Gledhill K, Jabado RW 2019. *Rhynchobatus djiddensis*. The IUCN Red List of Threatened Species 2019.

Lack M, Sant G 2008. Illegal, unreported and unregulated shark catch: A review of current knowledge and action (PDF, 1 MB).

Lack M, Sant G 2009. Trends in global shark catch and recent developments in management.

Lado E 2016. *The common fisheries policy: the quest for sustainability*. Brussels: John Wiley & Sons.

Lagabrielle E, Allibert A, Kiszka JJ, Loiseau N, Kilfoil JP, Lemahieu A 2018. Environmental and anthropogenic factors affecting the increasing occurrence of shark-human interactions around a fast-developing Indian Ocean Island. *Scientific Reports* 8.

Lamberth SJ 2006. White shark and other chondrichthyan interactions with the beach-seine (treknet) fishery in False Bay, South Africa. *African Journal of Marine Science* 28: 723–727.

Langley JM 2006. Vezo Knowledge: Traditional Ecological Knowledge in Andavadoaka, southwest Madagascar. Blue Ventures Conservation Report.

Lankester K, Fourgon D, Zableckis S 2012. EU tuna fisheries access in the Western Indian Ocean: with an analysis of the fisheries partnership agreement between Madagascar and The EU.

Last J 1929. Economic Fisheries of Zanzibar.

Last P, Bogorodsky S, Alpermann T 2016a. *Maculabatis ambigua* sp. Nov., a new whipray (Myliobatiformes: Dasyatidae) from the Western Indian Ocean. *Zootaxa* 4154: 66–78.

Last PR, Naylor GJP, Manjaji-Matsumoto BM 2016b. A revised classification of the family Dasyatidae (Chondrichthyes: Myliobatiformes) based on new morphological and molecular insights. *Zootaxa* 4139: 345–368.

Last PR, White WT, de Carvalho MR, Séret B, Stehmann MF, Naylor GJ 2016c. *Rays of the World* (1st edn). Clayton South: CSIRO Publishing.

Last PR, White WT, Séret B 2016d. Taxonomic status of maskrays of the *Neotrygon kuhlii* species complex (Myliobatoidei: Dasyatidae) with the description of three new species from the Indo-West Pacific. *Zootaxa* 4083: 533–561.

Lawson JM, Fordham S v., O'Malley MP, Davidson LNK, Walls RHL, Heupel MR, Stevens G, Fernando D, Budziak A, Simpfendorfer CA, et al. 2017. Sympathy for the devil: A conservation strategy for devil and manta rays. *PeerJ* 2017.

Lea JSE, Humphries NE, von Brandis RG, Clarke CR, Sims DW 2016. Acoustic telemetry and network analysis reveal the space use of multiple reef predators and enhance marine protected area design. *Proceedings of the Royal Society B: Biological Sciences* 283.

Lea JSE, Humphries NE, Clarke CR, Sims DW 2015. To Madagascar and back: Long-distance, return migration across open ocean by a pregnant female bull shark *Carcharhinus leucas*. *Journal of Fish Biology* 87: 1313–1321.

Leckraz S 2021. Marine and coastal areas under protection: Republic of Mauritius. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 103–118.

Leeney RH 2017. Are sawfishes still present in Mozambique? A baseline ecological study. *PeerJ* 2017.

Leeney RH, Abouhouri AB in prep. Using historical records and Local Ecological Knowledge to describe the historical distribution and current status of sawfishes (Pristidae) in Madagascar.

Lemahieu A, Blaison A, Crochelet E, Bertrand G, Pennober G, Soria M 2017. Human-shark interactions: The case study of Reunion Island in the south-west Indian Ocean. *Ocean and Coastal Management* 136: 73–82.

Letourneur Y, Chabanet P, Durville P, Taquet M, Teissier E, Parmentier M, Quéro J-C, Pothin K 2004. An updated checklist of the marine fish fauna of Reunion Island, south-western Indian Ocean. *Cybium* 28: 199–216.

Levine A 2007. Staying afloat: State agencies, local communities, and international involvement in marine protected area management in Zanzibar, Tanzania. *Conservation and Society* 5: 562.

Lezama-Ochoa N, Lopez J, Hall M, Bach P, Abascal F, Murua H 2020. Spatio-temporal distribution of the spinetail devil ray Mobula mobular in the eastern tropical Atlantic Ocean. Endangered Species Research 43: 447–460.

Loiseau N, Kiszka JJ, Bouveroux T, Heithaus MR, Soria M, Chabanet P 2016. Using an unbaited stationary video system to investigate the behaviour and interactions of bull sharks Carcharhinus leucas under an aquaculture farm. African Journal of Marine Science 38: 73–79.

Lopes S, Pinto M 2001. Illegal fishing: the case of Mozambique. Forging unity: coastal communities and the Indian Ocean's future. Chennai, India.

Louro CMM, Pereira MAM, Litulo C, Pereira TIFC, Fernandes RS 2017. Investigação e monitoria de espécies e ecossistemas nas áreas de conservação marinhas em Moçambique: Levantamento de prioridades e capacidades para a implementação de programas de monitoria. Report to the National Administration of Conservation Areas (ANAC). Maputo.

Lovatelli A 1996. Artisanal fisheries final report. Nairobi (Kenya).

Lucifora LO, García VB, Worm B 2011. Global diversity hotspots and conservation priorities for sharks. PLoS ONE 6.

Lundin G 1992. Coastal and Environment Problems in the United Republic of Tanzania.

Machado P, Matos J 2003. Analise da distribuicao, abundancia e biologia de tres especies de tubaroes de profundidade da vertente continental Portuguesa utilizando um sistema de informacao geographica . Relatorios cientificos e Tecnicos, Serie Digital. IPIMAR. p 23 pp.

Machumu M 2021. Marine and coastal areas under protection: United Republic of Tanzania - Tanzania mainland. In: UNEP-Nairobi Convention, WIOMSA (eds), Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets. Nairobi: UNEP and WIOMSA. pp 187–202.

MacNeil MA, Chapman DD, Heupel M, Simpfendorfer CA, Heithaus M, Meekan M, Harvey E, Goetze J, Kiszka J, Bond ME, et al. 2020. Global status and conservation potential of reef sharks. Nature 583: 801–806.

Madagascar 1994. Décret no 94/112 portant organisation générale des activités de pêche maritime.

Maduna SN, Hull KL, Farrell ED, Boomer JJ, Veríssimo A, Marino IAM, Mazzoldi C, Zane L, Wintner SP, Chesalin M v., et al. 2020. Historical biogeography of smoothhound sharks (genus Mustelus) of Southern Africa reveals multiple dispersal events from the Northern Hemisphere. Systematics and Biodiversity 18: 633–645.

Maduna SN, Rossouw C, da Silva C, Soekoe M, Bester-van der Merwe AE 2017. Species identification and comparative population genetics of four coastal houndsharks based on novel NGS-mined microsatellites. Ecology and Evolution 7: 1462–1486.

Maduna SN, da Silva C, Wintner SP, Roodt-Wilding R, Bester-Van Der Merwe AE 2016. When two oceans meet: Regional population genetics of an exploited coastal shark, *Mustelus mustelus*. *Marine Ecology Progress Series* 544: 183–196.

Maggiorani F, Maggiorani J 1990. Enquête sur la pêche artisanale Mahoraise. Tome 2: effort de pêche et captures.

Mahomoodally MF, Muthoorah LD 2014. An ethnopharmacological survey of natural remedies used by the Chinese community in Mauritius. *Asian Pacific Journal of Tropical Biomedicine* 4: S387–S399.

Mamode A 2011. Bycatch landings in Mauritius for 2009/2010.

Mamode AS, Sooklall T, Curpen M 2014. Mauritius National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2014 Information on fisheries, research and statistics.

Le Manach F, Abunge CA, Mcclanahan TR, Pauly D 2015a. Tentative reconstruction of Kenya's marine fisheries catch, 1950-2010. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010*. pp 37–51.

Le Manach F, Bach P, Barret L, Guyomard D, Fleury P-G, Sabarros PS, Pauly D 2015b. Reconstruction of the domestic and distant-water fisheries catch of La Réunion (France), 1950-2010. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010*. Fisheries Centre, University of British Columbia. pp 83–98.

Le Manach F, Bach P, Boistol L, Robinson J, Pauly D 2015c. Artisanal fisheries in the world's second largest tuna fishing ground — Reconstruction of the Seychelles' marine fisheries catch, 1950-2010. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010*. pp 99–110.

Le Manach F, Gough C, Harris A, Humber F, Harper S, Zeller D 2012. Unreported fishing, hungry people and political turmoil: The recipe for a food security crisis in Madagascar. *Marine Policy* 36: 218–225.

Le Manach F, Gough C, Humber F, Harper S, Zelle D 2011a. Reconstruction of total marine fisheries catches for Madagascar (1950-2008). In: Harper S, Zeller D (eds), *Fisheries catch reconstructions: Islands, Part II*. Vancouver: The Fisheries Centre. pp 21–37.

Le Manach F, Gough C, Humber F, Harper S, Zeller D 2011b. Reconstruction of total marine fisheries cathes for Madagascar (1950-2008). In: Harper S, Zeller D (eds), *Fisheries catch reconstructions: Islands, Part II*. Fisheries Centre, University of british Columbia. pp 21–37.

Maoulida K, Hauzer M, Poonian C, Kiszka J 2009. Artisanal shark fisheries of the Comoros: status and threats. 6th Scientific Symposium of the Western Indian Ocean Marine Science Association, La Réunion, France, 24-29 August 2009.

Marchand J 1956. Twenty-Sixth Annual Report for the Period 1st April 1954 to 31st March, 1955.

Marchand J 1957. Twenty-Seventh Annual Report for the Period 1st April 1955 to 31st March, 1956.

Mariani S, Fernandez C, Baillie C, Magalon H, Jaquemet S 2021. Shark and ray diversity, abundance and temporal variation around an Indian Ocean Island, inferred by eDNA metabarcoding. *Conservation Science and Practice* 3.

Marques da Silva I 2015. Response to questionnaire completed by I. Marques da Silva, Universidade Lúrio, Nampula. Unpublished.

Marshall AD 2009. *Biology and population ecology of* Manta birostris *in southern Mozambique*. PhD, University of Queensland, Brisbane.

Marshall AD, Bennett MB 2010. Reproductive ecology of the reef manta ray *Manta alfredi* in southern Mozambique. *Journal of Fish Biology* 77: 169–190.

Marshall AD, Compagno LJ v, Bennett MB 2009. Article Redescription of the genus Manta with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). *Zootaxa* 2301: 1–28.

Marshall AD, Dudgeon CL, Bennett MB 2011. Size and structure of a photographically identified population of manta rays *Manta alfredi* in southern Mozambique. *Marine Biology* 158: 1111–1124.

Marshall N 1997a. Trade in sharks and shark products in Kenya waters. In: Marshall N, Barnett R (eds), *The trade in sharks and shark products in the Western Indian and Southeast Altantic Oceans*. Nairobi, Kenya: TRAFFIC East/Southern Africa. pp 31–38.

Marshall N 1997b. The Seychelles shark fishery. In: Marshall N, Barnett R (eds), *The trade in sharks and shark products in the Western Indian and Southeast Atlantic Oceans*. Nairobi: TRAFFIC East/SOuthern Africa. pp 13–18.

Marshall N 1997c. The Somali Shark Fishery in the Gulf of Aden and the Western Indian Ocean. In: Marshall N, Barnett R (eds), *The trade in sharks and shark products in the Western Indian and Southeast Atlantic Oceans*. TRAFFIC East/Southern Africa. pp 24–30.

Marshall NT, Barnett R 1997. The trade in sharks and shark products in the Western Indian and Southeast Atlantic Oceans. Nairobi, Kenya.

Martin J 2011. Fisheries in the Seychelles and fisheries agreements with the EU. Note IP/B/PECH/NT/2011_04. Brussels, Belgium.

Mayol TL 2013. Madagascar's nascent locally managed marine area network. *Madagascar Conservation & Development* 8: 91–95.

Mbukwa R, Shunula P, Mshana JG, Sweke EA, Mchenga ISS 2019. United Republic of Tanzania National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2019.

McAuley RB, Simpfendorfer CA, Hyndes GA, Allison RR, Chidlow JA, Newman SJ, Lenanton RCJ 2006. Validated age and growth of the sandbar shark, *Carcharhinus plumbeus* (Nardo 1827) in the waters off Western Australia. *Environmental Biology of Fishes* 77.

McClanahan T, Davies J, Maina J 2005. Factors influencing resource users and managers' perceptions towards marine protected area management in Kenya. *Environmental Conservation* 32.

McClanahan T, Muthiga NA, Abunge CA 2016. Establishment of Community Managed Fisheries' Closures in Kenya: Early Evolution of the *Tengefu* Movement. *Coastal Management* 44.

McClenachan L, Cooper AB, Dulvy NK 2016. Rethinking Trade-Driven Extinction Risk in Marine and Terrestrial Megafauna. *Current Biology* 26: 1640–1646.

McCord ME, Lamberth SJ 2009. Catching and tracking the world's largest Zambezi (bull) shark *Carcharhinus leucas* in the Breede Estuary, South Africa: The first 43 hours. *African Journal of Marine Science* 31: 107–111.

McEachran JD, Fechhelm JD 1982. A new species of skate from the western Indian Ocean, with comments on the status of Raja (Okamejei) (Elasmobranchii: Rajiformes). *Proceedings of the Biological Society of Washington* 95: 440–450.

McLean B, Hikmany A-NH, Mangora M, Shalli M 2012. Legal and Institutional Framework for Effective Management of Marine Managed Areas in Tanzania, Zanzibar Report. *SSRN Electronic Journal*.

MCSS 2015. Response to questionnaire completed by D. Rowat. Unpublished.

McVean AR, Walker RCJ, Fanning E 2006. The traditional shark fisheries of southwest Madagascar: A study in the Toliara region. *Fisheries Research* 82: 280–289.

Micarelli P, Venanzi E 2019. New grey reef shark (*Carcharhinus amblyrhynchos*) nursery in the Mozambique channel close to Nosy Be Island - Madagascar. *Poster contribution for the European Elasmobranch Associatio*.

MLFD 2014. An overview of the fisheries subsector: Achievements, challenges and priorities for the financial year 2014/15.

MLFD 2015. National Fisheries Policy of 2015.

MLFD 2018. The United Republic of Tanzania Ministry of Livestock and Fisheries - Marine fisheries frame survey 2018 report.

Mngulwi B 2006. Country review: United Republic of Tanzania. In: de Young C (ed.), *Review of the state of the world marine capture fisheries management: Indian Ocean. FAO Fisheries Technical Paper No. 488*. Rome: FAO. p 458 pp.

Mohamed Y, Simba F 2016. Role of Fishing on Economic Development of Somalia: Case Study of Lido Beach Mogadishu Somalia. *Finance Management* 99: 42944–42951.

Moore A, Gates A 2020. Deep-water observation of scalloped hammerhead *Sphyrna lewini* in the Western Indian Ocean off Tanzania. *Marine Biodiversity Records* 8.

Mootoosamy A, Fawzi Mahomoodally M 2014. A quantitative ethnozoological assessment of traditionally used animal-based therapies in the tropical island of Mauritius. *Journal of Ethnopharmacology* 154: 847–857.

Mourier J, Soria M, Blaison A, Simier M, Certain G, Demichelis A, Hattab T 2021. Dynamic use of coastal areas by bull sharks and the conciliation of conservation and management of negative human–wildlife interactions.

Aquatic Conservation: Marine and Freshwater Ecosystems 31: 2926–2937.

MRAG 2005. Review of impacts of illegal, unreported and unregulated fishing on developing countries (final report). London, U.K.

MRAG 2012. A review of bycatch in the Indian Ocean gillnet tuna fleet focusing on India and Sri Lanka. Washington, D.C.

MRAG, CapFish 2008. Study and analysis of the status of IUU fishing in the SADC region and an estimate of the economic, social and biological impacts.

MRHP 2014. Arrete Ministeriel N° 37.069/2014 portant définition du plan d'aménagement concerté des pêcheries de la baie d'Antongil.

Mulochau T, Quod J 2013. Nouvelles découvertes dans les profondeurs marines de la Réunion.

Murua H, Arrizabalaga H, Huang J, Romanov E, Bach P, de Bruyn P, Chavance P, de Molina A 2009. Ecological Risk Assessment (ERA) for species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC): a first attempt. Mahé, Seychelles.

Murua H, Santiago J, Coelho R, Zudaire I, Neves C, Rosa D, Semba Y, Geng Z, Bach P, Arrizabalaga H, Baez JC 2018. *Updated Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC)*. Indian Ocean Tuna Commission, Mahé, Seychelles.

Musembi P, Cowburn B, Sluka R 2017. Biodiversity and conservation of elasmobranchs in Watamu Marine National Park and Reserve.

Musick JA, Musick S 2011. Fisheries and Aquaculture Reviews and Studies SHARKS.

Musse G, Mahamud H 1999. Current status of marine fisheries in Somalia. In: Lokman S, Azhar M, Nasir M, Borowitzka M (eds), *Assessment & Monitoring of Marine System*. Kuala Terengganu, Malaysia: Universiti Putra Malaysia Terengganu.

Mutombene R, Chauca I, Chacate O 2015. Assessment of the status and reporting of artisanal fisheries in Mozambique: Case study of two coastal provinces, Cabo Delgado and Nampula. Maputo.

Muttenzer F 2015. The social life of sea-cucumbers in Madagascar: Migrant fishers' household objects and display of a marine ethos. *Etnofoor* 27: 101–121.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J 2000. Biodiversity hotspots for conservation priorities. *Nature* 403.

Myers RA, Baum JK, Shepherd TD, Powers SP, Peterson CH 2007. Cascading Effects of the Loss of Apex Predatory Sharks from a Coastal Ocean. *Science* 315.

Nadeau A, Evano H, Laurence A, Aureche V, Hervé G, Martin-Baillet V, Blanchard F 2014. Situation de la pêche a la Réunion en 2013. Délégation IFREMER océan Indien Station de La Réunion.

Nairobi Convention 2021. Towards a more sustainable fisheries sector in Comoros. Accessed from https://www.nairobiconvention.org/towards-a-more-sustainable-fisheries-sector-in-comoros/, 2021-11-10.

Ndegwa S, Mueni E, Kiilu B, Ndoro C, Shikami K, Kimani E, Okema G, Wambiji N 2020. Kenya National Report to the Scientific Committee of the Indian Ocean Tuna Commission.

NEPAD 2011. Capture of the Antillas Reefer and its successful confiscation.

Nevill J 2005. *Establishing a Baseline for Shark Fishery Management in the Seychelles*. MSc thesis, University of Newcastle Upon Tyne.

Nevill J 2016. Scalloped Hammerhead Fishery Assessment Report.

Nevill JEG, de Groene A, Dando M 2015. An Identification Guide for the Sharks of the Seychelles Artisanal Fishery.

Ngusaru A 2000. The present state of knowledge of marine science in Tanzania: Synthesis report.

Nhwani L 1981. The Dagaa Fishery of Tanga. *Tanzania Notes and Records* 86/87: 29–33.

Nhwani L 1984. The Collection of Fisheries Statistics in Tanzania: Suggestions for Improvement. In: Iversen A, Myklevoll S (eds), *The Proceedings of the Norad-Tanzania Seminar to Review the Marine Fish Stocks and Fisheries in Tanzania*. Mbegani, Tanzania: Fisheries Division/NORAD. pp 127–132.

Niedermüller S, Ainsworth G, de Juan S, Garcia R, Ospina-Alvarez A, Pita P, Villasante S 2021. The shark and ray meat network: A deep dive into a global affair.

Norman B, Catlin J 2007. Economic importance of conserving whale sharks. Technical Report 411 November. Sydney.

NSRI 2011. National Sea Rescue Institute Report. Accessed from www.nsri.org.za/2011/11/search-for-4-people-on-a-life-raft-adrift-at-sea/, 2021-11-13.

O'Brien SM, Gallucci VF, Hauser L 2013. Effects of species biology on the historical demography of sharks and their implications for likely consequences of contemporary climate change. *Conservation Genetics* 14: 125–144.

Obura D 2001. Kenya. *Marine Pollution Bulletin* 42: 1264–1278.

Obura D 2012. The Diversity and Biogeography of Western Indian Ocean Reef-Building Corals. *PLoS ONE* 7.

Obura DO, Burgener V, Owen S, Gonzales A 2017. Reviving the western Indian Ocean economy: actions for a sustainable future. Gland, Switzerland.

Obura DO, Wells S, Church J, Horrill C 2002. Monitoring of fish and fish catches by local fishermen in Kenya and Tanzania. *Marine and Freshwater Research* (53 vol.). pp 215–222.

Oddenyo RM 2017. *Trophic ecology and exploitation status of shark species (Pisces: Elasmobranchii) in the north coast of Kenya*. University of Eldoret.

Oddenyo RM, Kyalo KM, Wambiji N, Ogutu B 2016. The Status of the Shark Fishery in Kenya. In: Kimani EN, Wambiji N, Christopher A, Okemwa G (eds), *State of the Kenya Marine Fisheries Report 2016*. Mombasa: Kenya Marine and Fisheries Research Institute.

Oddenyo RM, Mueni E, Abunge N, Kodia C, Obota MA, Musembi C, Muthiga P, Bernard, Mwasi J 2018. *Kenya sharks baseline assessment report for the National Plan of Action for the Conservation and Management of Sharks*. IOTC-2019-WPEB15-11.

Ojamaa P, Martí C-P 2015. Directorate-General for Internal Policies Policy Department B: Structural and cohesion policies. Fisheries in Reunion, In depth analysis.

Okes N, Sant G 2019. *An overview of major shark catchers, traders and species*. TRAFFIC, Cambridge, UK.

Okes N, Sant G 2022. *Missing sharks: A country review of catch, trade and management recommendations for CITES-listed shark species*. TRAFFIC, Cambridge, UK.

Okeyo D 1998. Updating names, distribution and ecology of riverine fish of Kenya in the Athi-Galana-Sabaki river drainage system.

Oliver A, Sant G, Fowler S 1998. International Plan of Action for the Conservation and Management of Sharks. *Shark News 12 – newsletter of the IUCN Shark Specialist Group*. Berkshire, UK.: The Nature Conservation Bureau.

Oliver S, Braccini M, Newman SJ, Harvey ES 2015. Global patterns in the bycatch of sharks and rays. *Marine Policy* 54: 86–97.

Olson D, Dinerstein E 1998. The Global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. *Conservation biology* 12: 502–515.

Onandia I, Santiago J, Grande M, Murua J 2021. Silky shark (*Carcharhinus falciformis*) post release survival in tropical tuna purse seiners. Update report.

Osuka K, Kawaka JA, Samoilys MA 2021. Evaluating Kenya's coastal gillnet fishery: trade-offs in recommended mesh-size regulations. *African Journal of Marine Science* 43: 15–29.

Osuka K, Murunga M, Samoilys M, Obota C 2016. Integrating FADs monitoring with co-management structures-A pilot study.

Oury N, Jaquemet S, Simon G, Casalot L, Vangrevelynghe G, Landron F, Magalon H 2021. Forensic genetic identification of sharks involved in human attacks. *Forensic Science International: Genetics* 54.

Pacoureau N, Rigby CL, Kyne PM, Sherley RB, Winker H, Carlson JK, Fordham S v., Barreto R, Fernando D, Francis MP, et al. 2021. Half a century of global decline in oceanic sharks and rays. *Nature* 589: 567–571.

Palha de Sousa B 2011. Sharks caught as bycatch in Mozambican waters. 7th Working Party on Ecosystem and Bycatch, Maldives, 24-27th October 2011, IOTC-2011-WPEB07-24.

Palha de Sousa B 2012. Mozambique National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2012. IOTC-2012-SC15-NR 19.

Parin N v., Timokhin IG, Novikov NP, Shcherbachev YN 2008. On the composition of talassobathyal ichthyofauna and commercial productivity of Mozambique Seamount (the Indian Ocean). *Journal of Ichthyology* 48: 361–366.

Passerotti MS, Andrews AH, Carlson JK, Wintner SP, Goldman KJ, Natanson LJ 2014. Maximum age and missing time in the vertebrae of sand tiger shark (*Carcharias taurus*): validated lifespan from bomb radiocarbon dating in the western North Atlantic and southwestern Indian Oceans. *Marine and Freshwater Research* 65.

Pauly D 1994. From growth to Malthusian overfishing: stages of fisheries resources misuse. *SPC Traditional Marine Resource Management and Knowledge Information Bulletin* 3: 7–14.

Pavitt A, Malsch K, King E, Chevalier A, Kachelriess D, Vannuccini S, Friedman K 2021. *CITES and the sea: Trade in commercially exploited CITES-listed marine species*. Rome: FAO Fisheries and Aquaculture Technical Paper No. 666.

Peatman T, Pilling G 2016. Monte Carlo simulation modelling of purse seine catches of silky and oceanic whitetip sharks. *12th Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission*. Bali, Indonesia: WCPFC-SC12. pp 3–11.

Peel LR, Daly R, Keating Daly CA, Stevens GMW, Collin SP, Meekan MG 2019a. Stable isotope analyses reveal unique trophic role of reef manta rays (*Mobula alfredi*) at a remote coral reef. *Royal Society Open Science* 6.

Peel LR, Stevens GMW, Daly R, Daly CAK, Lea JSE, Clarke CR, Collin SP, Meekan MG 2019b. Movement and residency patterns of reefmanta rays *Mobula alfredi* in the Amirante Islands, Seychelles. *Marine Ecology Progress Series* 621: 169–184.

Peel LR, Stevens GMW, Daly R, Keating Daly CA, Collin SP, Nogués J, Meekan MG 2020. Regional Movements of Reef Manta Rays (*Mobula alfredi*) in Seychelles Waters. *Frontiers in Marine Science* 7.

Pereira M 2021. Marine and coastal areas under protection: Mozambique. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 119–132.

Pereira MAM 2000. Preliminary checklist of reef-associated fishes of Mozambique. Maputo.

Pereira MAM, Fernandes RS 2014. Science for conservation in Mozambique's marine protected areas (2003–2013). Final report of the Workshop Science for Conservation in Moçambique. Maputo, 21–22 April 2014 (abstract). Maputo.

Persad R 2005. *An investigation of the bycatch of the offshore crustacean trawl fishery on the east coast of South Africa*. MSc thesis, University of KwaZulu-Natal (Oceanographic Research Institute).

Persson L, Lindop A, Harper S, Zylich K, Zeller D 2015. Failed State: Reconstruction of Domestic Fisheries Catches in Somalia 1950–2010. In: Le Manach F, Pauly D (eds), *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2)*. Fisheries Centre, University of British Columbia. pp 111–127.

Petit G 1930. L'Industrie des pêches à Madagascar. *Paris. Soc. Ed. Géo. Mar. et Colon., Bibliothèque de la faune des Colonies Françaises* undefined-392.

Pierce S 2014. Western Indian Ocean. In: Harrison L, Dulvy N (eds), *Sawfish: A Global Strategy for Conservation*. Vancouver, Canada: IUCN Species Survival Commission's Shark Specialist Group. p 56.

Pierce S, Norman B 2016. *Rhincodon typus*.

Pierce SJ, Trerup M, Williams C, Tilley A, Marshall A, Raba N 2008a. Shark fishing in Mozambique: A preliminary assessment of artisanal fisheries. Maputo.

Pierce SJ, White WT, Marshall AD 2008b. New record of the smalleye stingray, *Dasyatis microps* (Myliobatiformes: Dasyatidae), from the western Indian Ocean. *Zootaxa* 65–68.

Pike N 1873. *Sub-Tropical Rambles in the Land of the Aphanopteryx*. London: Sampson and Marston Low.

Pilcher N, Alsuhaibany A 2000. The Status of coral reefs in the Red Sea and Gulf of Aden. In: Wilkinson C (ed.), *Global Status of Coral Reefs: 2000*. Townsville, Australia: Australian Institute of Marine Sciences. pp 35–54.

Pirog A, Jaquemet S, Ravigné V, Cliff G, Clua E, Holmes BJ, Hussey NE, Nevill JEG, Temple AJ, Berggren P, et al. 2019a. Genetic population structure and demography of an apex predator, the tiger shark *Galeocerdo cuvier*. *Ecology and Evolution* 9: 5551–5571.

Pirog A, Jaquemet S, Soria M, Magalon H, Pirog AA, Jaquemet SA, Soria MC, Magalon HA 2015. First evidence of multiple paternity in the bull shark (*Carcharhinus leucas*). *Marine and Freshwater Research* 68: 195–201.

Pirog A, Magalon H, Poirout T, Jaquemet S 2019b. Reproductive biology, multiple paternity and polyandry of the bull shark *Carcharhinus leucas*. *Journal of Fish Biology* 95: 1195–1206.

Pirog A, Magalon H, Poirout T, Jaquemet S 2020. New insights into the reproductive biology of the tiger shark *Galeocerdo cuvier* and no detection of polyandry in Reunion Island, western Indian Ocean. *Marine and Freshwater Research* 71: 1301.

Pirog A, Ravigné V, Fontaine MC, Rieux A, Gilabert A, Cliff G, Clua E, Daly R, Heithaus MR, Kiszka JJ, et al. 2019c. Population structure, connectivity, and demographic history of an apex marine predator, the bull shark *Carcharhinus leucas*. *Ecology and Evolution* 9: 12980–13000.

Playfair RL, Günther A 1866. *The fishes of Zanzibar, with a list of the fishes of the whole east coast of Africa*. London: Johan van Voorst.

Poisson F 2010. Catch, Bycatch of Sharks, and Incidental Catch of Sea Turtles in the Reunion-Based Longline Swordfish Fishery (Southwest Indian Ocean) Between 1997 and 2000. *Global Change: Mankind-Marine Environment Interactions*. Springer Netherlands. pp 163–165.

Poisson F, Taquet M 2000. French swordfish longline fishery in the south west Indian Ocean: preliminary results from the PPR program. *IOTC Proceedings, WPB00–06 3*. Victoria (Seychelles): Indian Ocean Tuna Commission (IOTC). pp 169–201.

Poisson F, Séret B, Vernet AL, Goujon M, Dagorn L 2014. Collaborative research: Development of a manual on elasmobranch handling and release best practices in tropical tuna purse-seine fisheries. *Marine Policy* 44: 312–320.

Poisson F, Vernet AL, Filmalter JD, Goujon M, Dagorn L 2011. Survival rate of silky sharks (*Carcharhinus falciformis*) caught incidentally onboard French tropical purse seiners.

Poisson F, Vernet AL, Séret B, Dagorn L 2012. Good practices to reduce the mortality of sharks and rays caught incidentally by tropical tuna purse seiners.

Pollom R, Ebert DA, Kuguru B, Samoilys M 2019. *Holohalaelurus melanostigma*. *The IUCN Red List of Threatened Species*.

Pollom R, Gledhill K, Fernando S, Leslie R 2020. *Holohalaelurus favus*. *The IUCN Red List of Threatened Species*.

Pollom RA, Cheok J, Pacoureau N, Gledhill KS, Kyne PM, Ebert DA, Jabado RW, Herman KB, Bennett RH, da Silva C, et al. (*in prep.*). Overfishing and climate change elevate extinction risk of endemic sharks and rays in the southwest Indian Ocean hotspot.

Poonian CNS 2015. A first assessment of elasmobranch catch in Mauritian artisanal fisheries using interview surveys. *Phelsuma* 23: 19–29.

Poonian CNS, Hauzer MD, ben Allaoui A, Cox TM, Moore JE, Read AJ, Lewison RL, Crowder LB 2008. Rapid assessment of sea turtle and marine mammal bycatch in the Union of the Comoros. Western Indian Ocean Journal of Marine Science 7: 2. *Western Indian Ocean Journal of Marine Science* 7: 207–216.

Potenski MD 2007. Shark Research Institute-Operation Whale Shark.

Pothin K 2021. Marine and coastal areas under protection: French Territories in the Western Indian Ocean Region. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 41–56.

Pottie S, Flam AL, Keeping JA, Chivindze C, Bull JC 2021. Quantifying the distribution and site fidelity of a rare, non-commercial elasmobranch using local ecological knowledge. *Ocean and Coastal Management* 212.

Pramod G 2018. Kenya-Country Report. *Policing the Open Seas: Global Assessment of Monitoring Control and Surveillance in 84 countries, IUU Risk Intelligence* (Policy Report No. 1 edn). p 3 pp.

Prebble CEM, Rohner CA, Pierce SJ, Robinson DP, Jaidah MY, Bach SS, Trueman CN 2018. Limited latitudinal ranging of juvenile whale sharks in the Western Indian Ocean suggests the existence of regional management units. *Marine Ecology Progress Series* 601: 167–183.

Prugh LR, Stoner CJ, Epps CW, Bean WT, Ripple WJ, Laliberte AS, Brashares JS 2009. The rise of the mesopredator. *BioScience* 59: 779–791.

Quod J, Turquet J, Conejero S, Ralijaona C 2000. Ciguatera risk assessment in the Indian Ocean following the 1998 coral bleaching event. Coral Reef Degradation in the Indian Ocean: Status Report.

Rabearivony J, Thorstrom R, de Roland L, Rakotondratsima M, Razafimanjato G 2010. Protected area surface extension in Madagascar: Do endemism and threatened species remain useful criteria for site selection? *Madagascar Conservation & Development* 5.

Rahombanjanahary D 2012. Catch rates of sharks as bycatch by Malagasy longliners. 8th Working Party on Ecosystems and Bycatch. IOTC-2012-WPEB08-12 Rev_1.

Rajaonarimampianina H 2014. IUCN World Parks Congress: Sydney Promise. Accessed from Retrieved from http://www.fapbm.org/sites/default/files/upload/public/wpc_2014.pdf, 2021-11-11.

Rakotoson LR, Tanner K 2006. Community-based governance of coastal zone and marine resources in Madagascar. *Ocean and Coastal Management* 49: 855–872.

Ramahery V, Rahagalala H, Rakotomalala D 2021. Marine and coastal areas under protection: Madagascar. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 71–102.

Ramos H, Silva E, Gonçalves L 2013. Reduction of the deep-sea shark's by-catches in the Portuguese long-line black scabbard fishery. Final Report to the European Commission – DG MARE, MARE/2011/06 (SI2.602201).

Ramsar 1971. Convention on Wetlands of International Importance especially as Waterfowl Habitat.

Ramsar 2016. An Introduction to the Convention on Wetlands. Gland, Switzerland.

Ramsar 2021. Ramsar sites information service. Accessed from https://rsis.ramsar.org/ris-search/?solrsort=area_off_d%20desc&f%5B0%5D=regionCountry_en_ss%3AMadagascar&pagetab=1, 2021-11-11.

Randriarilala F, Rafalimanana T, Caverivière A 2008. Les captures accessoires des crevettiers industriels et artisanaux. In: Caverivière A, Chaboud C, Rafalimanana T (eds), *Les crevettes côtières de Madagascar: biologie, exploitation, gestion*. Marseille, France: IRD Editions.

Razafimandimby Y, Joachim L 2017. Update on shark catch characteristics by national longlinefleets in Madagascar (2010-2016). 13th Working Party on Ecosystems and Bycatch. IOTC-2017-WPEB13-11.

Razafindrainibe H 2010. Baseline study of the shrimp trawl fishery in Madagascar and strategies for bycatch management.

Reeve R 2004. The CITES treaty and compliance: progress or jeopardy? London.

Reeve R 2007. Wildlife trade, sanctions and compliance: lessons from the CITES regime. *International Affairs* 82: 881–897.

René F, Poisson F, Tessier E 1998. Evolution de la pêcherie palangrière ciblant l'espadon (Xiphias gladius) à partir de La Réunion. Evolution of the swordfish longline fishery Xiphias gladius operating in the lndian Ocean from Réunion island.

Republic of Kenya 2007. Legal Notice No. 402, The Fisheries (Beach Management Unit) Regulations. The Fisheries Act. Cap 378.

Republic of Kenya 2012a. Fisheries Act (Cap. 378) [Rev. 2012].

Republic of Kenya 2012b. Fisheries (General) Regulations (Cap. 378) [Rev. 2012].

Republic of Kenya 2012c. Fisheries (Foreign Fishing Craft) Regulations (Cap. 378) [Rev. 2012].

Republic of Kenya 2016a. Fisheries Management and Development Act, 2016. No. 35 of 2016.

Republic of Kenya 2016b. Ratification of Ports State Measures Agreement, a great step for Kenya towards blueing the National Economy.

Republic of Kenya 2020. The Kenya Gazette. Vol. CXXII —No. 83.

Republic of Madagascar 2020. Plan National de Gestion et de Conservation des Requins et Raies à Madagascar 2020 – 2024.

Republic of Mauritius 1968. The Constitution of Mauritius. 81 pp.

Republic of Mauritius 2007. Fisheries and Marine Resources Act 2007.

Republic of Mauritius 2013. Maurice Ile Durable Policy, Strategy and Action Plan.

Republic of Mozambique 1999. Law No. 10/99 on Forest and Wildlife Act. *Publicacao Oficial da Republica de Mocambique*.

Republic of Mozambique 2007. Ministerial Order No. 49/2007 approving the Regulation of the Co-Management Committee on Fishery Sector. 49/2007.

Republic of Mozambique 2009. Ministerial Order No. 58/2009 approving the National Plan of Action on prevention, prohibition and elimination of illegal fishing activities.

Republic of Mozambique 2013a. Lei n. 22/2013 de 1 de Novembro de 2013.

Republic of Mozambique 2013b. Diploma Ministerial n. 4/2013 de 7 de Janeiro.

Republic of Mozambique 2015. Boletim da Republica Publicacao Oficial da Republica de Mocambique. *Decreto Presidencial No. 17 of 2015*.

Republic of Mozambique 2020. Regulamento da Pesca Marítima (REPMAR). *Boletim da Republica Publicacao Oficial da Republica de Mocambique*.

Republic of South Africa 1998a. Marine Living Resources Act (No. 18 of 1998).

Republic of South Africa 1998b. Regulations in terms of the Marine Living Resources Act, 1998.

Republic of South Africa 2004. National Environmental Management Biodiversity Act, 2004 (No. 10 of 2004).

Republic of South Africa 2010. National Environmental Management: Biodiversity Act: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Regulations (No. R. 173 of 2010).

Republic of South Africa 2013. Regulations for the fishing of Elasmobranchs (Sharks) in the estuary of the Breede River (No. R. 105 of 2013).

Republic of South Africa 2014. Act No. 5 of 2014: Marine Living Resources Amendment Act, 2014. *Government Gazette*.

Republic of South Africa 2015a. Shark Biodiversity Management Plan. Pretoria.

Republic of South Africa 2015b. Marine Living Resources Act, 1998 (Act No. 18 OF 1998) Amendment of Regulation Published in Government Notice R. 1111 of 2 September 1998, as amended. *Government Gazette*.

Republic of South Africa 2015c. National Environmental Management: Biodiversity Act, 2004 (Act No. 10 OF 2004) Threatened or Protected Species Regulations. *Government Gazette*.

Republic of South Africa 2019. Regulation Gazette No. 42479, 23 May 2019, Vol. 647 No. 10950.

Republic of South Africa 2021a. Mid-year population estimates.

Republic of South Africa 2021b. South Africa as a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Accessed from https://www.dffe.gov.za/legislation/international_agreements/sapartytocites, 2021-11-13.

Republic of South Africa 2021c. Department of Forestry, Fisheries and the Environment (DFFE). Accessed from https://nationalgovernment.co.za/units/view/15/department-of-forestry-fisheries-and-the-environment-dffe, 2021-11-13.

Republic of Tanzania 1994. Marine Parks and Reserves Act, 1994 (Act No. 29 of 1994).

Republic of Tanzania 1998. Deep Sea Fishing Authority Act, 1998.

Republic of Tanzania 2003. Fisheries Act, 2003.

Republic of Tanzania 2009a. The Fisheries Regulations, 2009 [G.N. No. 308 OF 28/8/2009]. *Government Printer, Dar es Salaam*.

Republic of Tanzania 2009b. Deep Sea Fishing Authority Regulations, 2009 (G.N. No. 48 of 2009).

Republic of Tanzania 2014. Basic Demographic and Socio-Economic Profile Report Tanzania Mainland. Dar es Salaam.

Republic of Tanzania. 2016. Tanzania Fisheries Research Institute Act, 2016 (No. 11 of 2016).

Rice J 2017a. Stock assessment blue shark (*Prionace glauca*) in the Indian Ocean using Stock Synthesis.

Rice J 2017b. Final summary report of the stock status of oceanic whitetip sharks and CITES-listed hammerhead sharks based on the results of the IOTC/CITES Shark Data Mining Workshop.

Richmond M, Balarin J, Muhando C, Yahya S 2014. Social Investment in Biodiversity and Ecosystem Services, Zanzibar.

Rigby C, Simpendorfer C, Cornish A 2019. A practical guide to the effective design and management of MPAs for sharks and rays. Gland, Switzerland.

Robinson L, Sauer W 2013. A first description of the artisanal shark fishery in northern Madagascar: Implications for management. *African Journal of Marine Science* 35: 9–15.

Rocliffe S, Peabody S, Samoilys M, Hawkins JP 2014. Towards A Network of Locally Managed Marine Areas (LMMAs) in the Western Indian Ocean. *PLoS ONE* 9.

Rohner CA, Cochran JEM, Cagua EF, Prebble CEM, Venables SK, Berumen ML, Kuguru BL, Rubens J, Brunnschweiler JM, Pierce SJ 2020. No Place Like Home? High Residency and Predictable Seasonal Movement of Whale Sharks Off Tanzania. *Frontiers in Marine Science* 7.

Rohner CA, Flam AL, Pierce SJ, Marshall AD 2017. Steep declines in sightings of manta rays and devil rays southern Mozambique. *PeerJ Preprints* 5: e3051v1.

Rohner CA, Pierce SJ, Marshall AD, Weeks SJ, Bennett MB, Richardson AJ 2013. Trends in sightings and environmental influences on a coastal aggregation of manta rays and whale sharks. *Marine Ecology Progress Series* 482: 153–168.

Rohner CA, Richardson AJ, Prebble CEM, Marshall AD, Bennett MB, Weeks SJ, Cliff G, Wintner SP, Pierce SJ 2015. Laser photogrammetry improves size and demographic estimates for whale sharks. *PeerJ* 2015.

Romanov E, Bach P, Richard E, Ternon J, le Turc A 2011. PROSPER project: Preliminary results of ecosystem and bycatch studies in the waters of Réunion and Tromelin Islands.

Romanov E v, Sabarros PS, le Foulgoc L, Richard E, Lamoureux J-P, Rabearisoa N, Bach P 2013. Assessment of depredation level in Reunion Island pelagic longline fishery based on information from self-reporting data collection programme.

Roos D, Tessier E, Guyomard D 1998. Evolution de l’activité halieutique à La Réunion de 1990 à 1996. DRV/ RH/RST/98–14. Le Port (France).

Rosa R, Rummer JL, Munday PL 2017. Biological responses of sharks to ocean acidification. *Biology Letters* 13.

Rowat D 2007. Occurrence of whale shark (*Rhincodon typus*) in the Indian Ocean: A case for regional conservation. *Fisheries Research* 84: 96–101.

Rowat D, Brooks KS 2012. A review of the biology, fisheries and conservation of the whale shark *Rhincodon typus*. *Journal of Fish Biology* 80: 1019–1056.

Rowat D, Engelhardt U 2007. Seychelles: A case study of community involvement in the development of whale shark ecotourism and its socio-economic impact. *Fisheries Research* 84: 109–113.

Rowat D, Brooks K, March A, McCarten C, Jouannet D, Riley L, Jeffreys G, Perri M, Vely M, Pardigon B 2011. Long-term membership of whale sharks (*Rhincodon typus*) in coastal aggregations in Seychelles and Djibouti. *Marine and Freshwater Research* 62: 621.

Rowat D, Speed CW, Meekan MG, Gore MA, Bradshaw CJA 2009. Population abundance and apparent survival of the Vulnerable whale shark *Rhincodon typus* in the Seychelles aggregation. *ORYX* (43 vol.). pp 591–598.

Rupp A, Bornatowski H 2021. Food web model to assess the fishing impacts and ecological role of elasmobranchs in a coastal ecosystem of Southern Brazil. *Environmental Biology of Fishes* 104: 905–921.

Sabarros P, Romanov E, le Foulgoc L, Richard E, Lamoureux J, Bach P 2013. Commercial catch and discards of pelagic longline fishery of La Réunion Island based on the self-reporting data collection program. Presented at the 9th IOTC Working Party on Ecosystems and Bycatch (WPEB), La Réunion, September 12–16, 2013.

Sabriye A 2005. Feasibility report on the fisheries sector in South and Central Somalia. Current status, opportunities and constraints.

Sætre R, Silva R 1979. The marine fish resources of Mozambique. Servico de Investigacoes Pesqueiras, Maputo. Bergen, Norway.

Samatar A 2007. Somalia's post-conflict economy: a political economy approach. *Bildhaan: An International Journal of Somali Studies* 7: 126–168.

Samoilys M, Kanyange W 2008. Natural resource dependence, livelihoods and development: perceptions from Kiunga, Kenya.

Samoilys M, Pabari M, Andrew T, Maina GW, Church J, Momanyi A, Mibei B, Monjane M, Shah A, Menomussanga M, et al. 2015. Resilience of Coastal Systems and Their Human Partners in the Western Indian Ocean. Nairobi, Kenya.

Samoilys MA, Obura DO 2011. Marine conservation successes in Eastern Africa. Mombasa, Kenya: CORDIO East Africa. Mombasa.

Samoilys MA, Kanyange NW, IUCN East Africa Regional Office., IUCN Regional Office for Southern Africa. 2008. *Natural resource dependence, livelihoods and development: perceptions from Kiunga, Kenya*. IUCN Eastern and Southern Africa Regional Office (ESARO).

Samoilys MA, Osuka K, Maina GW, Obura DO 2016. Artisanal fisheries on Kenya's coral reefs: Decadal trends reveal management needs. *Fisheries Research* 186.

de San M 1983. Profil de la pêche artisanale aux Comores. Moroni.

SANBI 2019. Summary Report: Non-detriment Findings made by the Scientific Authority.

Sancelme T, Goetze J, Jaquemet S, Meekan MG, Flam A, Watts AM, Speed CW 2020. Contrasting patterns in the abundance of fish communities targeted by fishers on two coral reefs in southern Mozambique. *African Journal of Marine Science* 42: 95–107.

Schaeffer D 2004. Assessment of the Artisanal Shark Fishery and Local Shark Fin Trade on Unguja Island, Zanzibar.

Schleyer M 2015. Introduction – Biodiversity. In: UNEP-Nairobi Convention, WIOMSA (eds), *The Regional State of the Coast Report: Western Indian Ocean*. Nairobi, Kenya: UNEP and WIOMSA. pp 1–546.

SDF&BE 2015. Response to questionnaire completed by K.B. Kyalo. Unpublished.

SDF&BE 2016. Response to questionnaire completed by S. Ndegwa on 20th January 2016. Unpublished.

Sekadende B, Scott L, Anderson J, Aswani S, Francis J, Jacobs Z, Jebri F, Jiddawi N, Kamukuru AT, Kelly S, et al. 2020. The small pelagic fishery of the Pemba Channel, Tanzania: What we know and what we need to know for management under climate change. *Ocean and Coastal Management* 197.

Selig ER, Turner WR, Troëng S, Wallace BP, Halpern BS, Kaschner K, Lascelles BG, Carpenter KE, Mittermeier RA 2014. Global priorities for marine biodiversity conservation. *PLoS ONE* 9.

Serena F, Abella AJ, Bargnesi F, Barone M, Colloca F, Ferretti F, Fiorentino F, Jenrette J, Moro S 2020. Species diversity, taxonomy and distribution of Chondrichthyes in the Mediterranean and Black Sea. *European Zoological Journal* 87: 497–536.

Seychelles 1987. Fisheries Regulations 1987 (Cap. 82).

Seychelles 1998. Amendment to the Fisheries Regulations 1987.

Seychelles 2003. Wild Animals (Whale Shark) Protection Regulation (Cap. 247).

Seychelles 2006. Fisheries (Shark Finning) Regulations, 2006 (S.I. No. 7 of 2006).

Seychelles 2011. Customs Management Act 2011.

Seychelles 2012a. Wild Animals and Birds Protection Act (Cap. 247). Consolidated version of 30 June 2012 of Act No. 37 of 1961 as amended last by Act No. 9 of 2001.

Seychelles 2012b. Export of Fishery Products Act. Cap. 77A.

Seychelles 2014a. Fisheries Act (No. 20 of 2014).

Seychelles 2014b. Customs (Export Permit) Regulations 2014.

Seychelles 2014c. Customs (Prohibited and Restricted Goods) Regulations 2014.

Seychelles 2014d. National Parks and Nature Conservancy Act (Cap. 141).

Seychelles 2019. Seychelles fisheries sector policy and strategy.

SFA 2007a. Republic of Seychelles: Seychelles National Plan of Action for the Conservation and Management of Sharks. Mahé.

SFA 2007b. Annual report 2005. Victoria (Seychelles).

SFA 2014. Seychelles fisheries statistical report. Year 2014. Victoria, Mahé, Seychelles.

SFA 2015a. Response to questionnaire completed by J. Bijoux. Unpublished.

SFA 2015b. Response to questionnaire completed by R. Govinden. Unpublished.

SFA 2015c. Annual Report 2013. Victoria, Mahé, Seychelles.

SFA 2016. Republic of Seychelles National Plan of Action for the Conservation and Management of Sharks 2016-2020.

SFA 2019. Annual report 2015-2016.

Shehe MA, Jiddawi NS 1997. The status of shark fisheries in Zanzibar. In: Fowler SL, Reed TM, Dipper FA (eds), *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997*. The IUCN Species Survival Commission. pp 158–161.

Sheik Heile A, Glaser S 2020. Somalia National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2020. Mogadishu.

Sheik Heile A, Glaser S, Hassan J, Farah L, Weheliye F 2018. Improving the catch data collection system for Somali fisheries: Project Kalluun.

Shung C, Jhumun-Foolheea H 2020. Mauritius National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2020.

Sigana D 2009. Tuna fishery in Kenya. IOTC-2009-SC-INF09.

Sigana D, Tuda P, Samoilys M 2008. Social, economic and environmental impacts of beach seining in Kenya — an information review and field study. Mombasa, Kenya.

da Silva C 2007. *The status and prognosis of the smoothhound shark (*Mustelus mustelus*) fishery in the southeastern and southwestern Cape coasts, South Africa*. Rhodes University, Grahamstown.

da Silva C, Bürgener M 2007. 2007 traffic report on shark meat. *TRAFFIC Bulletin* 21: 55–65.

da Silva C, Booth AJ, Dudley SFJ, Kerwath SE, Lamberth SJ, Leslie RW, McCord ME, Sauer WHH, Zweig T 2015. The current status and management of South Africa's chondrichthyan fisheries. *African Journal of Marine Science* 37: 233–248.

da Silva C, Winker H, Parker D, Kerwath S 2019. Assessment of smoothhound shark *Mustelus mustelus* in South Africa.

da Silva Ferrette BL, Coelho R, Peddemors VM, Ovenden JR, de Franco BA, Oliveira C, Foresti F, Mendonça FF 2021. Global phylogeography of the smooth hammerhead shark: Glacial refugia and historical migration patterns. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31: 2348–2368.

da Silva Ferrette BL, Mendonça FF, Coelho R, de Oliveira PGV, Hazin FHV, Romanov E v., Oliveira C, Santos MN, Foresti F 2015. High connectivity of the crocodile shark between the Atlantic and southwest Indian oceans: Highlights for conservation. *PLoS ONE* 10.

Simango 2016. Caracterização da dinâmica actual de exploração do tubarão na pesca artesanal em Moçambique, sua contribuição sócio-económica e políticas para uma gestão sustentável.

Simpfendorfer CA, Dulvy NK 2017. Bright spots of sustainable shark fishing. *Current Biology* 27: R97–R98.

Simpfendorfer CA, Heupel MR, White WT, Dulvy NK 2011. The importance of research and public opinion to conservation management of sharks and rays: A synthesis. *Marine and Freshwater Research* (62 vol.). pp 518–527.

SIOFA 2015. Report of the Second Meeting of the Parties to the Southern Indian Ocean Fisheries Agreement (SIOFA) Mauritius 17 to 20 March, 2015.

SIOFA 2019. Conservation and Management Measure for Sharks (Sharks). 1–3.

Slade LM, Kalangahe B 2015. Dynamite fishing in Tanzania. *Marine Pollution Bulletin* 101: 491–496.

Smale M 1998. Evaluation of Shark Populations around the Masoala Peninsular, North East Madagascar. Final Report. Antananarivo.

Smale MJ 1991. Occurrence and feeding of three shark species, *Carcharhinus brachyurus, C. obscurus* and *Sphyrna zygaena*, on the Eastern Cape coast of South Africa. *South African Journal of Marine Science* 11: 31–42.

Smale MJ 2008. Pelagic shark fisheries in the Indian Ocean. In: Camhi MD, Pikitch EK, Babcock EA (eds), *Sharks of the Open Ocean: Biology, Fisheries and Conservation*. Oxford: Blackwell Publishing.

Smith A 1839. Pisces. *Illustrations of the zoology of South Africa; consisting chiefly of figures and descriptions of the objects of natural history collected during an expedition into the interior of South Africa in 1834–36* (4 vol.). London: Smith, Elder, and Co. pp 1–77.

Smith A 1849. Pisces. *Illustrations of the Zoology of South Africa*. London: Smith, Elder, and Co. pp 1–77.

Smith J, Smith M 1969. *The fishes of Seychelles*. Grahamstown, South Africa: The JLB Smith Institute of Ichthyology. Rhodes University.

Smith JLB 1949. *The Sea Fishes of Southern Africa*. South Africa Central News Agency Ltd.

Smith JLB 1955. XXXVIII—The fishes of Aldabra—Part I. *Annals and Magazine of Natural History* 8: 304–312.

Smith JLB 1965. *The Sea Fishes of Southern Africa* (5th edn). Central News Agency Ltd.

Smith JLB, Smith MM 1965. *The fishes of Seychelles*. Grahamstown: The J.L.B. Smith Institute of Ichthyology.

Smith M, Heemstra P 1991. *Smith's Sea Fishes* (1st edn). Johannesburg: Southern Book Publishers.

Smith MM, Heemstra PC 1986. *Smith's Sea Fishes*. Johannesburg: Macmillan.

Soilihi A 2014. Union des Comores rapport national destiné au Comité scientifique de la Commission des thons de l'océan Indien.

Sommer Corinna, Schneider W, Poutiers J-Maurice 1996. *FAO species identification field guide for fishery purposes - The living marine resources of Somalia*. Rome: Food and Agriculture Organization of the United Nations.

Sone E 2010. Piracy in the Horn of Africa: The Role of Somalia's Fishermen. Monterey, CA.

Soria M, Tremblay Y, Blaison A, Forget F, Crochelet E, Dagorn L 2021. Large-scale movements and site fidelity of two bull sharks *Carcharhinus leucas* estimated from a double-tagging experiment at Réunion Island (southwest Indian Ocean). *African Journal of Marine Science* 43: 135–140.

Sousa M, Marshall N, Smale M 1997. The shark trade in Mozambique. In: Marhsall N, Barnett R (eds), *The trade in sharks and shark products in the Western Indian and Southeast Atlantic Oceans*. Nairobi: TRAFFIC East/Southern Africa. pp 67–79.

Souto M 2014. Artisanal fisheries and climate change project (FishCC).

Spalding M, Ravilious C, Green E 2001. *World Atlas of Coral Reefs*. Berkeley, CA: University of California Press.

Spalding MD, Fox HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Lourie SA, et al. 2007. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. *BioScience* 57.

Springer S 1968. Triakis fehlmanni, a new shark from the coast of Somalia. *Proceedings of the Biological Society of Washington* 81: 613–624.

Springer S, D'Aubrey J 1972. Two new scyliorhinid sharks from the east coast of Africa with notes on related species. Durban.

Stein RW, Mull CG, Kuhn TS, Aschliman NC, Davidson LNK, Joy JB, Smith GJ, Dulvy NK, Mooers AO 2018. Global priorities for conserving the evolutionary history of sharks, rays and chimaeras. *Nature Ecology and Evolution* 2: 288–298.

Stelbrink B, von Rintelen T, Cliff G, Kriwet J 2010. Molecular systematics and global phylogeography of angel sharks (genus Squatina). *Molecular Phylogenetics and Evolution* 54: 395–404.

Stevens G 2011. Field Guide to the Identification of Mobulid Rays (Mobulidae): Indo-West Pacific.

Stevens JD 1984. Life-History and Ecology of Sharks at Aldabra Atoll, Indian Ocean.

Stevens JD, Walker TI, Cook SF, Fordham S 2005. Threats faced by chondrichthyan fish. In: Fowler S, Cavanagh R, Camhi M, et al. (eds), *Sharks, rays and chimaeras: the status of the Chondrichthyan fishes*. Gland, Switzerland and Cambridge: IUCN Species Survival Commission Shark Specialist Group. pp 48–54.

Stewart JD, Jaine FRA, Armstrong AJ, Armstrong AO, Bennett MB, Burgess KB, Couturier LIE, Croll DA, Cronin MR, Deakos MH, et al. 2018. Research priorities to support effective Manta and Devil Ray conservation. *Frontiers in Marine Science* 5.

Stow A, Zenger K, Briscoe D, Gillings M, Peddemors V, Otway N, Harcourt R 2006. Isolation and genetic diversity of endangered grey nurse shark (*Carcharias taurus*) populations. *Biology Letters* 2: 308–311.

Stromme T 1984. Cruise Report R/V "Dr. Fridtjof Nansen": second fisheries resource survey north-east coast of Somalia 24–30 August 1984. Reports on Surveys with the R/V Dr Fridtjof Nansen. Bergen, Norway.

Stromme T 1987. Annex IV–Sectoral Report on Marine Resources. *Coastal and Marine Environmental Problems of Somalia*. Nairobi, Kenya: UNEP Regional Seas Reports and Studies No. 84, Annexes. UNEP.

Sumaila U, Bawumia M 2014. Fisheries, ecosystem justice and piracy: A case study of Somalia. *Fisheries Research* 157: 154–163.

Sweenarain S 2011. Value Chain Assessment: Artisanal Fisheries of Mauritius & Rodrigues. Port Louis.

SWIOFC 2013. Report of the Performance Review of the South West Indian Ocean Fisheries Commission.

SWIOFC 2019. Guidelines for minimum terms and conditions (MTC) for foreign fisheries access in the Southwest Indian Ocean Fisheries Commission (SWIOFC) Region. SWIOFC/WPCCTF/19/ Inf 5 E.

Taglioni F, Guiltat S 2015. Le risque d'attaques de requins à La Réunion. *EchoGéo*.

Taglioni F, Guiltat S, Teurlai M, Delsaut M, Payet D 2018. A Spatial and Environmental Analysis of Shark Attacks on Reunion Island (1980-2017).

Talla P, de Young C, Gallène J 2004. Refonte du cadre juridique et définition d'une stratégie opérationnelle de gestion des pêcheries Union des Comores. Rapport Final et compendium des documents du projet TCP/COI/2902. Rome.

Taniuchi T, Ishihara H, Tanaka S, Hyodo S, Murakami M, Séret B 2003. Occurrence of two elasmobranchs *Carcharhinus leucas* and *Pristis microdon*, in Betsiboka River, west Madagascar. *Cybium* 27: 237–241.

Temple AJ, Kiszka JJ, Stead SM, Wambiji N, Brito A, Poonian CNS, Amir OA, Jiddawi N, Fennessy ST, Pérez-Jorge S, et al. 2018. Marine megafauna interactions with small-scale fisheries in the southwestern Indian Ocean: a review of status and challenges for research and management. *Reviews in Fish Biology and Fisheries* 28: 89–115.

Temple AJ, Wambiji N, Poonian CNS, Jiddawi N, Stead SM, Kiszka JJ, Berggren P 2019. Marine megafauna catch in southwestern Indian Ocean small-scale fisheries from landings data. *Biological Conservation* 230: 113–121.

Tessier E, Rey-Valette H, Ah-Nième D, Bargain R, Venkatasamy A, Wendling B 2000. Systèmes halieutiques et DCP dans l'Océan Indien: une revue de la diversité des expériences et des résultats en termes d'intégration et de durabilité. In: le Gal Jy, Cayré P, Taquet M (eds), *Pêche thonière et dispositifs de concentration de poissons, Trois-Îlets (Martinique), October 15–19, 1999. Actes de Colloques 28)*. Plouzané (France): Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER).

Thurow F, Kroll D 1962. Report on the fisheries conditions in Somalia. Kiel, Germany.

Tibiriçá Y, Birtles A, Valentine P, Miller D 2011. Diving Tourism in Mozambique: An Opportunity at Risk? *Tourism in Marine Environments* 28: 1188–1193.

Topelko KN, Dearden P 2005. The shark watching industry and its potential contribution to shark conservation. *Journal of Ecotourism* 4: 108–128.

Towner A v., Wcisel MA, Reisinger RR, Edwards D, Jewell OJD 2013. Gauging the Threat: The First Population Estimate for White Sharks in South Africa Using Photo Identification and Automated Software. *PLoS ONE* 8.

TRAFFIC 2020. *Counteracting wildlife trafficking through Kenya's seaports*. Cambridge, United Kingdom.: TRAFFIC International.

Trans-Africa 2015. Improving Development and Management of Somalia's Marine Fisheries and Controlling Illegal, Unreported and Unregulated (IUU) Fishing.

Trystram C, Rogers K, Soria M, Jaquemet S, Rogers KM 2016. Feeding patterns of two sympatric shark predators in coastal ecosystems of an oceanic island ARTICLE Feeding patterns of two sympatric shark predators in coastal ecosystems of an oceanic island. *Canadian Journal of Fisheries and Aquatic Sciences*.

Tuda A, Thoya P 2021. Marine and coastal areas under protection: Kenya. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 57–70.

Turpie JK, Beckley LE, Katua SM 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. *Biological Conservation* 92: 59–72.

Ullah S, Gadain H 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia.

UN 1982. United Nations Convention on the Law of the Sea. 202.

UN 1995. Agreement for the implementation of the provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks. *United Nations conference on straddling fish stocks and highly migratory fish stocks, Sixth session, New York, 24 July-4August 1995*.

UN Comtrade 2021. United Nations Commodities Trade Statistics Database. Accessed from http://comtrade.un.org/, 2021-11-9.

UN General Assembly 2014. Convention on the Law of the Sea (Maritime Zone Notification M.Z.N.106.2014.LOS).

UNCTAD 2017. Trade and development report 2017: Beyond austerity: towards a global new deal. New York and Geneva.

UNEP 1972. Declaration of the United Nations Conference on the Human Environment.

UNEP 1985. *Conference for the protection, management and development of the marine and coastal environment of the Eastern African Region and related protocols*. Nairobi: United Nations Environment Programme.

UNEP 2005. The State of the Environment in Somalia: A Desk Study.

UNEP/CMS 2014. Kenya National Report of Parties on the Implementation of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS/COP11/Inf.20.3.KE.

UNEP/CMS 2017a. Concerted Actions adopted by the Conference of the Parties at its 12th meeting (Manila, October 2017).

UNEP/CMS 2017b. Proposal for a concerted action for the Mobulid rays (Mobulidae) already listed on Appendix I and II of the convention.

UNEP/CMS 2017c. Concerted Action for the whale shark (*Rhincodon typus*).

UNEP/CMS 2019a. Report on the implementation of the Concerted Action for the mobulid rays (Mobulidae).

UNEP/CMS 2019b. Report on the implementation of the Concerted Action for the whale shark (*Rhincodon typus)*.

UNEP/CMS 2019c. Proposal for a Concerted Action for the common guitarfish (*Rhinobatos rhinobatos*) listed on Appendix II of the Convention, the largetooth sawfish (*Pristis pristis*) listed on Appendix I and II of the Convention and the smalltooth sawfish (*Pristis pectinata*) listed on Appendix I and II of the Convention.

UNEP/CMS 2019d. Proposal for a Concerted Action for the common guitarfish (*Rhinobatos rhinobatos*) and bottlenose wedgefish (*Rhynchobatus australiae*) already on Appendix II of the Convention, and the families Rhinobatidae and Glaucostegidae.

UNEP/CMS 2019e. Kenya National Report of Parties on the Implementation of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS/COP13/NR.065.

UNEP-Nairobi Convention and WIOMSA 2021a. *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. UNEP and WIOMSA, Nairobi, Kenya, 298 pp

UNEP-Nairobi Convention and WIOMSA 2021b. *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. WIO MPA Database version August 2021 UNEP, WIOMSA, and Macquarie University.

UNEP-WCMC, IUCN 2017. Protected Area Profile for Mozambique from the World Database of Protected Areas [online] www.protectedplanet.net. January 2017.

UNEP-WCMC, IUCN 2021a. Protected Planet: [Comoros; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021] Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNEP-WCMC, IUCN 2021b. Protected Planet: [Kenya; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNEP-WCMC, IUCN 2021c. Protected Planet: [Madagascar; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNEP-WCMC, IUCN 2021d. Protected Planet: [Mozambique; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNEP-WCMC, IUCN 2021e. Protected Planet: [Protected Area Profile for Seychelles; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNEP-WCMC, IUCN 2021f. Protected Planet: [Protected Area Profile for Aldabra Atoll; The World Database on Protected Areas (WDPA)/The

Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedpl. Accessed from www.protectedplanet.net, 2021-11-12.

UNEP-WCMC, IUCN 2021g. Protected Planet: [Somalia; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNEP-WCMC, IUCN 2021h. Protected Planet: [United Republic of Tanzania; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [September 2021], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

UNGA 2007. 61/105. Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments. *Resolution adopted by the General Assembly on 8 December 2006* 21pp.

UNGA 2013. 67/79. Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instrument. *Resolution adopted by the General Assembly on 11 December 2012* 30 pp.

Union of Comoros 1982. Loi n° 82-015 relative à l'activité des navires de pêche étrangers dans les zones maritimes comoriennes.

Union of Comoros 2014. 5th National report on biological diversity.

Union of Comoros 2020. Portant promulgation de la loi N° 07-011/AU portant révision du Code des Pêches et de L'Aquaculture, Loi N°07-011/AU du août 2007. 1–50.

United Nations 1992. Convention on biological diversity. United Nations, New York. Accessed from https://www.cbd.int/doc/legal/cbd-en.pdf, 2021-11-10.

United Republic of Tanzania 2003. National Integrated Coastal Environmental Management Strategy. Dar es Salaam.

University of Windsor 2015. Response to questionnaire completed by N. Hussey. Unpublished.

Vannuccini S 1999. Shark Utilization, Marketing, and Trade. Rome.

Venables S, Winstanley G, Bowles L, Marshall AD 2016. A Giant Opportunity: The Economic Impact of Manta Rays on the Mozambican Tourism Industry—An Incentive for Increased Management and Protection. *Tourism in Marine Environments* 12.

Venables SK, van Duinkerken DI, Rohner CA, Marshall AD 2020. Habitat use and movement patterns of reef manta rays *Mobula alfredi* in southern Mozambique. *Marine Ecology Progress Series* 634: 99–114.

Venables SK, Marshall AD, Armstrong AJ, Tomkins JL, Kennington WJ 2021. Genome-wide SNPs detect no evidence of genetic population structure for reef manta rays (*Mobula alfredi*) in southern Mozambique. *Heredity* 126: 308–319.

Viana ST de F, de Carvalho MR, Ebert DA 2017. *Squalus bassi* sp. nov., a new long-snouted spurdog (Chondrichthyes: Squaliformes: Squalidae) from the Agulhas Bank. *Journal of Fish Biology* 91: 1178–1207.

Viana ST de F, Lisher MW, de Carvalho MR 2018. Two new species of short-snouted dogfish sharks of the genus *Squalus* Linnaeus, 1758, from southern Africa (Chondrichthyes: Squaliformes: Squalidae). *Marine Biodiversity* 48.

Vianna GMS, Meekan MG, Pannell D, Marsh S, Meeuwig JJ 2010. Wanted Dead or Alive? The relative value of reef sharks as a fishery and an ecotourism asset in Palau. Perth.

Vignaud TM, Maynard JA, Leblois R, Meekan MG, Vázquez-Juárez R, Ramírez-Macías D, Pierce SJ, Rowat D, Berumen ML, Beeravolu C, et al. 2014. Genetic structure of populations of whale sharks among ocean basins and evidence for their historic rise and recent decline. *Molecular Ecology* 23: 2590–2601.

Wallace JH 1967a. The batoid fishes of the east coast of southern Africa. Part II: manta, eagle, duckbill, cownose, butterfly and sting rays. Investigational Report. Durban.

Wallace JH 1967b. The batoid fishes of the east coast of southern Africa. Part I: sawfishes and guitarfishes. Investigational Report. Durban.

Wallace JH 1967c. The batoid fishes of the east coast of southern Africa. Part III: skates and electric rays. Investigational Report. Durban.

Walls RHL, Dulvy NK 2020. Eliminating the dark matter of data deficiency by predicting the conservation status of Northeast Atlantic and Mediterranean Sea sharks and rays. *Biological Conservation* 246.

Wamukoya GM, Mirangi JM, Ottichillo WK 1996. Report on the marine aerial survey of the marine mammals, turtles, sharks and rays.

Ward-Paige CA, Davis B, Worm B 2013. Global population trends and human use patterns of Manta and Mobula rays. *PLoS ONE* 8.

WCED 1987. World commission on environment and development. Our common future.

WCS 2015. Government of Madagascar Creates Country's First Shark Sanctuary. Accessed from http://press.wcs.org/NewsReleases/tabid/13614/articleType/ArticleView/articleId/6563/Government-of-Madagascar-Creates-Countrys-First-Shark-Sanctuary.aspx, 2021-11-11.

Weigmann S 2016. Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the world, with a focus on biogeographical diversity. *Journal of Fish Biology* 88: 837–1037.

Weigmann S, Kaschner CJ 2017. *Bythaelurus vivaldii*, a new deep-water catshark (Carcharhiniformes, Scyliorhinidae) from the northwestern Indian Ocean off Somalia. *Zootaxa* 4263: 97–119.

Weigmann S, Stehmann MFW 2016. *Sinobatis brevicauda* n. sp., a new deep-water legskate (Rajiformes, Anacanthobatidae) and first generic record from the western Indian Ocean. *Zootaxa* 4137: 478–500.

Weigmann S, Ebert DA, Clerkin PJ, Stehmann MFW, Naylor GJP 2016. *Bythaelurus bachi* n. sp., a new deep-water catshark (Carcharhiniformes, Scyliorhinidae) from the southwestern Indian Ocean, with a review of *Bythaelurus* species and a key to their identification. *Zootaxa* 4208: 401–432.

Weigmann S, Ebert DA, Séret B 2021a. Resolution of the *Acroteriobatus leucospilus* species complex, with a redescription of *A. leucospilus* (Norman, 1926) and descriptions of two new western Indian Ocean species of *Acroteriobatus* (Rhinopristiformes, Rhinobatidae). *Marine Biodiversity* 51.

Weigmann S, Gon O, Leeney RH, Barrowclift E, Berggren P, Jiddawi N, Temple AJ 2020. Revision of the sixgill sawsharks, genus *Pliotrema* (Chondrichthyes, Pristiophoriformes), with descriptions of two new species and a redescription of *P. warreni* Regan. *PLoS ONE* 15.

Weigmann S, Kaschner CJ, Thiel R 2018. A new microendemic species of the deepwater catshark genus *Bythaelurus* (Carcharhiniformes, Pentanchidae) from the northwestern Indian Ocean, with investigations of its feeding ecology, generic review and identification key. *PLoS ONE* 13.

Weigmann S, Séret B, Stehmann MFW 2021b. *Notoraja hesperindica* sp. nov., a new colorful deep-sea softnose skate (Elasmobranchii, Rajiformes, Arhynchobatidae) and first generic record from the western Indian Ocean. *Marine Biodiversity* 51.

Weigmann S, Stehmann MFW, Thiel R 2013. *Planonasus parini* n. g. and n. sp., a new genus and species of false cat sharks (Carchariniformes, Pseudotriakidae) from the deep northwestern Indian Ocean off Socotra Islands. *Zootaxa* 3609: 163–181.

Weigmann S, Stehmann MFW, Thiel R 2014a. *Rajella paucispinosa* n. sp., a new deep-water skate (Elasmobranchii, Rajidae) from the western Indian Ocean off South Mozambique, and a revised generic diagnosis. *Zootaxa* 3847: 359–387.

Weigmann S, Stehmann MFW, Thiel R 2014b. Contribution to the taxonomy and distribution of *Pristiophorus nancyae* (Elasmobranchii: Pristiophoriformes) from the deep western Indian Ocean. *Marine Biodiversity* 44: 189–202.

Wekesa PN 2013. Kenya National Report to the Scientific Committee of the Indian Ocean Tuna Commission. IOTC–2013–SC16–NR13.

West W, Kerwath S 2015. South African National Report to the Scientific Committee of the Indian Ocean Tuna Commission. Report to the IOTC Scientific Committee. Victoria, Seychelles.

White WT 2007. Aspects of the biology of carcharhiniform sharks in Indonesian waters. *Journal of the Marine Biological Association of the United Kingdom* 87: 1269–1276.

White WT, Weigmann S 2014. *Carcharhinus humani* sp. nov., a new whaler shark (Carcharhiniformes: Carcharhinidae) from the western Indian Ocean. *Zootaxa* 3821: 71–87.

White WT, Ebert DA, Naylor GJP 2017. Revision of the genus *Centrophorus* (Squaliformes: Centrophoridae): Part 2 - Description of two new species of *Centrophorus* and clarification of the status of *Centrophorus lusitanicus* Barbosa du Bocage & de Brito Capello, 1864. *Zootaxa* 4344: 86–114.

White WT, Ebert DA, Naylor GJP, Ho HC, Clerkin P, Veríssimo A, Cotton CF 2013. Revision of the genus *Centrophorus* (squaliformes: Centrophoridae): Part 1-redescription of *Centrophorus granulosus* (bloch & schneider), a senior synonym of *C. acus* Garman and *C. niaukang* Teng. *Zootaxa* 3752: 35–72.

Whitty TS, Davis P, Poonian C, Leandre I 2010. Rapid assessment of marine megafauna capture, fishing effort, and socioeconomic and cultural drivers of artisanal fisheries in northern Madagascar.

Wickel J, Jamon A, Guézel R 2009a. Guide des principaux poissons commerciaux de Mayotte: Identification et écologie. Service des affaires maritimes de Mayotte.

Wickel J, Jamon A, Kiszka J, Layssac K, Nicet J-B, Sauvignet H, Seret B 2010. Structure des communautés de requins et autres poissons prédateurs des bancs récifaux de Geyser, Zélée et Iris (Canal de Mozambique).

Wickel J, Jamon A, Kiszka J, Nicet J-B, Sauvignet H, Seret B, Layssac K 2009b. Structure des communautés de requins et autres poissons prédateurs des bancs récifaux de Geyser, Zélée et Iris (Canal de Mozambique).

Wickel J, Jamon A, Pinault M, Durville P, Chabanet P 2014. Composition et structure des peuplements ichtyologiques marins de l'île de Mayotte (sud-ouest de l'océan Indien). *Cybium* 38: 179–203.

WildAid 2007. The end of the line? Global threat to sharks. WildAid and OCEANA.

Winker H, Parker D, da Silva C, Kerwath S 2020. First comprehensive assessment of soupfin shark Galeorhinus galeus in South Africa.

Wintner S, Cliff G 1996. Age and growth determination of the blacktip shark, *Carcharhinus limbatus*, from the east coast of South Africa. *Oceanographic Literature Review* 12: 1275.

Wintner SP, Dudley SFJ 2000. Age and growth estimates for the tiger shark, *Galeocerdo cuvier*, from the east coast of South Africa. *Marine and Freshwater Research* 51: 43.

Wintner SP, Dudley SFJ, Kistnasamy N, Everett B 2002. Age and growth estimates for the Zambezi shark, *Carcharhinus leucas*, from the east coast of South Africa. *Marine and Freshwater Research* 53: 557.

WIOFish 2021. Western Indian Ocean Fisheries Database. Accessed from http://www.wiofish.org/access-our-database, 2021-11-10.

WIOMSA 2011. Migrant fishers and fishing in the Western Indian Ocean: socio-economic dynamics and implications for management. Final report of commissioned research project MASMA/CR/2008/02. Zanzibar, Tanzania.

World Bank 2005. Blueprint 2050: Sustaining the Marine Environment in Mainland Tanzania and Zanzibar. Washington, DC.

World Bank 2015. Madagascar Country Profile. Accessed from http://data.worldbank.org/country/madagascar, 2021-11-11.

World Bank 2018. The world by income: Classified according to World Bank estimates of 2016 GNI per capita (current US dollars, Atlas method).

World Bank 2019. Somalia Issues Fishing Licenses: Fees will Help Develop Fisheries Sector. Accessed from https://www.worldbank.org/en/news/factsheet/2019/03/07/somalia-issues-fishing-licenses-fees-will-help-develop-fisheries-sector#ref3, 2021-11-12.

World Bank 2021. World Bank Open Data. Accessed from data.worldbank.org, 2021-11-10.

Worm B, Davis B, Kettemer L, Ward-Paige CA, Chapman D, Heithaus MR, Kessel ST, Gruber SH 2013. Global catches, exploitation rates, and rebuilding options for sharks. *Marine Policy* 40: 194–204.

WRI 2003. Earth Trends: Coastal and Marine Ecosystems, Madagascar. Washington, DC, USA.

Yahya S 2021. Marine and coastal areas under protection: United Republic of Tanzania - Zanzibar. In: UNEP-Nairobi Convention, WIOMSA (eds), *Western Indian Ocean Marine Protected Areas Outlook: Towards achievement of the Global Biodiversity Framework Targets*. Nairobi: UNEP and WIOMSA. pp 203–214.

Yan HF, Kyne PM, Jabado RW, Leeney RH, Davidson LNK, Derrick DH, Finucci B, Freckleton RP, Fordham S v, Dulvy NK 2021. Overfishing and habitat loss drives range contraction of iconic marine fishes to near extinction.

de Young C 2006. Review of the state of world marine capture fisheries management: Indian. Rome.

Zanzibar 1996a. Environmental Management for Sustainable Development Act 1996 (No. 2 of 1996).

Zanzibar 1996b. Forest Resources Management and Conservation Act (No. 10 of 1996).

Zanzibar 2010. Fisheries Act, 2010 (No. 7 of 2010).

Ziegler J, Dearden P 2021. Whale shark tourism as an incentive-based conservation approach. In: Dove ADM, Pierce SJ (eds), *Whale sharks: Biology, ecology, and conservation*. Boca Raton: CRC Press.

Ziegler J, Araujo G, Labaja J, Snow S, King JN, Ponzo A, Rollins R, Dearden P 2020. Can ecotourism change community attitudes towards conservation? *Oryx* 55.

Ziegler JA, Diamant S, Pierce SJ, Bennett R, Kiszka JJ 2021. Economic Value and Public Perceptions of Whale Shark Tourism in Nosy Be, Madagascar. *Tourism in Marine Environments* 16: 167–182.

van Zyl K 1993. Marine products: die eerste 50 jaar. Cape Town.

APPENDIX A

Regional Roadmap for the Conservation and Management of Sharks and Rays in the Western Indian Ocean

Document prepared under the auspices of the

Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region

And the

Indian Ocean Commission Biodiversity Program

Final draft

JUNE 2018

Document prepared by Wildlife Conservation Society and TRAFFIC

List of Acronyms

BYCAM	BYCatch Assessment and Mitigation in Western Indian Ocean Fisheries Project
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMC	Convention on the Conservation of Migratory Species
CoP	Conference of Parties
CORDIO	Coastal Oceans Research and Development in the Indian Ocean
ELMO	South African Elasmobranch Monitoring
FAO	Food and Agriculture Organization
FARI	Forum of Academic and Research Institutions in the Western Indian Ocean
FIU	Florida International University
GCRMN	Global Coral Reef Monitoring Network
GEF	Global Environment Facility
HS	Harmonized System commodity export codes
IOC	Indian Ocean Commission
IOTC	Indian Ocean Tuna Commission
IPOA	International Plan of Action
IPOA-SHARKS	FAO International Plan of Action for the Conservation and Management of Sharks
ISSF	International Seafood Sustainability Foundation
IUCN	International Union for the Conservation of Nature
IUU	illegal, unreported and unregulated (fishing)
LMMA	locally managed marine area
MPA	marine protected area
MSC	Marine Stewardship Council
NC	Nairobi Convention
NGO	Non-governmental organization
NMCi	Northern Mozambique Channel initiative
NPOA	national plan of action
OCUP	Permanent and Unique Common Observers Monitoring Program
PSMA	Port State Measures Agreement
SMART	Spatial Monitoring and Reporting Tool
SOSF	Save Our Seas Foundation
StP	Nairobi Convention Science to Policy Forum
SWIOFish	Southwest Indian Ocean Fisheries Governance and Shared Growth Project
TBCA	transboundary conservation area
TOT	training of trainers
TRAFFIC	Trade Records Analysis of Flora and Fauna in Commerce),
UN	United Nations
WCS	Wildlife Conservation Society
WIO	Western Indian Ocean
WIO-C	Consortium for the Conservation of Coastal and Marine Ecosystems in the Western Indian Ocean
WIO-COMPAS	Western Indian Ocean Certification of Marine Protected Area Professionals
WIOFish	Western Indian Ocean Fisheries Database
WIOMSA	Western Indian Ocean Marine Science Association
WIO-SAP	Strategic Action Program for the Protection of the Western Indian Ocean from Land-based Sources and Activities
WP	Working Party
WPEB	Working Party on Ecosystems and Bycatch
WWF	World Wide Fund for Nature

Regional Roadmap for the Conservation and Management of Sharks and Rays in the Western Indian Ocean

Introduction and Background

The Western Indian Ocean[119] (WIO) has been identified as a global hotspot for chondrichthyan (sharks, batoids and chimaeras) diversity (Dulvy et al. 2014), with 129 shark, 84 batoid (wedgefishes, skates and rays) and 9 chimaera species identified to date. The WIO is one of four global hotspots for chondrichthyan evolutionary distinctiveness (Dulvy et al. 2014), giving the chondrichthyans in the region a high irreplaceability value (Stein et al. 2018), and highlighting the need for their conservation.

The WIO is also characterized by extensive fisheries, from the artisanal level to large-scale industrial fleets, operating from the coast to the high seas, and including illegal, unreported and unregulated (IUU) fishing. There is a high demand for, and legal and illegal trade in, chondrichthyan products, particularly shark meat for local consumption, and shark and batoid fins and mobulid gill plates for the global shark fin and gill plate trade. Chondrichthyans are also incidentally taken in a variety of industrial and small-scale fisheries throughout the region. Chondrichthyan species are generally slow growing, with late maturity and low reproductive capacity, making them highly susceptible to overfishing (Worm et al. 2013).

Owing to overfishing and other human impacts, the stocks of numerous species have declined, putting several species under threat (Dulvy et al. 2014). According to the IUCN Red List of Threatened Species (www.iucnredlist.org), at the time or writing, 59 chondrichthyan species (25%) in the WIO are considered threatened, i.e., considered to be facing a high to extremely high risk of extinction in the wild (IUCN 2001), while 64 species (28%) are classified as Data Deficient, i.e., there is inadequate information to make a direct or indirect assessment of the species' risk of extinction.

The WIO has been identified as one of four global hotspots in terms of the number of imperilled chondrichthyan species (Davidson and Dulvy 2017), and anecdotal evidence suggests that this number is increasing. Recent updates to IUCN Red List categorisations for chondrichthyan species in other regions, such as European, Mediterranean and Arabian Seas populations, have shown severe increases in threat status, with many species being re-classified into higher threat categories (Jabado et al. 2018). The same negative result is expected in the WIO, when the recently updated threat categories are published from the WIO species later in 2018. There is thus a critical need for corrective management and improved conservation of the WIO chondrichthyan species, particularly those that are threatened or likely to become threatened.

Overexploitation of chondrichthyan species has direct impacts on their populations, and indirect impacts through cascading effects on the ecosystems and trophic webs. As thousands of people living in coastal communities within the WIO countries are dependent on fishes, chondrichthyan species and other marine resources for their income and livelihoods, as well as cultural or traditional uses, sustainable utilization of these resources is paramount and as much a social issue as it is an ecological issue. Human populations, and consequently the demand for marine resources (including sharks and rays), are increasing throughout the WIO. There is also evidence of human migrations towards coastal areas in search of improved food security and livelihoods (Barnes-Mauthe et al. 2013). Consequently, the impacts on chondrichthyan populations are likely to increase. However, there are currently poor data on the catches of chondrichthyan species, and large proportions of the catches, particularly in the artisanal sector and small-scale fisheries, as well as IUU fisheries, are not reported and remain unknown (Worm et al. 2013). There is thus a continued threat to WIO chondrichthyans, the severity of which is likely increasing.

[119] The geographic area referred to here by the term Western Indian Ocean includes the Indian Ocean territorial waters of the ten Nairobi Convention member states, from South Africa in the southwest, to Somalia in the northwest, and to Mauritius in the east, following the delineation of the Indian Ocean by the International Hydrographic Organization (2002), and excludes the marginal seas to the north.

Addressing these issues at an international level

The Food and Agriculture Organization (FAO) of the United Nations developed an international plan of action (IPOA-SHARKS) for the conservation and management of sharks and rays (FAO 1999), which advocated that "States that contribute to fishing mortality on a species or stock should participate in its management" and that "States should adopt a national plan of action for conservation and management of shark stocks (Shark-plan) if their vessels conduct directed fisheries for sharks or if their vessels regularly catch sharks in non-directed fisheries". The IPOA-SHARKS also suggested that this "applies to States in the waters of which sharks are caught by their own or foreign vessels and to States the vessels of which catch sharks on the high seas" (FAO 1999).

Addressing these issues in the Western Indian Ocean

Acknowledging the global status of threats to chondrichthyans, and mounting evidence of threats to chondrichthyan species in the WIO, the Nairobi Convention parties decided in 2012 to incorporate sharks into the Nairobi Convention Program of Work. At the 7th Conference of the Parties (CoP) to the Nairobi Convention, held in Maputo, Mozambique in 2012, Decision CP7/12: *Conservation of Sharks* called for "regional collaboration, in consultation with the Secretariats of the Convention on International Trade in Endangered Species, Convention on Migratory Species, regional fisheries management organizations and other partners, on the conservation and management of sharks" and requested "the Secretariat in collaboration with the Contracting Parties to prepare a regional status report on the state of sharks especially on matters of institutional, legal and capacity and report to the next Conference of Parties".

At the 8th CoP, held in Mahé, Seychelles in 2015, Decision CP8/9: *Threatened and Endangered Marine Species* was made "To *urge* the Secretariat, in partnership with the Wildlife Conservation Society, to finalize the Regional Status Report on Sharks and Rays in the Western Indian Ocean and circulate the report to all Contracting Parties for review and submit the final report with findings for consideration at the next Conference of Parties".

Accordingly, the Wildlife Conservation Society (WCS), in collaboration with TRAFFIC (Trade Records Analysis of Flora and Fauna in Commerce), Florida International University (FIU) and the IUCN shark specialist group, undertook a widespread assessment of the status of chondrichthyan species, and the fisheries that catch chondrichthyans and impact chondrichthyan populations, throughout the WIO, including all ten Nairobi Convention Member States. The assessment formed the basis of the status report *Sharks and Rays of the Western Indian Ocean – Biodiversity, Fisheries and Trade, Management and Conservation*.

Status report on chondrichthyans in the Western Indian Ocean region

The regional chondrichthyan status report identifies several recurring issues across the Nairobi Convention Member States and recommends necessary actions to address these issues. One of the issues identified was a general lack of legislation developed specifically for chondrichthyan species, or legislation which includes these taxa in their text, in most WIO countries. All ten Nairobi Convention Member States have shark-directed fisheries or fisheries that take sharks as bycatch, or harbour species of sharks that are captured by fisheries in the waters of other countries. However, by the start of 2017 national plans of action (NPOAs, as advocated by the FAO IPOA-Sharks) for shark and ray conservation and management had been developed in only three of these States, namely Seychelles, South Africa and Mauritius. Subsequently, Madagascar has completed a national roadmap and a NPOA (2018), while Kenya is currently developing a NPOA.

Preparation of this document

In response to the need for guiding policy in the WIO, a region-wide initiative was undertaken, to develop a policy document to guide and prioritize conservation and management activities for chondrichthyans in the WIO region. A Regional Technical Workshop, titled *Sharks and Rays of the Southwest Indian Ocean: Status Review and Development of a Roadmap for*

Conservation and Management, was held from 5-7 April in Mauritius and hosted by the Indian Ocean Commission (IOC) Biodiversity Program, in collaboration with the Nairobi Convention, WCS, and TRAFFIC. The workshop was attended by delegates from all ten of the Nairobi Convention Member States.

The workshop included an overview of current knowledge on the biodiversity, catch, and trade of sharks and rays in the region, as well as international mandates for their conservation and management. Representatives from the Comoros, France, Kenya, Madagascar, Tanzania, Zanzibar, Seychelles, Mozambique and Somalia presented issues relating to shark and ray conservation and management, including knowledge gaps, issues with governance and limitations in capacity.

Following a summary presentation of the findings and recommendations of the regional *Status Report*, participants were divided into three working groups to discuss these findings and recommendations, and to identify gaps in and priorities for conservation and management of chondrichthyans in the WIO. Building on outcomes from working groups, a draft regional roadmap for sharks and rays in the Nairobi Convention area was presented, composed of six key objectives and associated required actions to meet those objectives.

A subsequent workshop, titled *Advancing the development of a regional roadmap for the conservation and management of sharks and rays in the Southwest Indian Ocean* and held as a special session of the 10th WIOMSA (Western Indian Ocean Marine Science Association) scientific symposium in Dar es Salaam in November 2017, brought together stakeholders, including representatives from academic, research and management organizations, from seven Nairobi Convention Member States. At this meeting, delegates refined the objectives and required actions presented in the draft roadmap, to produce an updated ***Roadmap for the Conservation and Management of Sharks and Rays of the Western Indian Ocean***, which incorporates the comments and suggestions proposed during the November special session and which forms this basis of this document. The roadmap is presented in the roadmap matrix that follows.

Roadmap goal

The effective conservation and management of chondrichthyans in the Western Indian Ocean to ensure their optimal, long-term and sustainable use and maintaining their ecological function for the benefit of coastal States in the region.

Roadmap objectives

- To improve the knowledge both on shark and ray species and their fisheries, including their role in the ecosystem, to inform conservation and management,
- To ensure that directed fisheries for sharks and rays, and fisheries that catch sharks and rays incidentally, are sustainable and properly managed,
- To improve the conservation status of sharks and rays in the region through recovery of endangered species and restoration of depleted species, and enhance their contributions to ecosystem integrity, community livelihoods, and national economies,
- To increase public awareness of threats to sharks and rays and their habitat, and enhance public participation and conservation activities.

References

Barnes-Mauthe, M., K.L.L. Oleson and B. Zafindrasilivonona. 2013. The total economic value of small-scale fisheries with a characterization of post-landing trends: An application in Madagascar with global relevance. *Fisheries Research* **147**: 175-185.

Davidson, L. and N.K. Dulvy. 2017. Global marine protected areas to prevent extinctions. *Nature Ecology & Evolution* **1** (0040). DOI:10.1038/s41559-016-0040.

Dulvy, N.K., S.L. Fowler, J.A. Musick, R.D. Cavanagh, P.M. Kyne, L.R. Harrison, J.K. Carlson, L.N.K Davidson, S.V. Fordham, M.P. Francis, C.M. Pollock, C.A. Simpfendorfer, G.H. Burgess, K.E. Carpenter, L.J.V. Compagno, D.A. Ebert, C. Gibson, M.R. Heupel, S.R. Livingstone, J.C. Sanciangco, J.D. Stevens, S. Valenti and W.T. White. 2014. Extinction risk and conservation of the world's sharks and rays. *eLife* **3** (2014): e00590.

FAO. 1999. *International Plan of Action for reducing incidental catch of seabirds in longline fisheries. International Plan of Action for the conservation and management of sharks. International Plan of Action for the management of fishing capacity.* Food and Agriculture Organization. Rome, 1999. 33 pp.

International Hydrographic Organization. 2002. *The Indian Ocean and its sub-divisions*. International Hydrographic Organization, Special Publication N°23.

IUCN (2001) *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, United Kingdom: 30 pp.

Jabado RW, Kyne PM, Pollom RA, Ebert DA, Simpfendorfer CA, Ralph GM, Al Dhaheri SS, Akhilesh KV, Ali K, Ali MH, Al Mamari TMS, Bineesh KK, El Hassan IS, Fernando D, Grandcourt EM, Khan MM, Moore ABM, Owfi F, Robinson DP, Romanov E, Soares A-L, Spaet JY, Tesfamichael D, Valinassab T, Dulvy NK (2018) Troubled waters: Threats and extinction risk of the sharks, rays and chimaeras of the Arabian Sea and adjacent waters. *Fish and Fisheries*. https://doi.org/10.1111/faf.12311.

Kiszka, J. and R.P. van der Elst. 2015. Ch. 11: Elasmobranchs (sharks and rays). In: van der Elst R.P. and B.I. Everett (eds). *Offshore fisheries of the Southwest Indian Ocean: their status and the impact on vulnerable species*. Oceanographic Research Institute Special Publication 10. Durban, South Africa. 448pp.

Stein, R.W., C.G. Mull, T.S. Kuhn, N.C. Aschliman, L.N.K. Davidson, J.G. Boy, G.J. Smith, N.K. Dulvy and A.O. Mooers. 2018. Global priorities for conserving the evolutionary history of sharks, rays and chimaeras. *Nature Ecology and Evolution* https://doi.org/10.1038/s41559-017-0448-4.

Worm, B., B. Davis, L. Kettemer, C.A. Ward-Paige, D. Chapman, M.R. Heithaus, S.T. Kessel and S.H. Gruber. 2013. Global catches, exploitation rates, and rebuilding options for sharks. *Marine Policy* **40**: 194-204.

Roadmap matrix: Roadmap objectives, recommended actions, links to existing programs/projects that could facilitate, support or guide activities, and priority status (high – H, medium – M or low – L) for each activity at national and regional (WIO) levels.

Objective	Actions	Linked Projects/Programs	Priority
1. Improve Data Collection, Reporting and Use	Develop regional projects to expand and improve monitoring of chondrichthyan catches at national level, for artisanal, small-scale and industrial fisheries, and assimilate data at regional level. These projects should include *inter alia:* • developing/standardising survey methods where appropriate, • training personnel to collect data, • training personnel to identify chondrichthyans to species level, • developing appropriate local field guides (translated) to assist in species identification *in situ,* and • developing appropriate guides (translated) for the collection of biological samples.	➢ Development of field guides: starting with existing published materials, such as: ▪ FAO (http://www.fao.org/home/en/) ▪ FAO marine species biological data collection manual (http://www.fao.org/3/a-i6353e.pdf) ▪ WIOMSA (www.wiomsa.org/) ▪ IOC and SmartFish guides (http://commissionoceanindien.org/activites/smartfish/activites-activities/the-sharks-and-rays-initiative/) ▪ IOTC (http://www.iotc.org/science/species-identification-cards) ➢ Taxonomic expertise to develop guides ➢ Training: training of trainers (TOT) approach	National – H Regional – H 1 year for training; Build up guides: 5 years
	Develop and implement standardised catch monitoring systems for small-scale/informal fishers and sport fishing activities, with a particular emphasis on species-level identification, recording and reporting.	➢ Rapid Assessment Tool (WWF) ➢ Kenya State Department of Fisheries ➢ Kenya Beach Management Units ➢ BYCAM project ➢ WCS, CORDIO, other NGOs, fisheries ministries	National – H Regional – H Training and manuals 1 year
	Standardise chondrichthyan catch and landing data capture methods for industrial fisheries, with a particular emphasis on species-specific recording and reporting.	➢ Engage with IOTC and FAO on final reporting to FAO from IOTC – to standardise reporting and to obtain species-level data where possible. FAO WP on statistics (http://www.iotc.org/science/wp/working-party-data-collection-and-statistics-wpdcs)	National – H Regional – H 1 year

1. Improve Data Collection, Reporting and Use	Improve observer coverage, including automated/photographic/video coverage, on industrial fishing vessels that catch chondrichthyans, whether as target or incidental catch.	➢ Permanent and Unique Common Observers (OCUP, http://www.oceanic-dev.com/en/ocup-monitoring-program-orthongel/) ➢ Electronic monitoring system program (onboard and landing sites) ➢ IOTC Regional Observer Scheme (http://www.iotc.org/science/regional-observer-scheme-science) ➢ Creating awareness about tagged animals and how to return data	National – M Regional – H 2-5 years to implement; Continuous
	Establish chondrichthyan fisheries trade monitoring programs at a national level and at a regional level, which: • conduct analyses of national trade and use dynamics for sharks and rays, • improve monitoring and analysis of international trade data, including comparative analysis of trade data, • improve collection of Customs trade data for shark and ray products in international trade through ensuring the use of correct HS codes by exporters, • where appropriate, develop more detailed HS codes/ categories for shark and ray products in international trade, and • establish estimates of discards (at species level) to assist with stock assessments.	➢ Detect IT: Fish: TRAFFIC/WWF online tool for the automation of trade data analysis (https://detect.trade/) ➢ MSC ecolabelling (https://www.msc.org/get-certified/use-the-msc-ecolabel) to avoid falsification of data ➢ HS codes (http://2016.export.gov/california/sanfrancisco/qa/hssb/)	National – H 2-5 years to implement; Continuous
	Establish a regional database(s) for centralising data on catch and trade of chondrichthyans. Countries to explore options.	➢ Existing platforms, e.g., WIOFish (www.wiofish.org)	Regional – M 2 years

1. Improve Data Collection, Reporting and Use	Initiate and expand field surveys and other research efforts aimed at clarifying the status of sharks and rays in the WIO, including on population status and trends, connectivity, and other aspects to inform conservation and management.	➢ IUCN Red List assessments (IUCN shark specialist group, www.iucnssg.org/)	National – H Regional – M 5 years
	Expand knowledge on critical habitats for sharks and rays throughout the WIO to feed into marine spatial planning (MPA and LMMA designation) and fisheries management.	Critical habitat associated projects, e.g.: ➢ NC WIO-SAP Project (www.unenvironment.org/nairobiconvention/) ➢ CMS (www.cms.int/)	National – H Regional – M 5 years
	Improve knowledge of socioeconomic importance of chondrichthyan catches in small-scale fisheries in each country.	➢ FAO: Improving our knowledge on small-scale fisheries: data needs and methodologies (http://www.fao.org/3/a-i8134e.pdf) ➢ FAO: Voluntary guidelines for securing sustainable small-scale fisheries (http://www.fao.org/3/a-i4356en.pdf)	National – H Regional – H 2-5 years
	Conduct stock status or stock assessments on Vulnerable and Endangered chondrichthyan species, including: • identifying which species require stock assessments, • identifying data required for stock assessments of data poor species, and • identifying highly migratory species that need to be managed regionally.	➢ IOTC (www.iotc.org) ➢ Fisheries ministries ➢ Published literature ➢ IUCN shark and ray specialist group (www.iucnssg.org/) ➢ NC (www.unenvironment.org/nairobiconvention/) ➢ CITES (www.cites.org) ➢ CMS (www.cms.int/)	National – M Regional – M 5-10 years
	Provide support to citizen science programs that facilitate data collection/reporting on shark and ray species (for example sharks and rays observed by recreational divers, sports fishers and small-scale fishers), through online photograph submission platforms.	Existing platforms e.g.: ➢ iNaturalist (www.inaturalist.org), ➢ iSpot (www.ispotnature.org) ➢ ELMO (www.elmoafrica.org) ➢ Encourage sport/artisanal fishers to participate at the point of licencing ➢ Incentive-driven initiatives for reporting by fishers	National – L Regional – H Continuous

2. Strengthen Policy, Legislation for Sharks and Rays	Countries to assess existing policy and legislation on harvest and trade in chondrichthyan products, at national level, and: • develop national policy (e.g., NPOA) and/or legislation for the conservation and management of chondrichthyans (e.g., chondrichthyan biodiversity and management act) (with emphasis on threatened species), or • incorporate chondrichthyan species into existing national policy and legislation, to ensure that the legal framework provides for adequate regulation of chondrichthyan products in trade, and national implementation of trade-related provisions of international agreements.	➢ FAO IPOA-Sharks (www.fao.org/ipoa-sharks/en/) ➢ NC to assist Member States to develop national policy (NPOA) and legislation for chondrichthyan conservation, management and trade (www.unenvironment.org/nairobiconvention/) ➢ CITES Secretariat currently developing a project with regards to sharks and rays (www.cites.org) ➢ CMS Sharks MOU (www.cms.int/sharks/en)	National – H Regional – M 2-3 years
	Establish comprehensive management regimes for trade in shark and ray products, including to improve implementation of CITES shark measures (capacity building, permit issuance, endorsement and providing data in annual reports)	➢ CITES (www.cites.org) ➢ TRAFFIC (www.traffic.org)	National – M Regional – M 2-3 years
	Conduct non-detriment findings for CITES listed shark and ray species	➢ CITES (www.cites.org/eng/prog/ndf/index.php)	National – L Regional – M 2-3 years
	Strengthen policy and legislation at a regional level, and promote agreement on Chondrichthyan policy and legislation among NC Member States	➢ NC (www.unenvironment.org/nairobiconvention/)	National – H Regional – M 2-3 years
	NC Member States ratify and implement the Port State Measures Agreement and/or other international agreements on shark and ray conservation and management	➢ NC (www.unenvironment.org/nairobiconvention/) ➢ PSMA (www.fao.org/port-state-measures/en) ➢ CITES (www.cites.org) ➢ CMS (www.cms.int/)	National – M Regional – L 2-3 years
	Require all sharks and rays to be landed with fins naturally attached.		National – H 1-2 years

3. Reinforce Management and Conservation Measures	Identify best practice models (nationally and regionally) for reducing targeted or accidental catch of threatened chondrichthyans in small-scale fisheries and industrial fisheries and disseminate and replicate across the WIO region, and specifically: • establish measures to reduce fishing mortality of sharks and rays in line with the FAO Precautionary Approach to Capture Fisheries and FAO Code of Conduct for Responsible Fisheries, and • promote the design and implementation of shark and ray bycatch mitigation measures.	➢ FAO precautionary approach (http://www.fao.org/docrep/003/w3592e/w3592e00.htm#Contents) ➢ FAO Code of Conduct for Responsible Fisheries (http://www.fao.org/3/a-v9878e.htm) ➢ ISSF Bycatch Mitigation (https://iss-foundation.org/what-we-do/areas-of-focus/bycatch/) ➢ IOTC WPEB (http://www.iotc.org/science/wp/working-party-ecosystems-and-bycatch-wpeb) ➢ BYCAM Project (http://www.wiomsa.org/ongoing-project/by-catch-assessment-and-mitigation-in-western-indian-ocean-fisheries-bycam/)	National – H Regional – L 2-5 years
	Assess and expand the use of no-take zones to contribute to shark and ray conservation and management; in particular to safeguard threatened endemic species in the region. This activity should: • identify and proclaim MPAs specifically for the conservation/protection of chondrichthyan species, • adapt existing MPAs and LMMAs to provide protection for shark and ray species, and • explore the use of transboundary MPAs in the region.	➢ NMCi led by WWF and CORDIO (http://wwf.panda.org/our_work/oceans/solutions/northern_mozambique_channel_initiative.cfm) ➢ Kenya and Tanzania TBCA (www.unenvironment.org/nairobiconvention/projects) ➢ Global project to assess MPAs for sharks (www.sharkconservationfund.org/project/maximizing-outcomes-for-shark-and-ray-mpas/) ➢ WIO-COMPAS (http://www.wio-compas.org/) ➢ Group of Experts on Marine Protected Areas (https://www.unenvironment.org/nairobiconvention/who-we-are/expert-groups)	National – M Regional – M 2-3 years
	Integrate chondrichthyan management into national systems for community co-management and MPA management plans	➢ National level MPA and LMMA management plans	National – H Regional – M 5 years
	Improve coordination between government agencies and non-government actors involved in chondrichthyan management (fisheries, trade, biodiversity conservation, enforcement, research, monitoring, establishing national working groups).	➢ NC (www.unenvironment.org/nairobiconvention/) ➢ NC WIO-SAP Project, NC Science to Policy Platform (www.unenvironment.org/nairobiconvention/)	National – H Regional – H 2-3 years
	Promote recovery planning for threatened chondrichthyan species of the WIO, in particular migratory species.	➢ CMS Sharks MOU (www.cms.int/sharks/en) ➢ IUCN shark specialist group (www.iucnssg.org/)	National – M Regional – M 5 years

4. Improve compliance and enforcement	Address all aspects of IUU fishing of chondrichthyan species and trade in IUU sourced chondrichthyan products (such as fishing grounds, vessels, vessel flag States, catches, market locations, routes to market locations, enforcement).	➢ Fishi-Africa (https://fish-i-africa.org/) ➢ FAO IPOA-IUU (http://www.fao.org/fishery/ipoa-iuu/en) ➢ SmartFish (www.smartfish-coi.org/) ➢ IOTC IUU List (http://www.iotc.org/iotc-iuu-list)	National – H Regional – H Continuous
	Improve implementation of conservation and management measures in terms of commitments under international conventions.	➢ FAO IPOA-Sharks (www.fao.org/ipoa-sharks/en/) ➢ NC (www.unenvironment.org/nairobiconvention/) ➢ PSMA (www.fao.org/port-state-measures/en) ➢ CITES (www.cites.org) ➢ CMS (www.cms.int/) ➢ WIO-C Consortium (http://wio-c.org/) ➢ IOTC (www.iotc.org)	National – H Regional – H 2-5 years
	Improve enforcement and compliance in shark-directed fisheries and for chondrichthyan bycatch.	➢ IOTC (www.iotc.org) ➢ SmartFish (www.smartfish-coi.org/) ➢ IOC (http://commissionoceanindien.org/activites/smartfish/publications/manuals-and-guides/) ➢ NC (www.unenvironment.org/nairobiconvention/) ➢ PSMA (www.fao.org/port-state-measures/en) ➢ CITES (www.cites.org) ➢ CMS (www.cms.int/)	National – H Regional – H 2-3 years
	Disseminate and replicate effective community led surveillance and control measures in co-managed areas.	➢ SMART – Spatial Monitoring and Reporting Tool (www.smartconservationtools.org/)	National – H Regional – L 2-3 years

5. Strengthen National and Regional Capacity	Develop national capacity for chondrichthyan research throughout the WIO, including: • staff with relevant experience for monitoring work, archiving and data analysis, support to national students for graduate studies, regional exchanges and mentoring, and • consideration of the establishment of a dedicated regional capacity node to provide ongoing technical support – advice, mentoring, organizing technical exchanges – to shark and ray conservation and management at all levels in the WIO.	➢ NC (www.unenvironment.org/nairobiconvention/) ➢ SmartFish (www.smartfish-coi.org/) ➢ SWIOFish (http://projects.worldbank.org/P155642?lang=en) ➢ WIOMSA (www.wiomsa.org/) ➢ Forum of Academic and Research Institutions in the Western Indian Ocean (FARI) (WIOMSA) (https://www.unenvironment.org/nairobiconvention/who-we-are/expert-groups) ➢ GCRMN (www.icriforum.org/gcrmn) ➢ WIO-C Consortium (http://wio-c.org/about-us/) ➢ Academic and research facilities ➢ NGOs (*inter alia* CORDIO, WCS, WWF)	National – H Regional – H Continuous
	Provide species ID guides (including local names) for all sharks and rays and associated training at national level to fishers, and fisheries and customs staff.	➢ See objective 1	National – H Regional – H 2-5 years
	Seek national, regional and international financial, technical or material assistance and resources to enhance national capacity for management and research.	Global funders (e.g., GEF, World Bank, European Commission, FAO, SOSF), and regional funding sources or funded projects (e.g., NC, WIO-SAP, WIOMSA; IOTC) Innovative ideas for private and public sector involvement	National – H Regional – H Continuous
	Promote regional collaborative research and management throughout the WIO region.	➢ NC (www.unenvironment.org/nairobiconvention/) ➢ NC WIO-SAP Project (www.unenvironment.org/nairobiconvention/) ➢ WIO-C Consortium (http://wio-c.org/about-us/) ➢ WIOMSA (www.wiomsa.org/)	National – H Regional – H Continuous
	Establish and convene a Shark and Ray Task Force under the Nairobi Convention for coordinating actions and promoting technical and other exchanges for conservation of sharks and rays in the WIO.	➢ Consider working with an existing task force as a subcommittee, e.g.: NC expert groups (https://www.unenvironment.org/nairobiconvention/who-we-are/expert-groups)	National – H Regional – M 2 years

6. Improve Awareness-Raising and Communication	Conduct national and regional campaigns on the conservation and management of sharks and rays, focusing on: • the role of sharks and rays in marine ecosystems, • transforming public perception on the risks of sharks, • education campaigns for children, • shark and ray festivals, and • school programs. Assess the socioeconomic value of sharks and rays in each Member State, including both consumptive and non-consumptive (i.e., tourism) uses. Assess status of understanding and impacts of shark-human interactions (where relevant) and the positive and negative effects of intervention efforts.	➢ Educational facilities and events, such as National Museums; Wildlife clubs; SOSF; Environmental days; coastal clean-up events; tourism sector ➢ Sharks are valuable alive campaigns ➢ Assessments of potential economic value of sharks through tourism	National – H Regional – M Continuous

APPENDIX B

Recommendations for Shark and Ray Listings in the Annexes of the Nairobi Convention Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region

Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region

B1. Introduction

At the 7th Conference of the Parties (CoP7) to The Nairobi *Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region*[120] (Maputo, Mozambique, December 2012), the Member States, recognizing increasing global concern regarding the declining status of chondrichthyans (rays, skates, wedgefishes, sawfishes), agreed to include sharks (i.e., all chondrichthyans) in the Convention's Program of Work for 2013–2017 (Decision CP7/1) and adopted Decision CP7/12: *Conservation of Sharks*, calling for regional collaboration on the conservation and management of sharks, including with the Convention on International Trade in Endangered Species of Wild Fauna and Flora[121] (CITES), the Convention on the Conservation of Migratory Species of Wild Animals[122] (CMS), regional fisheries management organizations, and other partners, and for preparation by the Secretariat, in collaboration with the Contracting Parties, of a regional status report on the state of chondrichthyans in the Western Indian Ocean[123] (WIO). This document forms that report, initiated in 2014 by the Wildlife Conservation Society (WCS) in collaboration with the Nairobi Convention Secretariat and partners.

A parallel objective linked to the regional status report was to identify chondrichthyan species for consideration for listing on the Annexes of the *Nairobi Convention Protocol Concerning Protected Areas and Wild Fauna and Flora in the East African Region* (hereinafter referred to as the Nairobi Convention Protocol). The listing of species on the Nairobi Convention Protocol is intended to provide a legal instrument, in this case a centralized list of species, from which resource managers of Member States can identify chondrichthyan species that warrant specific management or legal protection.

There is a great need to improve the knowledge base and understanding of the status of chondrichthyans and their fisheries in the WIO; however, existing information from a range of assessments, such as those completed by the IUCN Shark Specialist Group (Dulvy et al. 2014[124]) of the International Union for the Conservation of Nature[125] (IUCN), provide a basis for considering species for inclusion in the Annexes of the Nairobi Convention Protocol. Many chondrichthyan species have also been listed in recent years on the Appendices of CITES and the Appendices of the CMS, thus increasing the mandate of governments and their environment agencies – as well as fisheries agencies – to address the conservation and management needs of these species. The Indian Ocean Tuna Commission[126] (IOTC) also lists several chondrichthyan species that may not be captured or retained by the IOTC-linked fisheries directed at tuna and tuna-like species.

This document presents recommendations for the listing of shark and batoid species in Annexes II, III, and IV of the *Nairobi Convention Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region.* Due to the dynamic nature of threats to these species, and considering both declining populations and improving conservation measures, and as new data become available, it is likely that classifications such as CITES listings and IUCN Red List status will change over time. Therefore, the proposed listings should be treated as dynamic and adaptive, in order that they may be amended in the future as deemed necessary.

---

[120] UNEP. 1985. Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region. United Nations Environment Programme, Nairobi. United Nations.
[121] www.cites.org
[122] www.cms.int/en
[123] The geographic area referred to here by the term Western Indian Ocean includes the Indian Ocean territorial waters of the ten Nairobi Convention member states, from South Africa (including the Eastern Cape Province and Kwazulu-Natal Province only) in the southwest, to Somalia in the northwest, and to Mauritius in the east, following the delineation of the Indian Ocean by the International Hydrographic Organization (2002), and excludes the marginal seas to the north.
[124] Dulvy, N.K., S.L. Fowler SL, and J.A. Musick. 2014. Extinction risk and conservation of the world's sharks and rays. eLIFE 3:e00590. http://dx.doi.org/10.7554/eLife.00590
[125] IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-2. http://www.iucnredlist.org
[126] www.iotc.org

B2. Recommendations for Listing of Sharks and Batoids in Annex II of the Nairobi Convention Protocol

Article 4 of the Nairobi Convention Protocol: *Species of Wild Fauna Requiring Special Protection* stipulates: "The Contracting Parties shall take all appropriate measures to ensure the strictest protection of the endangered wild fauna species listed in annex II. To this end, each Contracting Party shall strictly regulate and, where required, prohibit activities having adverse effects on the habitats of such species. In particular, the following activities shall, where required, be prohibited with regard to such species:

a. all forms of capture, keeping or killing;
b. damage to, or destruction of, critical habitats;
c. disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation;
d. destruction or taking of eggs from the wild or keeping these eggs even if empty;
e. possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognizable part or derivative thereof."

Following this definition, species proposed for listing under Annex II of the Nairobi Convention Protocol were identified based on their listing on one or more of the following:

I. **Convention on the Conservation of Migratory Species of Wild Animals Appendix I – Endangered migratory species[127] (CMS Appendix I):** This Appendix "comprises migratory species that have been assessed as being in danger of extinction throughout all or a significant portion of their range. The Conference of the Parties has further interpreted the term "endangered" as meaning "facing a very high risk of extinction in the wild in the near future" (Res. 11.33 paragraph 1)." Noting that CMS Appendix I requires that CMS Parties *"that are a Range State to a migratory species listed in Appendix I shall endeavour to **strictly protect** them by: prohibiting the taking of such species*, with very restricted scope for exceptions; conserving and where appropriate restoring their habitats; preventing, removing or mitigating obstacles to their migration and controlling other factors that might endanger them". Thus, species listed on CMS Appendix I should be strictly protected in CMS signatory States.

II. **Indian Ocean Tuna Commission (IOTC) Prohibited Species:** IOTC resolutions prohibit the capture of several species of sharks and batoids by Contracting Parties and Cooperating Non-Contracting Parties (collectively, CPCs). Thus, *IOTC prohibited species should be **prohibited from capture*** in IOTC fisheries of IOTC Member States.

III. **International Union for the Conservation of Nature (IUCN) Red List of Threatened Species[128]:** those species assessed as Critically Endangered (CR) or Endangered (EN)[129]:
   a. Critically Endangered (CR) species are "considered to be facing an extremely high risk of extinction in the wild";
   b. Endangered (EN) species are "considered to be facing a very high risk of extinction in the wild".

IV. **Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendix I[130] (CITES Appendix I):** This Appendix lists species that are "threatened with extinction and CITES prohibits international trade in specimens of these species". Thus, *species listed in CITES Appendix I should be prohibited from international trade*, from or to a signatory State.

In total, 49 species (28 shark species and 21 batoid species, Table 1), of the 224 shark and batoid species identified to date in the Nairobi Convention area of the WIO, are recommended for consideration for strict protection under Annex II of the Nairobi Convention Protocol, due to meeting one or more of the above criteria. Those species meeting criteria for both Annexes II and III are proposed here for listing under Annex II (i.e., requiring a higher level of protection).

[127] cms.int/en/page/appendix-i-ii-cms
[128] IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-2. iucnredlist.org, accessed 15 October 2021
[129] IUCN 2012. *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.
[130] cites.org/eng/app/appendices.php

Table 1: Shark and batoid species recommended for listing on Nairobi Convention Annex II, based on their listing either in CMS Appendix I (CMS I), as an IOTC prohibited species (IOTC), in CITES Appendix I (CITES I), or on the IUCN Red List of Threatened Species as Critically Endangered (IUCN CR) or Endangered (IUCN EN). The current IUCN Red List status for each species is also presented (CR = Critically Endangered, EN = Endangered, VU = Vulnerable).

Family	Species	Common name	Taxonomic reference	IUCN Red List	Criteria for listing on Annex II
Sharks					
Alopiidae	*Alopias pelagicus* [a]	pelagic thresher shark	Nakamura, 1935	EN	IOTC; IUCN EN
Alopiidae	*Alopias superciliosus* [a]	bigeye thresher shark	Lowe, 1841	VU	IOTC
Alopiidae	*Alopias vulpinus* [a]	common thresher shark	(Bonnaterre, 1788)	VU	IOTC
Carcharhinidae	*Carcharhinus amblyrhynchos*	grey reef shark	(Bleeker, 1856)	EN	IUCN EN
Carcharhinidae	*Carcharhinus longimanus* [b]	oceanic whitetip	(Poey, 1861)	CR	CMS I; IOTC; IUCN CR
Carcharhinidae	*Carcharhinus obscurus*	dusky shark	(Lesueur, 1818)	EN	IUCN EN
Carcharhinidae	*Carcharhinus plumbeus*	sandbar shark	(Nardo, 1827)	EN	IUCN EN
Carcharhinidae	*Negaprion acutidens*	sicklefin lemon shark	(Rüppell, 1837)	EN	IUCN EN
Carchariidae	*Carcharias taurus*	ragged-tooth shark	Rafinesque, 1810	CR	IUCN CR
Cetorhinidae	*Cetorhinus maximus*	basking shark	(Gunnerus, 1765)	EN	CMS I; IUCN EN
Centrophoridae	*Centrophorus granulosus*	gulper shark	(Bloch & Schneider, 1801)	EN	IUCN EN
Centrophoridae	*Centrophorus lesliei*	African gulper shark	White, Ebert & Naylor 2017	EN	IUCN EN
Centrophoridae	*Centrophorus squamosus*	leafscale gulper shark	(Bonnaterre, 1788)	EN	IUCN EN
Centrophoridae	*Centrophorus uyato*	little gulper shark	(Rafinesque, 1810)	EN	IUCN EN
Echinorhinidae	*Echinorhinus brucus*	bramble shark	(Bonnaterre, 1788)	EN	IUCN EN
Ginglymostomatidae	*Pseudoginglymostoma brevicaudatum*	shorttail nurse shark	Günther, 1867	CR	IUCN CR
Lamnidae	*Carcharodon carcharias*	great white shark	(Linnaeus, 1758)	VU	CMS I
Lamnidae	*Isurus oxyrinchus*	shortfin mako shark	Rafinesque, 1810	EN	IUCN EN
Lamnidae	*Isurus paucus*	longfin mako shark	Guitart Manday, 1966	EN	IUCN EN
Oxynotidae	*Oxynotus centrina*	angular rough shark	(Linnaeus, 1758)	EN	IUCN EN
Pentanchidae	*Holohalaelurus favus*	honeycomb izak	Human, 2006	EN	IUCN EN
Pentanchidae	*Holohalaelurus punctatus*	whitespotted izak	(Gilchrist, 1914)	EN	IUCN EN
Rhincodontidae	*Rhincodon typus* [c]	whale shark	Smith, 1828	EN	CMS I; IOTC; IUCN EN
Sphyrnidae	*Sphyrna lewini*	scalloped hammerhead	(Griffith & Smith, 1834)	CR	IUCN CR
Sphyrnidae	*Sphyrna mokarran*	great hammerhead	(Rüppell, 1837)	CR	IUCN CR
Stegostomatidae	*Stegostoma tigrinum*	zebra shark	(Hermann, 1783)	EN	IUCN EN
Triakidae	*Mustelus manazo*	starspotted smoothhound	Bleeker, 1855	EN	IUCN EN
Triakidae	*Mustelus mustelus*	common smoothhound	(Linnaeus, 1758)	EN	IUCN EN

Batoids (rays, skates, wedgefishes, sawfishes)					
Dasyatidae	*Himantura uarnak*	honeycomb stingray	(Gmelin, 1789)	EN	IUCN EN
Glaucostegidae	*Glaucostegus halavi*	Halavi guitarfish	Forsskål, 1775	CR	IUCN CR
Mobulidae	*Mobula alfredi* [d]	reef manta ray	(Krefft 1868)	VU	CMS I; IOTC
Mobulidae	*Mobula birostris* [d]	giant manta ray	(Walbaum 1792)	EN	CMS I; IOTC; IUCN EN
Mobulidae	*Mobula eregoodoo* [d]	longhorned pygmy devil ray	(Cantor 1849)	EN	CMS I; IOTC; IUCN EN
Mobulidae	*Mobula kuhlii* [d]	shortfin devil ray	(Valenciennes, 1841)	EN	CMS I; IOTC; IUCN EN
Mobulidae	*Mobula mobular* [d]	spinetail devil ray	(Bonnaterre, 1788)	EN	CMS I; IOTC; IUCN EN
Mobulidae	*Mobula tarapacana* [d]	sicklefin devil ray	(Philippi, 1892)	EN	CMS I; IOTC; IUCN EN
Mobulidae	*Mobula thurstoni* [d]	bentfin devil ray	(Lloyd, 1908)	EN	CMS I; IOTC; IUCN EN
Myliobatidae	*Aetomylaeus bovinus*	duckbill ray	(Saint-Hilaire, 1817)	CR	IUCN CR
Myliobatidae	*Aetomylaeus vespertilio*	ornate eagle ray	(Bleeker, 1852)	EN	IUCN EN
Myliobatidae	*Myliobatis aquila*	common eagle ray	(Linnaeus, 1758)	CR	IUCN CR
Pristidae	*Pristis pristis*	largetooth sawfish	(Linnaeus, 1758)	CR	CMS I; IUCN CR; CITES I
Pristidae	*Pristis zijsron*	green sawfish	Bleeker, 1851	CR	CMS I; IUCN CR; CITES I
Rajidae	*Raja ocellifera*	twineyed skate	Regan, 1906	EN	IUCN EN
Rajidae	*Rostroraja alba*	spearnose skate	(Lacepède, 1803)	EN	IUCN EN
Rhinidae	*Rhina ancylostomus*	bowmouth guitarfish	Bloch & Schneider, 1801	CR	IUCN CR
Rhinidae	*Rhynchobatus australiae*	bottlenose wedgefish	Whitley, 1939	CR	IUCN CR
Rhinidae	*Rhynchobatus djiddensis*	whitespotted wedgefish	(Forsskål, 1775)	CR	IUCN CR
Rhinobatidae	*Acroteriobatus leucospilus*	greyspot guitarfish	Norman, 1926	EN	IUCN EN
Rhinopteridae	*Rhinoptera jayakari*	shorttail cownose ray	Boulenger, 1895	EN	IUCN EN

[a] IOTC Resolution 12/09 (http://www.iotc.org/cmm/resolution-1209-conservation-thresher-sharks-family-alopiidae-caught-association-fisheries-iotc) "Fishing Vessels flying the flag of an IOTC Member or Cooperating Non-Contracting Party (CPCs) are prohibited from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae";

[b] IOTC Resolution 13/06 (http://www.iotc.org/cmm/resolution-1306-scientific-and-management-framework-conservation-sharks-species-caught) "CPCs shall prohibit, as an interim pilot measure, all fishing vessels flying their flag and on the IOTC Record of Authorized Vessels, or authorized to fish for tuna or tuna-like species managed by the IOTC on the high seas to retain onboard, tranship, land or store any part or whole carcass of oceanic whitetip sharks";

[c] IOTC Resolution 13/05 (http://www.iotc.org/cmm/resolution-1305-conservation-whale-sharks-rhincodon-typus) CPC's "shall prohibit their flagged vessels from intentionally setting a purse seine net around a whale shark in the IOTC area of competence, if it is sighted prior to the commencement of the set" and that "in the event that a whale shark is unintentionally encircled in the purse seine net, the master of the vessel shall: a) take all reasonable steps to ensure its safe release";

[d] IOTC Resolution 19/03 (https://iotc.org/cmm/resolution-1903-conservation-mobulid-rays-caught-iin-association-fisheries-iotc-area-competence) CPC's "shall prohibit all vessels from intentionally setting any gear type for targeted fishing of mobulid rays in the IOTC Area of Competence, if the animal is sighted prior to commencement of the set" and "shall prohibit all vessels retaining onboard, transhipping, landing, storing, any part or whole carcass of mobulid rays caught in the IOTC Area of Competence" and "shall require all their fishing vessels, other than those carrying out subsistence fishery, to promptly release alive and unharmed, to the extent practicable, mobulid rays as soon as they are seen in the net, on the hook, or on the deck, and do it in a manner that will result in the least possible harm to the individuals captured".

B3. Recommendations for Listing of Sharks and Batoids in Annex III of the Nairobi Convention Protocol

Article 5 of the Nairobi Convention Protocol: *Harvestable Species of Wild Fauna* stipulates:

"1. The Contracting Parties shall take all appropriate measures to ensure the protection of the depleted or threatened wild fauna species listed in annex III.

2. Any exploitation of such wild fauna species shall be regulated in order to restore and maintain the populations at optimum levels. Each Contracting Party shall develop, adopt and implement management plans for the exploitation of such species which may include:

1. the prohibition of the use of all indiscriminate means of capture and killing and of the use of all means capable of causing local disappearance of, or serious disturbance to, populations of a species;
2. closed seasons and other procedures regulating exploitation;
3. the temporary or local prohibition of exploitation, as appropriate, in order to restore viable population levels;
4. the regulation, as appropriate, of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals;
5. the safeguarding of breeding stocks of such species and their critical habitats in protected areas designated in accordance with article 8 of this Protocol;
6. exploitation in captivity."

Following this definition, species proposed for listing under Annex III of the Nairobi Convention Protocol were identified based on their listing on one or more of the following:

I. **IUCN Red List of Threatened Species**[131]: those species assessed as either Vulnerable (VU) or Near Threatened (NT)[132]:
   a. Vulnerable (VU) species are "considered to be facing a high risk of extinction in the wild";
   b. Near Threatened (NT) – a Near Threatened species "does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future".

II. **CMS Appendix II – Migratory species conserved through Agreements**[133]: This Appendix comprises "migratory species that have an unfavourable conservation status and that require international agreements for their conservation and management, as well as those that have a conservation status which would significantly benefit from the international cooperation that could be achieved by an international agreement. The Convention encourages the Range States to species listed on Appendix II to conclude global or regional Agreements for the conservation and management of individual species or groups of related species." This list excludes those species listed in CMS Appendix II that are also listed on CMS Appendix I and have already been included in the preceding section as proposed for inclusion on Annex II of the Nairobi Convention.

III. **CITES Appendix II**[134]: This Appendix lists species that are "not necessarily now threatened with extinction but that may become so unless trade is closely controlled".

In total, 68 species (47 shark species and 21 batoid species, Table 2) are recommended for listing on Annex III of the Nairobi Convention Protocol, due to their being listed as Vulnerable or Near Threatened on the IUCN Red List of Threatened Species, on CITES Appendix II or on CMS Appendix II. This list excludes those species already included in the preceding section as proposed for inclusion on Annex II of the Nairobi Convention.

[131] IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-2. iucnredlist.org, accessed 15 October 2021
[132] IUCN 2012. *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.
[133] cms.int/en/page/appendix-i-ii-cms
[134] cites.org/eng/app/appendices.php

Table 2: Shark and batoid species recommended for listing on Nairobi Convention Annex III, based on their listing on the IUCN Red List of Threatened Species as Vulnerable (IUCN VU) or Near Threatened (IUCN NT), in CMS Appendix II (CMS II) or CITES Appendix II (CITES II). The current IUCN Red List status for each species is also presented.

Family	Species	Common name	Taxonomic reference	IUCN Red List	Criteria for listing on Annex III
Sharks					
Carcharhinidae	*Carcharhinus albimarginatus*	silvertip shark	(Rüppell, 1837)	VU	IUCN VU
Carcharhinidae	*Carcharhinus altimus*	bignose shark	(Springer, 1950)	NT	IUCN NT
Carcharhinidae	*Carcharhinus amblyrhynchoides*	graceful shark	(Whitley, 1934)	VU	IUCN VU
Carcharhinidae	*Carcharhinus amboinensis*	pigeye shark	(Müller & Henle, 1839)	VU	IUCN VU
Carcharhinidae	*Carcharhinus brachyurus*	copper shark	(Günther, 1870)	VU	IUCN VU
Carcharhinidae	*Carcharhinus brevipinna*	spinner shark	(Valenciennes, 1839)	VU	IUCN VU
Carcharhinidae	*Carcharhinus falciformis*	silky shark	(Müller & Henle, 1839)	VU	IUCN VU; CMS II; CITES II
Carcharhinidae	*Carcharhinus leucas*	bull shark	(Valenciennes, 1839)	VU	IUCN VU
Carcharhinidae	*Carcharhinus limbatus*	blacktip shark	(Valenciennes, 1839)	VU	IUCN VU
Carcharhinidae	*Carcharhinus macloti*	hardnose shark	(Müller & Henle, 1839)	NT	IUCN NT
Carcharhinidae	*Carcharhinus melanopterus*	blacktip reef shark	(Quoy & Gaimard, 1824)	VU	IUCN VU
Carcharhinidae	*Carcharhinus sorrah*	spottail shark	(Valenciennes, 1839)	NT	IUCN NT
Carcharhinidae	*Loxodon macrorhinus*	Sliteye shark	(Müller & Henle, 1839)	NT	IUCN NT
Carcharhinidae	*Prionace glauca*	blue shark	(Linnaeus, 1758)	NT	IUCN NT; CMS II
Carcharhinidae	*Rhizoprionodon acutus*	milk shark	(Rüppell, 1837)	VU	IUCN VU
Carcharhinidae	*Scoliodon laticaudus*	spadenose shark	Müller & Henle, 1838	NT	IUCN NT
Carcharhinidae	*Triaenodon obesus*	whitetip reef shark	(Rüppell, 1837)	VU	IUCN VU
Centrophoridae	*Centrophorus moluccensis*	smallfin gulper shark	Bleeker, 1860)	VU	IUCN VU
Centrophoridae	*Deania calceus*	birdbeaked dogfish	(Lowe, 1839)	NT	IUCN NT
Centrophoridae	*Deania profundorum*	arrowhead dogfish	(Smith & Radcliffe, 1912)	NT	IUCN NT
Centrophoridae	*Deania quadrispinosa*	longsnout dogfish	(McCulloch, 1915)	VU	IUCN VU
Dalatidae	*Dalatias licha*	kitefin shark	(Bonnaterre, 1788)	VU	IUCN NT
Galeocerdidae	*Galeocerdo cuvier*	tiger shark	(Peron & Lesueur, in Lesueur, 1822)	NT	IUCN NT
Ginglymostomatidae	*Nebrius ferrugineus*	tawny nurse shark	(Lesson, 1830)	VU	IUCN VU
Hemigaleidae	*Hemigaleus microstoma*	sicklefin weasel shark	Bleeker 1852	VU	IUCN VU
Hemigaleidae	*Hemipristis elongata*	snaggletooth shark	(Klunzinger, 1871)	VU	IUCN VU
Hemigaleidae	*Paragaleus leucolomatus*	whitetip weasel shark	Compagno & Smale, 1985	VU	IUCN VU
Hexanchidae	*Heptranchias perlo*	sharpnose sevengill shark	(Bonnaterre, 1788)	NT	IUCN NT
Hexanchidae	*Hexanchus griseus*	bluntnose sixgill shark	(Bonnaterre, 1788)	NT	IUCN NT
Hexanchidae	*Hexanchus nakamurai*	bigeyed sixgill shark	Teng, 1962	NT	IUCN NT
Hexanchidae	*Notorynchus cepedianus*	broadnose sevengill shark	(Peron, 1807)	VU	IUCN VU
Odontaspididae	*Odontaspis ferox*	smalltooth sand tiger shark	(Risso, 1810)	VU	IUCN VU
Pentanchidae	*Bythaelurus hispidus*	bristly catshark	(Alcock, 1891)	NT	IUCN NT
Pentanchidae	*Halaelurus boesemani*	speckled catshark	Springer & D'Aubrey, 1972	VU	IUCN VU

Pentanchidae	*Halaelurus natalensis*	tiger catshark	(Regan, 1904)	VU	IUCN VU
Pentanchidae	*Haploblepharus fuscus*	brown shyshark	Smith, 1950	VU	IUCN VU
Pentanchidae	*Haploblepharus kistnasamyi*	Natal shyshark	Human & Compagno, 2006	VU	IUCN VU
Scyliorhinidae	*Cephaloscyllium sufflans*	balloon shark	(Regan, 1921)	NT	IUCN NT
Scyliorhinidae	*Scyliorhinus capensis*	yellowspotted catshark	(Müller & Henle, 1838)	NT	IUCN NT
Somniosidae	*Centroscymnus coelolepis*	Portuguese dogfish	Barbosa du Bocage & de Brito Capello, 1864	NT	IUCN NT
Somniosidae	*Centroscymnus owstoni*	roughskin dogfish	Gaman, 1906	VU	IUCN VU
Somniosidae	*Centroselachus crepidater*	longnose velvet dogfish	(Barbosa du Bocage & de Brito Capello, 1864)	NT	IUCN NT
Sphyrnidae	*Sphyrna zygaena*	smooth hammerhead	(Linnaeus, 1758)	VU	IUCN VU; CMS II; CITES II
Squalidae	*Squalus acutipinnis*	bluntnose spurdog	Regan, 1906	NT	IUCN NT
Squatinidae	*Squatina africana*	African angelshark	Regan, 1908	NT	IUCN NT
Triakidae	*Mustelus mosis*	Arabian smoothhound	Hemprich & Ehrenberg, 1899	NT	IUCN NT
Triakidae	*Scylliogaleus quecketti*	flapnose houndshark	Boulenger, 1902	VU	IUCN VU
Batoids (rays, skates, wedgefishes, sawfishes)					
Anacanthobatidae	*Anacanthobatis marmorata*	spotted legskate	(Von Bonde & Swart, 1923)	NT	IUCN NT
Aetobatidae	*Aetobatus ocellatus*	Indian eagle ray	(Kuhl, 1823)	VU	IUCN VU
Dasyatidae	*Bathytoshia lata*	brown stingray	(Garman, 1880)	VU	IUCN VU
Dasyatidae	*Dasyatis chrysonota*	blue stingray	(Smith, 1828)	NT	IUCN NT
Dasyatidae	*Himantura leoparda*	leopard whipray	Manjaji-Matsumoto & Last, 2008	VU	IUCN VU
Dasyatidae	*Maculabatis ambigua*	Baraka's whipray	Last, Bogorodsky, & Alpermann, 2016	NT	IUCN NT
Dasyatidae	*Pastinachus ater*	broad cowtail ray	(Macleay, 1883)	VU	IUCN VU
Dasyatidae	*Pateobatis fai*	pink whipray	(Jordan & Seale, 1906)	VU	IUCN VU
Dasyatidae	*Pateobatis jenkinsii*	Jenkins' whipray	(Annandale, 1909)	VU	IUCN VU
Dasyatidae	*Taeniurops meyeni*	blotched stingray	(Müller & Henle, 1841)	VU	IUCN VU
Dasyatidae	*Urogymnus asperrimus*	porcupine ray	(Bloch & Schneider, 1801)	VU	IUCN VU
Dasyatidae	*Urogymnus granulatus*	mangrove whipray	(Macleay, 1883)	VU	IUCN VU
Gymnuridae	*Gymnura poecilura*	longtail butterfly ray	(Shaw, 1804)	VU	IUCN VU
Narkidae	*Heteronarce garmani*	Natal electric ray	Regan, 1921	NT	IUCN NT
Rajidae	*Dipturus campbelli*	blackspot skate	(Wallace, 1967)	NT	IUCN NT
Rajidae	*Dipturus crosnieri*	Madagascar skate	(Séret, 1989)	VU	IUCN VU
Rajidae	*Leucoraja wallacei*	yellowspotted skate	(Hully, 1970)	VU	IUCN VU
Rajidae	*Raja clavata*	thornback skate	Linnaeus, 1758	NT	IUCN NT
Rajidae	*Raja straeleni*	biscuit skate	Poll, 1951	NT	IUCN NT
Rhinobatidae	*Acroteriobatus annulatus*	lesser guitarfish	Smith, 1841	VU	IUCN VU
Rhinobatidae	*Acroteriobatus zanzibarensis*	Zanzibar guitarfish	(Norman, 1926)	NT	IUCN NT

B4. Recommendations for Listing of Sharks and Batoids in Annex IV of the Nairobi Convention Protocol

Article 6 of the Nairobi Convention Protocol: Migratory Species stipulates: "The Contracting Parties shall, in addition to the measures specified in articles 3, 4 and 5, co-ordinate their efforts for the protection of migratory species listed in annex IV whose range extends into their territories. To this end, each Contracting Party shall ensure that, where appropriate, the closed seasons and other measures referred to in paragraph 2 of article 5 are also applied with regard to such migratory species."

Following this definition, species proposed for listing under Annex III of the Nairobi Convention Protocol were identified based on their listing on one or more of the following:

I. **CMS[135] Appendix I – Endangered migratory species (CMS Appendix I) or Appendix II – Migratory species conserved through Agreements:** The Appendices of CMS list threatened migratory species, including sharks and batoids. Therefore, all species listed on these two CMS Appendices are proposed for Annex IV of the Nairobi Convention Protocol.

II. **CMS Memorandum of Understanding on the Conservation of Migratory Sharks (CMS Sharks MOU), Annex I[136]**: In addition to the listing of shark and batoid species on Appendices I and II of CMS, a taxon-specific MOU was developed for migratory shark and batoid species (CMS Sharks MOU). This MOU provides an instrument under the CMS for achieving a favourable conservation status for migratory sharks and batoids. The CMS Sharks MOU is non-binding, but encourages signatories "to strengthen and improve their role in taking measures to improve or restore a favourable conservation status of sharks listed in Annex 1 of the Memorandum of Understanding". Annex I lists migratory species of sharks and batoids for which this conservation measure is intended to apply, including 25 species of sharks and batoids that occur in the WIO.

III. **Fowler[137] (2014)**: In a global review of migratory chondrichthyan fishes, Fowler (2014) identified and listed a number of shark and batoid species that can be defined as migratory or possibly migratory. These include 30 migratory shark species and 14 migratory batoid species, as well as 12 possibly migratory shark species and 9 possibly migratory batoid species, that occur within the WIO. Fowler (2014) used the definitions presented in CMS Article I[138] and defined "migratory species" as species for which "the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries".

IV. **The United Nations Convention on the Law of the Sea[139] (UNCLOS) Annex I *Highly Migratory Species*[140]**: UNCLOS Annex I lists three species of sharks as being, and four families of sharks as containing, "highly migratory species", most of which were also identified by Fowler (2014). No batoid species are listed on UNCLOS Annex I.

In total, 71 species (46 shark species and 25 batoid species, Table 3) are proposed for listing on Annex IV of the Nairobi Convention Protocol, based on their listing on CMS Appendix I and/or II, the CMS Sharks MOU Annex I, identification by Fowler (2014) as migratory (M) or possibly migratory (PM), or their listing on UNCLOS Annex I at the family level (UNCLOS) or species level (UNCLOS species) as "highly migratory species". Several species proposed for listing on Annexes II or III are also proposed here for listing in Annex IV, as Annex IV listing is based on the species' migratory ecology, rather than threat status, thus warranting separate listing.

[135] cms.int/en/page/appendix-i-ii-cms
[136] cms.int/sharks/en/species
[137] Fowler, S. 2014. *The Conservation Status of Migratory Sharks*. UNEP/CMS Secretariat. Bonn, Germany. 30pp.
[138] cms.int/en/convention-text
[139] un.org/depts/los/convention_agreements/convention_overview_convention.htm
[140] un.org/depts/los/convention_agreements/texts/unclos/annex1.htm

Table 3: Shark and batoid species recommended for listing on Nairobi Convention Annex IV, based on their listing on CMS Appendix I (CMS I), CMS Appendix II (CMS II) or the CMS Sharks MOU (if not listed on CMS Appendix I or II), or being identified as migratory (M) or possibly migratory (PM) as defined by Fowler (2014), or their listing as migratory on UNCLOS Annex I at the family level (UNCLOS) or species level (UNCLOS species).

Family	Species	Common name	Taxonomic reference	IUCN Red List	Criteria for listing on Annex IV
Sharks					
Alopiidae [a]	*Alopias pelagicus*	pelagic thresher shark	Nakamura, 1935	EN	CMS II; M; UNCLOS
Alopiidae [a]	*Alopias superciliosus*	bigeye thresher shark	Lowe, 1841	VU	CMS II; M; UNCLOS
Alopiidae [a]	*Alopias vulpinus*	common thresher shark	(Bonnaterre, 1788)	VU	CMS II; M; UNCLOS
Carcharhinidae [a]	Carcharhinidae family	requiem sharks	Jordan & Evermann, 1986	-	UNCLOS
Carcharhinidae [a]	*Carcharhinus albimarginatus*	silvertip shark	(Rüppell, 1837)	VU	PM; UNCLOS
Carcharhinidae [a]	*Carcharhinus altimus*	bignose shark	(Springer, 1950)	NT	PM; UNCLOS
Carcharhinidae [a]	*Carcharhinus amblyrhynchoides*	graceful shark	(Whitley, 1934)	VU	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus amblyrhynchos*	grey reef shark	(Bleeker, 1856)	EN	PM; UNCLOS
Carcharhinidae [a]	*Carcharhinus amboinensis*	pigeye shark	(Müller & Henle, 1839)	VU	PM; UNCLOS
Carcharhinidae [a]	*Carcharhinus brachyurus*	copper shark	(Günther, 1870)	VU	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus brevipinna*	spinner shark	(Valenciennes, 1839)	VU	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus falciformis*	silky shark	(Müller & Henle, 1839)	VU	CMS II; M; UNCLOS
Carcharhinidae [a]	*Carcharhinus galapagensis*	Galapagos shark	(Snodgrass & Heller, 1905)	LC	PM; UNCLOS
Carcharhinidae [a]	*Carcharhinus humani*	Human’s whaler shark	White & Weigmann, 2014	DD	UNCLOS
Carcharhinidae [a]	*Carcharhinus leucas*	bull shark	(Valenciennes, 1839)	VU	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus limbatus*	blacktip shark	(Valenciennes, 1839)	VU	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus longimanus*	oceanic whitetip	(Poey, 1861)	CR	CMS I; M; UNCLOS
Carcharhinidae [a]	*Carcharhinus macloti*	hardnose shark	(Müller & Henle, 1839)	NT	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus melanopterus*	blacktip reef shark	(Quoy & Gaimard, 1824)	VU	PM; UNCLOS
Carcharhinidae [a]	*Carcharhinus obscurus*	dusky shark	(Lesueur, 1818)	EN	CMS II; M; UNCLOS
Carcharhinidae [a]	*Carcharhinus plumbeus*	sandbar shark	(Nardo, 1827)	EN	M; UNCLOS
Carcharhinidae [a]	*Carcharhinus sorrah*	spottail shark	(Valenciennes, 1839)	NT	PM; UNCLOS
Carcharhinidae [a]	*Loxodon macrorhinus*	sliteye shark	(Müller & Henle, 1839)	NT	UNCLOS
Carcharhinidae [a]	*Negaprion acutidens*	sicklefin lemon shark	(Rüppell, 1837)	EN	M; UNCLOS
Carcharhinidae [a]	*Prionace glauca*	blue shark	(Linnaeus, 1758)	NT	CMS II; M; UNCLOS
Carcharhinidae [a]	*Rhizoprionodon acutus*	milk shark	(Rüppell, 1837)	VU	PM; UNCLOS
Carcharhinidae [a]	*Scoliodon laticaudus*	spadenose shark	Müller & Henle, 1838	NT	UNCLOS
Carcharhinidae [a]	*Triaenodon obesus*	whitetip reef shark	(Rüppell, 1837)	VU	UNCLOS
Carchariidae	*Carcharias taurus*	ragged-tooth shark	Rafinesque, 1810	CR	M
Cetorhinidae	*Cetorhinus maximus*	basking shark	(Gunnerus, 1765)	EN	CMS I; M; UNCLOS species
Galeocerdidae [b]	*Galeocerdo cuvier*	tiger shark	(Peron & Lesueur, 1822)	NT	M; UNCLOS
Ginglymostomatidae	*Nebrius ferrugineus*	tawny nurse	(Lesson, 1830)	VU	M
Hemigaleidae	*Hemipristis elongata*	snaggletooth shark	(Klunzinger, 1871)	VU	PM
Hexanchidae	*Hexanchus griseus*	bluntnose sixgill shark	(Bonnaterre, 1788)	NT	M; UNCLOS species
Hexanchidae	*Notorynchus cepedianus*	sevengill shark	(Peron, 1807)	VU	M
Lamnidae [a, c]	*Carcharodon carcharias*	great white shark	(Linnaeus, 1758)	VU	CMS I; M; UNCLOS

Lamnidae [a, c]	*Isurus oxyrinchus*	shortfin mako shark	Rafinesque, 1810	EN	CMS II; M; UNCLOS
Lamnidae [a, c]	*Isurus paucus*	longfin mako shark	Guitart Manday, 1966	EN	CMS II; M; UNCLOS
Odontaspididae	*Odontaspis ferox*	smalltooth sand tiger shark	(Risso, 1810)	VU	PM
Odontaspididae	*Odontaspis noronhai*	bigeye sand tiger shark	(Maul, 1955)	LC	PM
Pseudocarchariidae	*Pseudocarcharias kamoharai*	crocodile shark	(Matsubara, 1936)	LC	PM
Rhincodontidae	*Rhincodon typus*	whale shark	Smith, 1828	EN	CMS I; M; UNCLOS species
Somniosidae	*Somniosus antarcticus*	southern sleeper shark	Whitley, 1939	LC	M
Sphyrnidae [a]	*Sphyrna lewini*	scalloped hammerhead	(Griffith & Smith, 1834)	CR	CMS II; M; UNCLOS
Sphyrnidae [a]	*Sphyrna mokarran*	great hammerhead	(Rüppell, 1837)	CR	CMS II; M; UNCLOS
Sphyrnidae [a]	*Sphyrna zygaena*	smooth hammerhead	(Linnaeus, 1758)	VU	CMS II; M; UNCLOS
Triakidae	*Mustelus mustelus*	smoothhound shark	(Linnaeus, 1758)	EN	M
Batoids (rays, skates, wedgefishes, sawfishes)					
Aetobatidae	*Aetobatus ocellatus* [d]	Indian eagle ray	(Kuhl, 1823)	VU	M
Dasyatidae	*Dasyatis chrysonota*	blue stingray	(Smith, 1828)	NT	PM
Dasyatidae	*Himantura uarnak*	honeycomb stingray	(Gmelin, 1789)	EN	M
Dasyatidae	*Megatrygon microps*	smalleye stingray	(Annandale, 1908)	DD	M
Dasyatidae	*Pateobatis fai* [d]	pink whipray	(Jordan & Seale, 1906)	VU	M
Dasyatidae	*Pteroplatytrygon violacea*	pelagic stingray	(Bonaparte, 1832)	LC	M
Gymnuridae	*Gymnura natalensis*	diamond ray	(Gilchrist & Thompson, 1911)	LC	PM
Mobulidae	*Mobula alfredi*	reef manta ray	(Krefft 1868)	VU	CMS I; M
Mobulidae	*Mobula birostris*	giant manta ray	(Walbaum 1792)	EN	CMS I; M
Mobulidae	*Mobula eregoodoo*	longhorned pygmy devil ray	(Cantor 1849)	EN	CMS I; PM
Mobulidae	*Mobula kuhlii*	shortfin devil ray	(Valenciennes, 1841)	EN	CMS I; M
Mobulidae	*Mobula mobular*	spinetail devil ray	(Bonnaterre, 1788)	EN	CMS I; M
Mobulidae	*Mobula tarapacana*	sicklefin devil ray	(Philippi, 1892)	EN	CMS I; M
Mobulidae	*Mobula thurstoni*	bentfin devil ray	(Lloyd, 1908)	EN	CMS I; PM
Myliobatidae	*Aetomylaeus bovinus* [d]	Duckbill ray	(Saint-Hilaire, 1817)	CR	PM
Myliobatidae	*Aetomylaeus vespertilio*	Ornate eagle ray	(Bleeker, 1852)	EN	PM
Myliobatidae	*Myliobatis aquila*	Bull ray	(Linnaeus, 1758)	CR	PM
Pristidae	*Pristis pristis*	largetooth sawfish	(Linnaeus, 1758)	CR	CMS I; M
Pristidae	*Pristis zijsron*	green sawfish	(Bleeker, 1851)	CR	CMS I
Rajidae	*Raja clavata*	thornback skate	Linnaeus, 1758	NT	PM
Rajidae	*Raja straeleni*	biscuit skate	Poll, 1951	NT	M
Rhinidae	*Rhynchobatus australiae*	bottlenose wedgefish	Whitley, 1939	CR	CMS II
Rhinidae	*Rhynchobatus djiddensis*	whitespotted wedgefish	(Forsskål, 1775)	CR	CMS Sharks MOU; M
Rhinobatidae	*Acroteriobatus annulatus* [d]	lesser guitarfish	(Smith, 1841)	VU	M
Torpedinidae	*Torpedo fuscomaculata*	blackspotted electric ray	Peters, 1855	DD	PM

[a] Listed by family in UNCLOS Annex I: un.org/depts/los/convention_agreements/texts/unclos/annex1.htm
[b] Previously in family Carcharhinidae and therefore listed by family in UNCLOS Annex I
[c] Listed on UNCLOS Annex I under previous taxonomic family name - Isuridae
[d] Taxonomic update since Fowler (2014)