INDIAN OCEAN

INTRODUCTION

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GEOGRAPHY

The waters of the Indian Ocean Region span a vast range of oceanographic features from eastern Africa across the large gulfs of Aden and Oman, the Arabian, Red, and Andaman Seas; the Bay of Bengal to the Malay Peninsula and the Sunda Islands in the east; and the southern tip of Africa in the south. The warmest of all ocean regions covers a total of 70,560,000 km^2, with Exclusive Economic Zones (EEZ) of over 20 countries (some of which are included in the Africa regional section of this report) as well as two European countries administering several overseas territories in the region. Littoral states are home to about 35% of the world's human population and include among the world's most densely populated and fastest growing states.

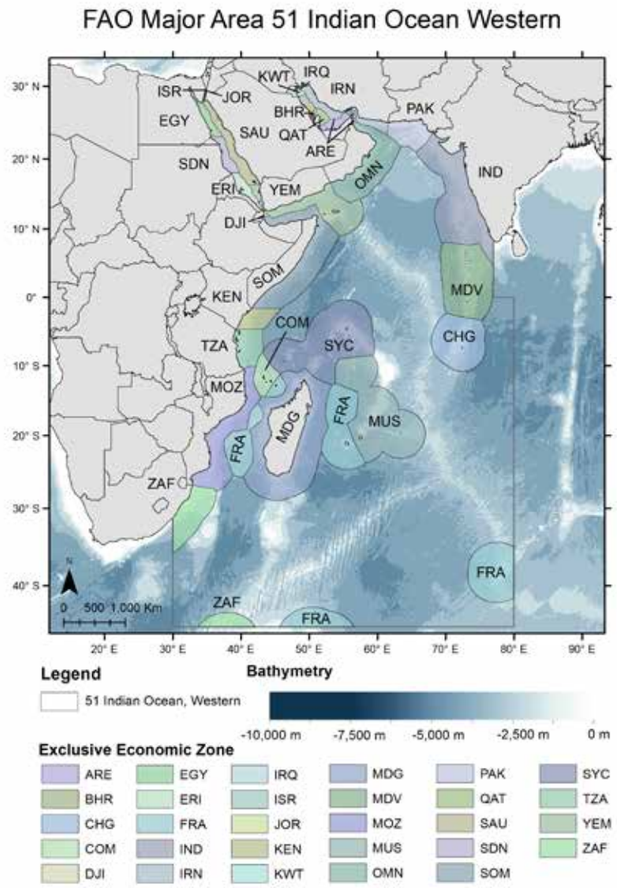
The Arabian and Red Seas have highly saline water, while the Indus and Ganges-Brahmaputra-Meghna river systems drain massive volumes of freshwater into the Indian Ocean. As a result, salinity levels vary significantly across the Indian Ocean Region. Semi-annually reversing surface circulation from monsoon winds and rain, with tropical cyclones occurring before and after the wet season, characterise the Bay of Bengal in the northeast. The northwestern region has among the driest climates with very little rainfall. Tides are diurnal (daily) on the coast of the Andaman Sea, mostly semidiurnal (twice daily) on the coast of eastern Africa and Bay of Bengal and mixed in the Arabian Sea. Upwellings in the northern Arabian Sea, and at the tips of the Indus and Swatch-of-No-Ground submarine canyons cause nutrients to concentrate in surface waters, producing large quantities of phytoplankton that support high primary productivity and diverse marine life. Coastal waters are generally characterised by coral reefs, islands and mangrove thickets, that stabilize the coastal margin and offer important breeding and nursery grounds for a high diversity of marine wildlife.

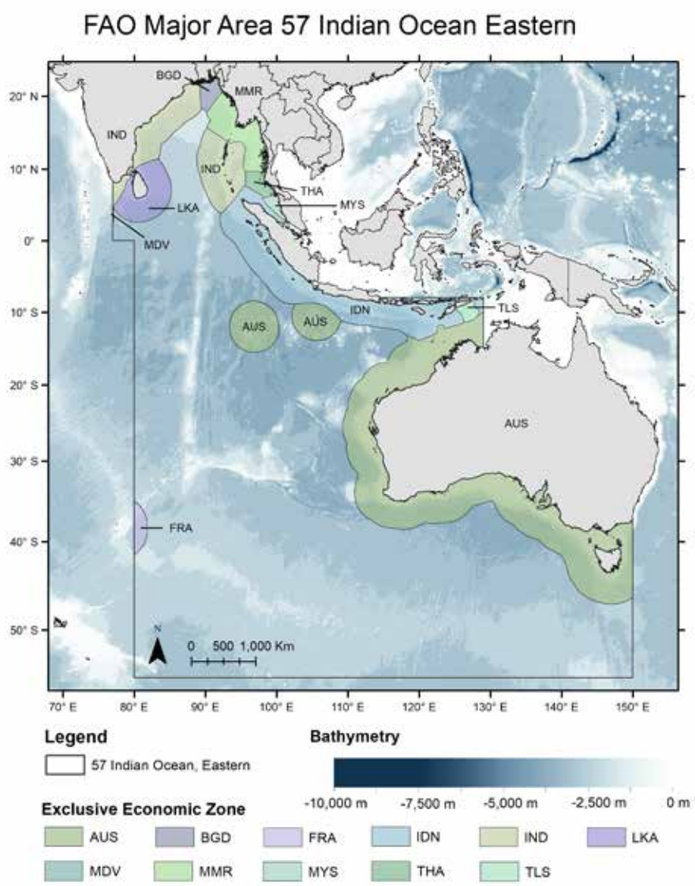
The economic development of littoral countries has been uneven, with many nations having attained independence within the last century. The region is a source of valuable fishing and mineral resources, and a major conduit for international trade, especially for crude oil, with processed seafood emerging as a major export item. The warm climate, beautiful beaches, clear waters, and species diversity in several parts draw growing numbers of tourists to the region.

OVERVIEW OF CATCHES, LANDINGS, TRADE IN THE REGION

The Indian Ocean Tuna Commission (IOTC) is the regional fisheries management organisation (RFMO) responsible for conserving and managing stocks in the Western and Eastern Indian Ocean (Food and Agriculture Organization of the United Nations [FAO] statistical areas 51 and 57, respectively), and in adjacent seas north of the Antarctic Convergence from Africa across Asia to Australia for stocks that migrate in or out of the Indian Ocean. Species under IOTC management include eight tuna, three mackerel, and five billfish species, as well as non-target species caught incidentally by tuna and tuna-like fishing operations, including sea turtles, marine mammals, seabirds, sharks, and rays. Member countries are required to report annually on fishing catch and effort by species and gear (for selected species, which vary by gear), monitoring systems and research programmes, and on progress with implementing IOTC resolutions, risk assessments, and strategic plans of action for sharks and rays, seabirds, sea turtles, and marine mammals (see Chapter 6).

Although fishery landings have generally been poorly documented in this region, available data show that some of the most important shark and ray fishing and trading nations globally are found here. In 2020, regional reported shark and ray landings to the FAO were estimated at 155,738 metric tonnes (mt), a decline from 249,223 mt in 1999 (FAO, 2024). Despite three countries in the region not reporting their shark and ray catches, these landings represent 18.1% of globally reported shark and ray landings (860,190.2 mt in 2020) with the top shark fishing nations including India, Iran (Islamic Republic of), Yemen (Republic of), Sri Lanka, and Oman (Sultunate of).





Map of the Food and Agriculture Organization of the United Nations (FAO) Major Fishing Area 51 – Western Indian Ocean and Fishing Area 57 – Eastern Indian Ocean. Exclusive Economic Zones are for illustrative purposes only. Jurisdictions are labelled using three-letter codes (ISO 3166-1).

SUMMARY OF ISSUES AND TRENDS IN THE INDIAN OCEAN REGION

Biology and status

According to the IUCN Red List of Threatened Species, of the 237 shark, ray, and chimaera species confirmed or suspected to occur in the Indian Ocean Region (Table 1; IUCN, 2024), 27 species are endemic to the Indian Ocean Region, of which five species occur only in Yemen, three in India, and one each in Pakistan and Oman (Table 2). A regional IUCN Red List assessment for sharks, rays, and chimaeras that was limited to the Arabian Sea and adjacent waters highlighted that with 78 of the 153 species threatened with an elevated risk of extinction (50.9%), the proportion of threatened species is substantially higher than in other areas where regional assessments have been conducted (Jabado et al., 2018). Even with limited data from many countries, overall results suggest that most shark and ray populations in the region have significantly declined or in some cases been locally extirpated due to largely uncontrolled and unregulated fisheries combined with habitat degradation (Jabado et al., 2018). The deteriorating quality and increasing fragmentation of freshwater, estuarine, coastal, and marine habitats, for example due to infrastructure projects, sand mining and dam and barrage constructions, is exacerbated by climate change impacts.

Fisheries and utilisation

Fisheries resources in the region are under extreme pressure, with several bony fish species thought to be fully or over-exploited and reported declines between 40–80% since the 2000s. Within the same period, there has been growing demand for sharks and rays for food security through the provision of animal protein as well as to supply the global trade in their parts. As a result, fishing effort has increased in traditional shark and ray fisheries (Jabado et al., 2018) and retention of all shark and ray catches is incentivised.

Although sometimes targeted, sharks and rays caught in the Indian Ocean Region are predominantly the result of incidental capture in fisheries targeting other demersal or pelagic species (Jabado & Spaet, 2017). Commercially valued shrimp (Penaeidea), croakers (Sciaenidae), snappers (Lutjanidae), grunts (Haemulidae), and rays are primarily captured in nearshore coastal waters by small-scale fisheries of littoral countries employing gillnets, longlines, hook and line, trawls, and purse seines, with occasional large-scale trips. High-value pelagic fish species, including tuna, billfish, and other tuna-like species are taken mostly by industrial trawl, longline, and purse seine fishing vessels. In addition to national fisheries, foreign fleets from major fishing nations, including Japan, European Union (EU) Member States, Republic of Korea, and Russian Federation, operate in

Table 1: Shark and ray species endemic to the Western Indian Ocean Region | Source: Compiled by authors

SCIENTIFIC NAME	COMMON NAME
Acroteriobatus omanensis	Oman Guitarfish
Acroteriobatus salalah	Salalah Guitarfish
Acroteriobatus variegatus	Stripenose Guitarfish
Aetomylaeus milvus	Ocellate Eagle Ray
Amblyraja reversa	Reverse Skate
Cruriraja andamanica	Anadaman Pygmy Skate
Fenestraja mamillidens	Prickly Skate
Gymnura tentaculata	Tentacled Butterfly Ray
Maculabatis arabica	Pakistan Whipray
Maculabatis bineeshi	Shorttail Whipray
Maculabatis randalli	Arabian Banded Whipray
Okamejei ornata	Ornate Skate
Rhinobatos annandalei	Bengal Guitarfish
Rhinobatos punctifer	Spotted Guitarfish
Telatrygon crozieri	Indian Sharpnose Ray
Torpedo adenensis	Aden Torpedo
Torpedo suessii	Red Sea Torpedo
Apristurus breviventralis	Shortbelly Catshark
Apristurus investigatoris	Broadnose Catshark
Carcharhinus dussumieri	Whitecheek Shark
Carcharhinus leiodon	Smoothtooth Blacktip Shark
Cephaloscyllium silasi	Indian Swellshark
Chiloscyllium arabicum	Arabian Carpetshark
Halaelurus quagga	Quagga Catshark
Heterodontus omanensis	Oman Bullhead Shark
Planonasus indicus	Eastern Dwarf False Catshark
Planonasus parini	Dwarf False Catshark

Table 2: Species richness (overall number of species present) number of threatened (Critically Endangered, Endangered, and Vulnerable) species, number of endemic species, and number of Threatened endemic species, of sharks, rays and chimaeras, per jurisdiction, in the Indian Ocean Region | Source: Compiled by authors from IUCN (2024)

JURISDICTION	SPECIES RICHNESS	THREATENED SPECIES	ENDEMIC SPECIES	THREATENED ENDEMICS
Bahrain	48	32		
Bangladesh	77	63		
Chagos Archipelago	18	16		
Djibouti	43	27		
Egypt	88	61		
Eritrea	52	37		
India	147	101	3	
Iran	75	55		
Iraq	45	33		
Jordan	9	7		
Kuwait	48	33		
Maldives	40	30		
Oman	90	59	1	
Pakistan	94	69	1	
Qatar	53	39		
Saudi Arabia	69	50		
Sri Lanka	97	74		
Sudan	52	37		
United Arab Emirates	62	47		
Yemen	84	48	5	2

the EEZs of many countries and the high seas (De Young, 2006; Jabado & Spaet, 2017; Jabado et al., 2018). Most reports suggest that illegal, unreported, and unregulated (IUU) fishing occurs with increasing incursions of fleets in waters outside their national jurisdiction (Jabado et al., 2018).

Management and conservation

While there has been progress with shark and ray management in the region, it remains inconsistently implemented due to stark differences in governance capacity. Some countries have either fully banned the fishing of sharks and/or rays (e.g. Maldives, Kingdom of Saudi Arabia, and Sudan), protected some species (e.g. India, Pakistan, Sri Lanka, United Arab Emirates, and Bangladesh), or prohibited the export in fins (e.g., India). However, fisheries monitoring is limited in most countries of the region, making it difficult to evaluate whether these measures have been successful. Effective enforcement of fisheries and trade regulations and monitoring remains a challenge for most countries in the Indian Ocean Region.

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Arabian Carpetshark
Pastinachus sephen | Philippe Lecomte

AREAS BEYOND NATIONAL JURISDICTION – INDIAN OCEAN

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AN OVERVIEW

Areas of the sea beyond national jurisdictions (in international waters, outside Exclusive Economic Zones - EEZs) in the Indian Ocean fall under the Indian Ocean Tuna Commission's (IOTC) Area of Competence. These encompass a surface area of 78,162,363 km². As of 2022, there are 31 Contracting Parties and Cooperating Non-Contracting Parties (including the European Union [EU], collectively called CPCs) to the IOTC (IOTC, 2022a). Regional fisheries management organisations (RFMOs) such as the IOTC, though primarily dedicated to the management of tuna and tuna-like species, often have conservation measures and guidelines to support and regulate shark and ray catches within their regions. There are 17 key sharks and rays and species groups that are regularly reported as interacting with IOTC fisheries (IOTC, 2022a). These include Bigeye Thresher (*Alopias superciliosus*), Pelagic Thresher (*Alopias pelagicus*), Common Thresher (*Alopias vulpinus*), Silky Shark (*Carcharhinus falciformis*), Oceanic Whitetip Shark (*Carcharhinus longimanus*), White Shark (*Carcharodon carcharias*), Tiger Shark (*Galeocerdo cuvier*), Shortfin Mako (*Isurus oxyrinchus*), Longfin Mako (*Isurus paucus*), Porbeagle (*Lamna nasus*), Blue Shark (*Prionace glauca*), Crocodile Shark (*Pseudocarcharias kamoharai*), Whale Shark (*Rhincodon typus*), Scalloped Hammerhead (*Sphyrna lewini*), other hammerheads (*Sphyrna* spp.), Pelagic Stingray (*Pteroplatytrygon violacea*), and mobulids (*Mobula* spp.; IOTC, 2022a). However, the CPCs have reported at least an additional 40 species that reside in the Indian Ocean and may interact with IOTC fisheries.

The IOTC has adopted the following resolutions for the management of shark populations of identified species (IOTC, 2023):

Resolution 12/09 - On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC Area of Competence: prohibits the landing and selling of thresher sharks caught in association with fisheries in the IOTC agreement area, as well as encourages their live release. This requires data reporting to IOTC, especially for fisheries targeting sharks.

Resolution 13/05 - On the conservation of Whale Shark: prohibits intentional purse seine setting on tunas associated with Whale Shark. If a Whale Shark is unintentionally encircled within purse seine nets, the shark is to safely be released and the incident reported to the appropriate authorities.

Resolution 13/06 - On a scientific and management framework on the Conservation of Sharks species caught in association with IOTC managed fisheries: prohibits the landing, retention, and selling of Oceanic Whitetip Shark. If caught, the shark is to be released alive and unharmed to the extent possible.

Resolution 17/05 - On the Conservation of Sharks caught in association with fisheries managed by IOTC: imposes obligations on CPCs to introduce measures to protect sharks, and to reduce bycatch or discards of sharks, and implements a fin to carcass ratio of 5%. CPCs shall take the necessary measures to require that their fishers fully utilise their entire catches of sharks, apart from species prohibited by the IOTC. This shall prohibit the removal of shark fins on board vessels. CPCs shall prohibit the purchase, offer for sale and sale of shark fins which have been removed by finning.

Resolution 18/02 - On management measures for the Conservation of Blue Shark caught in association with IOTC fisheries: requires vessels that catch Blue Shark to monitor, collect data on, and report catches to work towards sustainable fishing.

Resolution 19/03 - On the Conservation of Mobulid Rays caught in association with fisheries in the Area: prohibits intentional targeting of mobulid rays as well as retaining onboard, transhipping, landing, or storing any part or whole carcass. The exception to this is subsistence fisheries, who are instead encouraged to use more selective gear to reduce fishing mortality. Live release handling procedures are detailed in the resolution.

Resolution 19/05 - On a ban on discards of Bigeye Tuna (*Thunnus obesus*), Skipjack Tuna (*Katsuwonus pelamis*), Yellowfin Tuna (*T. albacares*), and non-targeted species caught by purse seine vessels in the IOTC Area of Competence: calls for a ban on discards of bycatch or non-target species (including sharks and rays) in purse-seine tuna fisheries.

PRODUCTION

From 2000–2021, a total of 38,580,144 metric tonnes (mt) of marine catch was reported to the IOTC, of which 5.05% (1,949,621 mt) comprised of sharks and rays (IOTC, 2022b). In the same time period, Indonesia had the greatest shark catches, reaching up to 444,589 mt (other countries averaged at 44,310 mt; IOTC, 2022b). The other top countries in terms of reported shark catches to IOTC were Yemen with 201,972 mt (20.28% of total marine catch, 995,810 mt); followed by Iran with 177,954 mt (3.93% of total marine catch, 4,526,755; Figure 1). No data on rays or chimaeras were reported from these countries (IOTC, 2022b). Conversely, countries reported ~40–53% of their total catches comprising sharks and rays between 2000–2021, although their total catches were lower (IOTC, 2022b). The top five countries included Guinea (52.69%, 6,803 mt of 12,912 mt), Sudan (52.05%, 1,387 mt of 2,665 mt), Portugal (50.96%, 26,415 mt of 51,836 mt), Bangladesh (41.18%, 39,012 mt of 94,742 mt), and Madagascar (40.11%, 124,804 mt of 311,183 mt; IOTC, 2022b).

Most shark catch reported between 2000–2021 was recorded under the generic 'Selachimorpha (Pleurotremata)' code with 971,664 mt, followed by Blue Shark (527,578 mt), Silky Shark (106,582 mt), and thresher sharks (*Alopias* spp., 84,648 mt). Most ray catch reported during this time period was recorded under the generic 'Rajiformes' code with 6,919 mt, followed by Spinetail Devil Ray under its former '*Mobula japonica*' (3,556 mt) and current name '*Mobula mobular*' (3,334 mt), Oceanic Manta Ray (*Mobula birostris*, 2,634 mt), other mobulids (Mobulidae, 1,643 mt), and others (131 mt; IOTC, 2022b).

CONSERVATION MANAGEMENT

The IOTC Working Party on Ecosystems and Bycatch (WPEB) reviews and analyses matters relevant to bycatch, byproduct, and non-target species which are affected by IOTC fisheries for tuna and tuna-like species (i.e., sharks and rays, sea turtles, seabirds, marine mammals, and other fishes), as well as the ecosystems in which they operate. The aim of the Working Party is to develop mechanisms which can be used to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission.

The IOTC and the Western and Central Pacific Fisheries Commission (WCPFC) began trialling a Bycatch Data Exchange Protocol (BDEP) template that aims to provide a framework for consistent management of bycatch data within RFMOs. A 2016 IOTC report recommended that this BDEP continue in 2017 for the Indian Ocean (IOTC-WPDCS12, 2016). However, the template has yet to be finalised and implemented as of 2023.

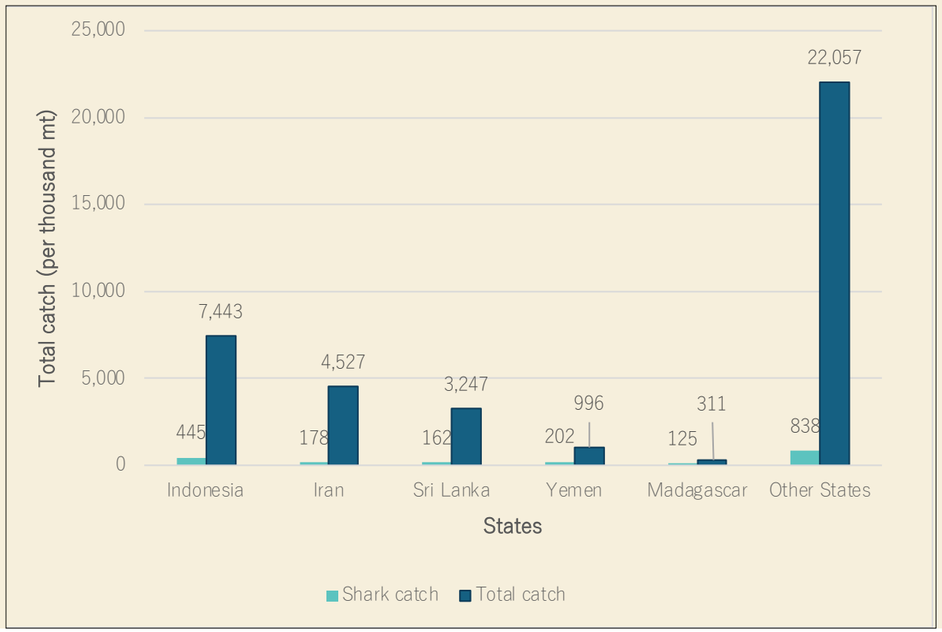

Figure 1: Top five greatest reporters of shark catches to Ithe Indian Ocean Tuna Commission (IOTC) from 2000–2021 Source: compiled by authors from IOTC (2022)

More active protection measures are needed to reverse the declines of threatened sharks and rays from this region. Such issues might be addressed after the ratification of the new agreement on Biodiversity Beyond National Jurisdiction Treaty (BBNJ) which provides a framework to set up Marine Protected Areas (MPAs) in the high seas, and may benefit sharks and rays. However, an implementation agency has not been clearly identified to enforce the protection of the MPAs that might arise out of BBNJ. Further, many species that occur in areas beyond national jurisdiction are not prioritised for data collection within RFMO jurisdictions and specifically, the IOTC.

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BAHRAIN

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BAHRAIN

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INTRODUCTION

The Kingdom of Bahrain (henceforth 'Bahrain') is a small island nation in the Persian Gulf (also known as Arabian Gulf and hereby referred to as 'the Gulf'), which shares its fish stocks with adjacent countries (Morgan, 2006). Bahrain's Exclusive Economic Zone (EEZ) is 8,826 km^2 (Sea Around Us, 2016). It consists of 33 natural islands, with the 51-km long and 18-km wide Island of Bahrain being the largest. Bahrain has a coastline of 950 km (FAO, 2023) and marine fisheries provide a source of income, employment and recreation opportunities while symbolising significant natural and cultural heritage as part of the Bahraini identity. The fisheries sector is artisan in nature and is multispecies and multi-gear (Ali & Abahussain, 2013), with a reported catch to the FAO in 2022 of 19,836.59 metric tonnes (mt) of fish with sharks and rays accounting for 26.65 mt of this (FAO, 2024).

The Gulf is a shallow sea, with an average depth of 35 m. Its semi enclosed structure, coupled with a low level of water exchange with the Indian Ocean results in high evaporation rates. Despite the extreme temperatures that fluctuate between 16°C in the winter and up to 36°C in the summer and high salinity levels of about 45 in the eastern waters of Bahrain and 55.1 in the western waters (Al-Wedaei et al., 2011; AlMealla et al., 2024), Bahrain's sea supports diverse and unique ecosystems and fish fauna (Naser, 2014).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site title, known as 'Pearling, testimony of an island economy' was inscribed on 30 June 2012 and includes three offshore oyster beds, namely, Najwat and Hayr Bul Thamah, Hayr Shtayyah, and Hayr Bu Am'amah accompanying a Buffer zone, collectively known as the Northern Hayrat area (UNESCO, 2012).

Reef Bul Thamah is a natural coral reef which is part of the Najwat Bul Thamah area. In local terminology both Najwat and Hayr refer to an area dominated by an oyster bed ecosystem. Oyster beds are located all around Bahrain's territorial waters (mainly east, west, and north of the main island). The Northern Hayrat area is well known not just for its rich pearl oyster beds but also for its diverse community of fish species, sponges, patch coral reefs that are associated with the pearl oyster beds, and other benthic organisms (AlMealla & Hepburn, 2024). Based on local knowledge, the Northern Hayrat is also home to a diverse array of rays and sharks in addition to other megafauna.

Coral reefs in Bahrain occupy a total area of 850 km^2 (Burt et al. 2013), which is larger than the country's land mass with reefs mainly distributed in the northern and eastern territorial waters, with Fasht Al Adhm being the largest (170 km^2; AlMealla & Hepburn, 2024; AlMealla et al., 2024). The largest and last standing natural aggregation of mangroves in Bahrain is situated in Tubli Bay which is both a Ramsar site and Marine Protected Area (MPA) due to its ecological significance as an important wetland for many resident and migratory birds.

Seagrass beds are mainly distributed along the southeast and west coast with the most extensive seagrass beds found around Hawar Islands (Al-Wedaei et al., 2011), which is also the main host area for the largest aggregation of Dugong (*Dugong dugon*) in the world (Khamis et al., 2023).

From a conservation aspect, the Northern Hayrat including Reef Bul Thamah (Decision No. (2) and (3) of 2017), Hawar Islands and surrounding seas (Decision No. (16) of 1996) and the mangroves in Ras Sanad Nature Reserve located in Tubli Bay (Law No. (53) of 2006) are protected by national law as MPAs.

FISHERIES

Fleets

Fisheries are mostly artisanal in nature, following a 1998 prohibition on industrial trawling activities. In 2023, there were an estimated 2,300 fishing boats operating in Bahrain waters. These are mainly fiberglass boats (85%), with the remainder being traditional wooden dhows. Most vessels are small with 71% being less than 25.9 ft (~7.89 m) in length and only 6% being more than 36.0 ft (~10.97 m). Prior to 1998, up to nine steel-hulled fish trawlers operated in Bahraini waters. These vessels were assigned to fish in waters deeper than 20 m. However, they often trawled in shallow water areas, thereby causing conflict with other fishers. As a result, these steel trawlers were banned on 1 June 1998 (Morgan, 2006). Dhow trawlers were still in use to catch shrimp until 2018, when all trawlers were banned (See 'Policy' section).

In 2016, it was estimated that 2,521 vessels, mainly gillnetters and longliners, made up the fishing fleet. There were an estimated 11,821 individuals employed by this industry at this time (FAO, 2023). In 2015, the estimated total capture production was 15,000 mt. During 2004–2009, cuttlefish, jellyfish, rays, sharks, and lobster were classified as 'others' and comprised a small portion of total landings (Ali & Abahussain, 2013).

Gear

Most landings of sharks and rays are from gillnets, although *hadrah* (intertidal stake nets), *gargoor* (wire fish traps), and some hook and line fishing also contribute to incidental catch in fisheries (Moore & Peirce, 2013).

PRODUCTION

Overall landings

Fishery landing statistics were previously maintained by the General Directorate for Protection of Marine Resources which was also the agency previously responsible for collecting data and fisheries management. The General Directorate for the Protection of the Marine Resources no longer exists. As of spring 2024, following a restructure in the government, the Directorate of Fisheries under the General Directorate of Marine Resources has been moved under the jurisdiction of the Supreme Council for Environment. However, due to internal changes, national data collection and the release of the annual fisheries reports have ceased (AlMealla, personal observation, 2023).

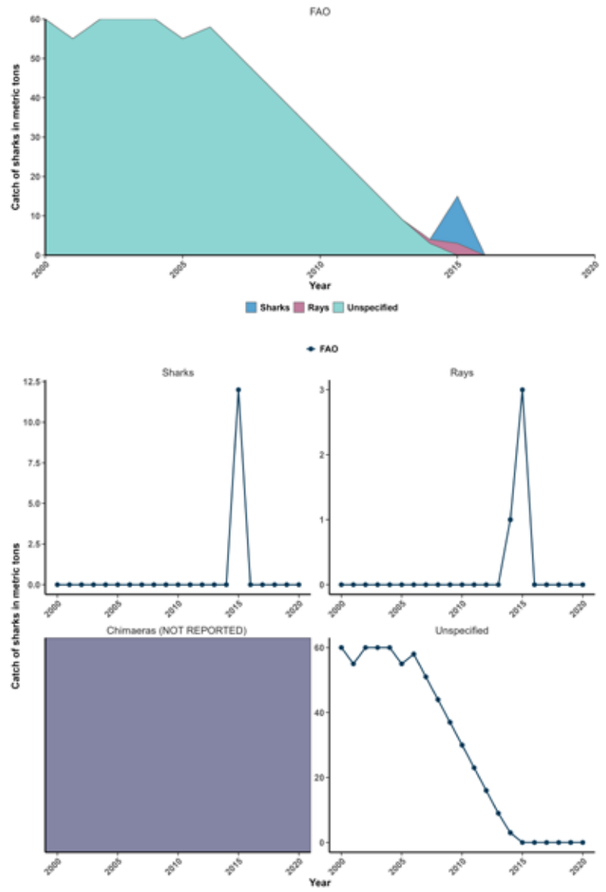
Capture fisheries production in 2021 was 15,720 mt based on reports to the World Bank (The World Bank Group, 2024). During 2004–2009, cuttlefish, jellyfish, rays, sharks, and lobster were classified as 'others' and comprised a small portion of total landings (Ali & Abahussain, 2013).

Data reported to the Food and Agriculture Organization of the United Nations (FAO) showed that from shark and ray landings fluctuated from 2004–2022. In this time period, 5–97 mt of 'requiem sharks nei [not elsewhere included]' and 1–51 mt of 'stingrays, butterfly rays nei' were landed. In 2022, an estimated 14.89 mt and 11.76 mt, respectively were reported (FAO, 2024).

Species-specific

Thirty-one (16 shark and 15 ray) species are observed in fishery landings. Arabian Smoothhound (*Mustelus mosis*), Milk Shark (*Rhizoprionodon acutus*), Banded Eagle Ray (*Aetomylaeus nichofii*), Spottail Shark (*Carcharhinus sorrah*), Cowtail Ray (*Pastinachus sephen*), and Arabian Banded Whipray (*Maculabatis randalli*) were the most common species in landings statistics

Bahrain's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022)



(Shark Conservation Society, 2012; Moore & Peirce, 2013). Milk Shark was the main composition (85%) of bycatch in the gillnet fishery (Abdulqader, 2001; Shark Conservation Society, 2012).

TRADE

Processing

All sharks caught are presumably consumed locally, usually smaller-sized specimens are sold in fish markets. These are especially sold to local, east Asians (Ali & Abahussain, 2013; Almojil, 2021; AlMealla, personal observation, 2024). Larger sharks have been observed to be exported, but their destination and for what purpose are unknown. There have been some reports suggesting that sharks and wedgefishes from Bahrain are transported overland for sale in Saudi Arabia (Almojil, 2021; R. W. Jabado, personal communication, 2024).

CULTURAL SIGNIFICANCE

Shark and ray products have been widely used in Bahrain historically and still were in 2012 (Moore, 2012). For example, shark liver is used to waterproof the wooden vessels, meat is consumed locally, while fins are exported to southeast Asia. Historically, sawfish were occasionally entangled in gillnets during the spring and their rostra were cut off for private collections.

RESEARCH

There is currently no ongoing research on sharks and rays in Bahrain. Nuwat, an environmental research and education organisation in Bahrain is launching a research project which aims to map the distribution of sharks and rays, investigate their seasonality and areas that are thought to be nursery areas through a multi-faced approach that combines fish market surveys, local ecological knowledge, and eDNA to better inform decision makers on conservation needs.

MANAGEMENT

Governance framework

The Supreme Council for Environment (SCE) is the official governmental agency responsible for marine biodiversity and fisheries management. The Directorate of Fisheries, Directorate of Biodiversity and the Directorate of Protected Areas all under the SCE umbrella work together on marine conservation and management. Enforcement of relevant laws is also enabled through the Directorate of Coast Guards under the Ministry of Interior.

Bahrain is a Member of the Regional Commission on Fisheries (RECOFI) and a Member of the Regional Organization for the Protection of the Marine Environment (ROPME; Morgan, 2006). Additionally, Bahrain is a party to the Convention on the Conservation of Migratory Species of Wild Animals (CMS), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and the Convention on Biological Diversity (CBD).

RECOMMENDATIONS

Policy

Bahrain has laws that specify shrimp nets measurements and mesh sizes. All fishing vessels are required to be registered.

Annually, ministerial decrees are issued on closed and open shrimp-fishing seasons. This usually includes a four-month closed season from mid-March to mid-July (Ali & Abahussain, 2013).

Bahrain has banned trawl fisheries as per Resolution No. 205 of 2018. This is strictly monitored and reported and shared with the public online.

In 2024, the SCE announced a ban on catching Spangled Emperor (*Lethrinus nebulosus*, locally known as *Sheri*), White-spotted Spinefoot (*Siganus canaliculatus*, locally known as rabbitfish or *Safi*), and Two-bar Seabream (*Acanthopagrus bifasciatus*, locally known as *Andak*) within territorial waters in April–May, and prohibiting the export of all types of fish, shrimp, and other sea animals caught in territorial waters, except for crabs and jellyfish, whether fresh, chilled, frozen, salted, canned or smoked (Edict (1) of 2024).

There is a regional Gulf Cooperation Council (GCC) effort to harmonise shrimp closed seasons to six months annually. Bahrain has increased its closed season from three to five months.

Industrial trawlers have been banned in Bahrain since 1998 and, in place of these, artisanal trawl fishing vessels carry out all shrimp fishing (Morgan, 2006).

There are several laws in place to protect Bahrain's wildlife, including threatened shark and ray species. In Law No. (7) of 2022 regarding the environment Article 74 prohibits:

1. Killing, hunting, smuggling, capturing and harming of threatened species;
2. Destroying bird nests or eggs of threatened species;
3. Cutting, destroying, or damaging coral reefs, shells, sea cucumbers or other threatened organisms or plants whether they are terrestrial or marine;
4. Possessing or transporting threatened species without a license from the council;
5. Trading threatened species whether they are alive or dead, as well as their parts, products, or derivatives without a license from the council; and
6. Introducing invasive species.

In 2012, fishing for Green Sawfish (*Pristis zijsron*) was prohibited, and those caught must be reported and the fish must be released.

There are six declared MPAs, namely the Hawar Islands, Tubli Bay, Mashtan Island, Dohat Arad, the Northern Hayrat (oyster beds), and Hayr and Najwat Bul Thamah (Al-Abdulrazzak, 2016; Jabado et al., 2017). In addition, several protected areas including Northern Hayrat and Najwat Bul Thamah in the northern waters, Arad Bay and Tubli Bay of main island coasts, Mashtan Island in the eastern waters, and Hawar Island in the southeastern waters adjacent to Qatari western waters, have been stated (Mansoor, 2023). Further to this, Bahrain has recognized two Ramsar sites: Hawar Islands and Tubli Bay.

Enforcement and monitoring

Bahrain does not have focused enforcement on shark and ray policies but has long-term monitoring programmes in certain areas for marine water and sediment quality, as well as marine mortality and illegal fishing activities. Surveys have been done in various years in the Northern Hayrat and Najwat Bul Thamah in addition to bird surveys have taken place at Hawar Islands and Tubli Bay. However, there are no monitoring programs in place for sharks and rays.

Efforts to raise public awareness and educate members of the public regarding national protected areas are ongoing and have been implemented for the last couple of years (Mansoor, 2023).

Science/knowledge/research

There are gaps in research, and in capacity to undertake research and to conduct monitoring and enforcement.

- Sawfish bycatch monitoring;
- Landing-based shark and ray monitoring;
- Whale Shark (*Rhincodon typus*) encounter monitoring;
- More research is needed on sharks and rays in Bahrain's waters;
- Funding for scientific research is required to enable local researchers to implement and sustain the projects; and
- Sawfish and Whale Shark tracking programmes are needed to understand their distribution and movement.

Management/governance/conservation

- Develop a regional management plan for sawfishes and Whale Shark;
- Support research on sawfishes and Whale Shark for better understanding their biology and ecology, to develop more effective conservation measures;
- Develop a regional network for sawfish and Whale Shark conservation;
- Enhance the public awareness and capacity building;
- Determine the distribution and seasonality of sharks and rays in Bahraini waters; and
- Map the areas that they utilise and for what purpose to enable conservation and spatial planning.

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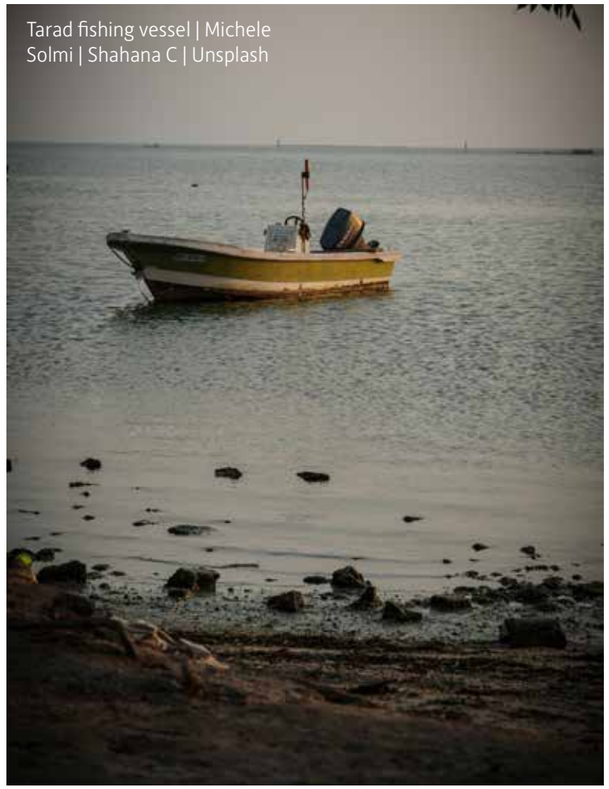
A *hadrah*, stake net, in Bahrain | Eman Ali | Unsplash

Dhow fishing vessel at Sitra, Bahrain | Michele Solmi | flickr.com (CC BY-NC-SA 2.0.)

Green Sawfish *Pristis zijsron* accidentally caught in Bahrain | Hua Hsun Hsu



Tarad fishing vessel | Michele Solmi | Shahana C | Unsplash

Common Blacktip Shark *Carcharhinus limbatus* at a fish market in Bahrain | feiche | iNaturalist.org (CC BY-NC-ND)

BANGLADESH

Santanu Majumdar | Ocean Image Bank

BANGLADESH

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INTRODUCTION

Located in the Indian Ocean, to the north of the Bay of Bengal, Bangladesh is a small country with an Exclusive Economic Zone (EEZ) of approximately 118,813 km^2. Bangladesh shares borders with Indian and Myanmar.

Bangladesh's 700 km long coastline along the northern Bay of Bengal is dominated by the estuary formed by sediment-laden freshwater inflow of one of the world's largest river systems: Padma (Ganges), Jamuna (Brahmaputra), and Meghna Rivers. Shifting shallows (<10 m) dominating the central coast are priority habitats particularly for rays. Two thirds of the Sundarbans, the world's largest contiguous mangrove forest, which straddles 6,000 km² of the southwestern coast in Bangladesh, with small mangrove patches and shallow nearshore waters extending to the east, provide critical nursery habitat for sharks and rays. Along the southeastern coast, the water is slightly deeper (20–50 m) and relatively less turbid, with a small (<8 km²) coral assemblage at the southernmost tip. The tip of the Swatch-of-No-Ground submarine canyon cuts into the continental shelf to within 40 km of the Sundarbans mangrove forest. The cool upwelling canyon waters intermix with nutrient rich waters from the tidal mangrove channels, creating a highly productive refugium for marine wildlife, including sharks and rays.

FISHERIES

Fleets

Around 70,000 artisanal fishing boats, of which 43,136 are registered and about half mechanised, operate in the coastal waters of Bangladesh. The 234 licensed industrial trawling vessels targeting fish and shrimp are restricted to operating in depths greater than 40 m (DoF, 2022).

Gear

Medium-mesh (8–11 cm) gillnets between 3,000–7,000 m in length, targeting Hilsa (*Tenualosa ilisha*) and fixed small-mesh funnel or set-bag nets are responsible for about three quarters of all shark landings by weight, 96% of all sharks landed by number, and for about 65% of the total ray landings from small-scale fisheries (BFD & WCS, 2021). Small-scale baited and unbaited longlines with many hooks targeting rays accounted for about 85% of the total number of rays landed (BFD & WCS, 2021). Non-target catches of sharks and rays from industrial trawlers range between 400–900 metric tonnes (mt) per year according to official government records.

PRODUCTION

Overall landings

Annual landing statistics published by the Department of Fisheries (DoF, 2022) indicate that catches of sharks and rays constitute around 1% of the total marine fisheries catch and report gradual declines in shark and ray landings from 6,234 metric tonnes (mt) in 2001–2002 to 3,373 mt in 2019–2020, with an increase to 8,228 mt in 2020–2021. These official figures published as a single group (sharks and rays) are derived from two sampled landing centres for small-scale fisheries and log records from industrial trawling vessels. There are no data available for chimaeras.

Species-specific

Landings are dominated by a few relatively common species, namely Spadenose Shark (*Scoliodon laticaudus*), Scalloped Hammerhead (*Sphyrna lewini*), Bluespotted Maskray (*Neotrygon caeruleopunctata*), Bengal Whipray (*Brevitrygon imbricata*), Honeycomb Whipray (*Himantura undulata*), and Bleeker's Whipray (*Pateobatis bleekeri*). The large number of Critically Endangered (CR) Scalloped Hammerheads and Vulnerable (VU) Honeycomb Whiprays being landed are of particular concern. Frequent landings of large numbers of individuals of other relatively common or non-threatened species were documented for Bull Shark (*Carcharhinus leucas*), Blacktip Shark (*C. limbatus*), Spottail Shark (*C. sorrah*), and Tiger Shark (*Galeocerdo cuvier*). The total value of shark catches recorded during almost 3,000 visits to eight coastal landing sites between 2016–2019 was estimated to be at least USD 1.4–2.0 million per year, and the value of ray catches was an estimated USD 0.7–1.2 million per year at landing (i.e., before added-value from processing; BFD & WCS, 2021).

TRADE

Processing

Shark and ray fins are generally cut off at landing, salted and sun dried for export, primarily to Hong Kong Special Administrative Region (SAR). Additionally, mobulid gill plates are dried in the sun for export, primarily to China and Thailand. Small sharks and rays are sold whole, fresh or salted and dried. This includes Spadenose Shark or hound sharks (*Iago* spp.). Bengal Whipray, Bluespotted Maskray, Kuhl's Maskray (*Neotrygon kuhlii*), and Scaly Whipray (*Brevitrygon walga*). Medium-sized shark species (e.g., Spottail Shark or Milk Shark [*Rhizoprionodon acutus*]) are usually sold in pieces, fresh or dried, to local consumers or buyers from Myanmar. Salted dried meat from larger species is sold mostly to Myanmar. Due to its turning black when dried, only fresh devil ray meat (*Mobula* spp.) is consumed locally, while the dried and salted meat is sold to traders for export mostly to Myanmar (BFD & WCS, 2021). Sundried skins of sharks (e.g., Pigeye Shark [*Carcharhinus amboinensis*] and Bull Shark), and rays (particularly from guitarfishes [Rhinobatidae], wedgefishes [Rhinidae], and stingrays and whiprays [Dasyatidae]) are reportedly sold to buyers from the Middle East, Europe, and from Myanmar for re-export to China (Bahadur, 2010; Haroon, 2010; Hasan et al., 2017; WCS, 2018). Liver oil is extracted by chopping and boiling the liver in metal containers (Bahadur 2010; Haroon, 2010; Hasan et al., 2017). Dried cartilage is traded locally and exported to China, Hong Kong SAR, and Singapore (Hasan et al., 2017; Haque et al., 2018).

Domestic

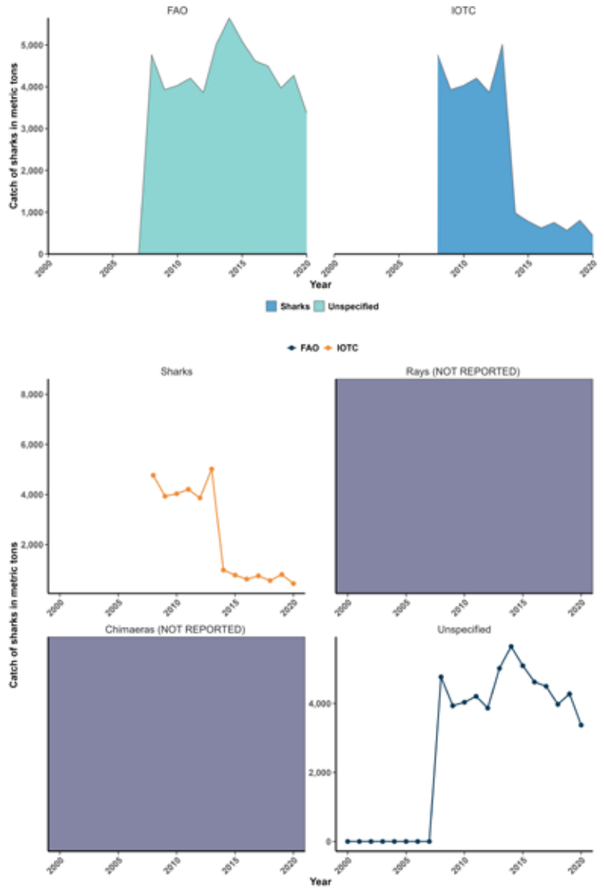
Meat of small sharks and rays is consumed locally, either fresh or salted and dried. Ray and shark skins or hides are reportedly made into shoes, wallets, belts, handbags, and purses in Bangladesh (Haroon, 2010; Roy et al., 2014; Uddin et al., 2018), but traders claim that skins are not used domestically but exported, mainly via Myanmar to Hong Kong SAR or China (BFD & WCS, 2021). Processed liver oil is used locally as lubricant in tanning and textile industries (Haroon, 2010), fish or poultry feed, and occasionally by pharmaceutical companies (Haque et al., 2020). Other shark and ray body parts are also sold to fish or poultry feed producers (Bahadur, 2010; Haque et al., 2020). Indigenous communities reportedly consume unsalted, sun-dried shark guts (Bahadur, 2010; Hasan et al., 2017). Dry sawfish rostra for display as showpieces can sell for up to USD 300 (BFD & WCS, 2021).

Export

Dried fins are exported, graded according to size, with a value of around USD 11.8/kg for fins between 2–4 inches (~5.08–10.16 cm) in length, increasing with every 2 inches (or 5.08 cm) in size to over USD 94.4/kg for fins over 20 inches (~50.8 cm) in length (BFD & WCS, 2021). According to official records, Bangladesh exported between 0 and nearly 1,000 mt of dried fins annually from 1990–2010, almost none from 2011–2018, and then over 2,000 mt in 2018/2019. Hong Kong SAR customs recorded 25.6, 45.0, 1.8, and 6.8 mt of shark fins imported from Bangladesh in 2016, 2017, 2018, and 2019, respectively, but only 0.4 mt in 2020 (BFD & WCS, 2021). This decrease is likely due to lower demand because of COVID-19 restrictions on gatherings, such as in restaurants and for wedding celebrations, in Hong Kong SAR where shark fins are primarily consumed in shark fin soup (BFD & WCS, 2021).

Traders buy processed shark fins, meat, and skins, and then export them to Myanmar for re-export to Singapore, Hong Kong SAR, China, and the United States (US; Roy et al., 2007). Chinese buyers frequently contact mediators or traders in Bangladesh to order products that are then sent via Myanmar. Dry and fresh meat of rays, mobulid gill plates, liver oil, and left-over parts are shipped from Chattogram and Cox's Bazar to Teknaf, across the border to Myanmar and on to China and Thailand (Haque et al., 2020). Only an estimated 10–20% of this trade follows proper legal procedures (Roy et al., 2015).

Bangladesh's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tons (mt) | Source: FAO (2022) and IOTC (2022)



CULTURAL SIGNIFICANCE

Fresh sawfish meat as well as dried small specimens of rhino rays are widely believed to have curative medical properties. Shark and ray meat can, seemingly increasingly, be found for sale in many markets across the country. Among 100 shark and ray consumers questioned in nine locations along the coast with major fish landing sites, most (85%) were Hindus, Buddhists, Christians, or ethnic minorities, with the remaining being Muslim, and 63% said they eat sharks or rays at least once a month and 37% eat shark or ray meat every week (BFD & WCS, 2021).

RESEARCH

The Department of Fisheries and the Bangladesh Fisheries Research Institute conduct shark- and ray-related research in collaboration with national universities or associated researchers, focusing primarily on taxonomy and market/trade value chains. The Wildlife Conservation Society (WCS) regularly conducts at-sea fisheries investigations and maintains citizen science networks established among coastal fishers, who report geo-referenced and photo-verified shark and ray catches, and landing site data collectors.

MANAGEMENT

Governance framework

The management of sharks and rays is a shared responsibility of the Forest Department, primarily responsible for protecting threatened wildlife; and the Department of Fisheries, responsible for managing fisheries, with additional assistance mandated from the Navy, Coast Guard, and River Police for enforcing fisheries regulations, as well as from Customs, Police, and Border Guard Bangladesh for enforcing trade regulations and combating illegal wildlife trade.

Policy

An amendment to the listing of sharks and rays protected under the Wildlife (Conservation and Security) Act 2012 was adopted in 2021 and aligns national species protection with commitments under 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 Resolutions of the Indian Ocean Tuna Commission (IOTC). The Marine Fisheries Act 2020, the primary law governing marine

Honeycomb Whipray *Himantura undulata* sold at market in Bangladesh | Md. Sabbir Ahammed iNaturalist.org (CC BY-NC)

Bull Shark *Carcharhinus leucas* landed in Bangladesh | Biswas Sajib | iNaturalist.org (CC BY-NC)

Small scale fishing boat in Bangladesh | Ashraful Pranto | Unsplash

fisheries, does not specifically regulate shark or ray fisheries but enables the regulating of fishing gear and vessel licences. Three multiple-use Marine Protected Areas (MPAs) encompass priority shark and ray habitat in coastal waters, with extensions and a proposal for other effective area-based conservation measures (OECM) covering nearshore habitats and connecting two MPAs in a 'Blue Belt' currently under consideration.

Enforcement and monitoring

Government agencies and non-governmental organisations (NGOs) are working to improve institutional capacity for enforcement and monitoring of spatial regulations, fisheries rules, wildlife protection, and for combating illegal wildlife trade. Plans include strengthening systematic monitoring of industrial fishing vessels, fish landing and processing centres, and export shipments. Educational outreach programmes are conducted by NGOs and individual researchers for building marine stewardship and local conservation constituencies, enabling fisheries stakeholders to differentiate protected shark and ray species, and encouraging safe releases of these species and compliance with spatial and species regulations at sea.

Community involvement

The involvement of communities in formal shark and ray conservation efforts has been minimal, despite enabling policies on co-management of natural resources and protected areas. However, mutually beneficial collaborations between NGOs and coastal fishing communities through citizen science networks have proven successful, and there are plans to adopt this approach for enabling community-based monitoring of MPAs.

Gaps

It was not until the passage of the Wildlife (Conservation and Security) Act 2012, that shark or ray species were legally protected in Bangladesh. Considerable confusion prevails among law enforcement officers regarding the legal protection of sharks and rays. The Shark and Ray Amendment 2021, which lists eight genera and 23 species of sharks and rays under Schedule I, and one genus and 29 species of sharks and rays under Schedule II, brings clarity for law enforcement officials. It also aligns national legislation with CITES, CMS, and IOTC commitments and recent IUCN Red List of Threatened Species conservation status assessments. However, the act currently lacks legal definitions for the respective schedules and guidance on penalties resulting from infractions.

A key challenge faced in combating illegal shark and ray trade is the difficulty of arresting and prosecuting criminals. When a suspected wildlife criminal is arrested and a case is filed, successful prosecutions are rare, and the penalties are relatively minor. One significant impediment is a provision in the Wildlife (Conservation and Security) Act 2012 that makes Forest Department officials criminally liable if a judge finds there is insufficient evidence to prosecute an arrested violator. The implication of this provision is that, instead of using this law to arrest and prosecute wildlife criminals, the Forest Act (1927) is applied to arrest wildlife traders. The relatively minor penalties of this law provide little deterrence for perpetrators (BFD & WCS, 2021).

The current recording and reporting on shark and ray catches and landings lacks spatial coverage, geo-spatial information and details on genera or species that are crucial for quantifying fishery impacts on shark and ray stocks and reporting to CITES, CMS, and IOTC. Information particularly on pelagic sharks and on rays caught by industrial trawlers, as well as the at-sea transshipment trade is likely underreported and largely uncontrolled. Furthermore, shark and ray catches are frequently landed, processed, and traded at unofficial sites, which further inhibits monitoring and enforcement (GoB, 2023).

Dried shark fins and ray gill plates and skins are often mixed with dry fish shipments. Official catch and trade statistics do not differentiate shark or ray species, or their products from fish swim bladders. No other shark or ray products are listed in the annually published export data by the Department of Fisheries Statistics. This reduces the traceability of shark and ray products originating from Bangladesh and results in revenue loss for the Government. This also limits the ability to track international trade and make science-based recommendations.

RECOMMENDATIONS

Bangladesh is a stronghold for several threatened shark and ray species in need of urgent protection, including Ganges Shark (*Glyphis gangeticus*), Largetooth Sawfish (*Pristis pristis*), Giant Freshwater Whipray, Great Hammerhead (*Sphyrna mokarran*), Scalloped Hammerhead, Sharpnose Guitarfish (*Glaucostegus granulatus*), Ocellate Eagle Ray (*Aetomylaeus milvus*), and Spinetail Devil Ray (*Mobula mobular*). Frequent landings of large numbers of individuals of other relatively common species, including Spadenose Shark, Bull Shark, Blacktip Shark, Spottail Shark, Tiger Shark, Bengal Whipray, Bleeker's Whipray, and Bluespotted Maskray, provide potential opportunities for developing a sustainable shark and ray fishery based on rigorous science and in compliance with national wildlife laws and international obligations under CITES and CMS.

The 'National Conservation Strategy and Plan of Action for Sharks and Rays in Bangladesh 2023-2032' provides strategic guidance on priority conservation and management actions needed to effectively protect and sustainably manage sharks and rays. It was jointly developed by the forest/wildlife and fisheries departments in broad consultation with other shark and ray fishery and trade stakeholders, and reflects the best available science, international commitments, and locally feasible solutions for shark and ray management and conservation (GoB, 2023).

Policy

Enforcement of existing licensing and business regulations, including for online traders, as well as mandating species-specific declarations of import/export consignments would inform the sustainability of the shark and ray trade and incentivise traders to comply with national and international trade regulations and species protection laws (BFD & WCS, 2021).

In addition to low levels of awareness about protected species among government and non-government fisheries stakeholders, the institutional capacity to systematically monitor target and non-target catches, landings and trade, and adaptively manage MPAs needs to be substantially enhanced.

Science/knowledge/research

Awareness about laws and rules regulating trade in sharks and rays was found to be low among domestic consumers (WCS, 2018). Increasing consumption of shark and ray meat has been observed across the country, which means that the retention of sharks and rays is not only being driven by the global market

but also increasingly by domestic demand. The 'Shark and Ray Assessment Report' provides baseline information on their status, threats and governance in Bangladesh based on results from scientific investigations, citizen science networks, educational outreach and policy initiatives, and published reports (BFD & WCS, 2021).

Management/governance/conservation

The 'National Conservation Strategy and Plan of Action for Sharks and Rays in Bangladesh 2023-2032' indicates progress made in Bangladesh on sharing up-to-date information on status and threats, defining conservation priorities and feasible management interventions (GoB, 2023). Developing this plan coupled with efforts to strengthen CITES compliance also catalysed stronger collaboration and coordination between relevant government agencies, NGOs, and development partners. The collaborative implementation of recommended actions detailed in the plan would improve communication, monitoring, and enforcement of science-based and community-informed shark and ray management regulations that aim to balance the need of threatened species with human demands for a healthy ocean that supports healthy people.

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Giant Freshwater Whipray *Urogymnus polylepis* in Cox's Bazar fish landing site, Bangladesh | G M Masum Billah | WCS Bangladesh

Shark and ray fins, including from hammerheads (*Sphyrna* spp.) and giant guitarfish (*Glaucostegus* spp.) drying in the sun in Cox' s Bazar, Bangladesh | Robiul Kauser | WCS Bangladesh

CHAGOS ARCHIPELAGO

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INTRODUCTION

The Chagos Archipelago is a remote collection of islands, submerged banks, seamounts, and their surrounding waters in the central Indian Ocean. The Chagos Archipelago and associated waters were declared a fully protected Marine Protected Area (MPA) in 2010 by the United Kingdom's (UK) Government, classified as an IUCN Management Category 1a strict nature reserve, ending all licensed and legal fisheries (Hays et al., 2020). Although shark abundances have experienced historical declines (Ferretti et al., 2018), due to legal and illegal, unreported, and unregulated (IUU) fishing prior to the MPA designation (Collins et al., 2021), the Chagos Archipelago still harbours regionally significant populations of several shark species (Letessier et al., 2019). However, levels of IUU activity spiked to alarming levels during the COVID-19 pandemic (Collins et al., 2023), which is likely to have substantially impacted already-depleted shark abundances in the northern atolls (Dunn et al., 2023).

The archipelago also hosts various Mobulidae (mantas and devil rays) species that are threatened with extinction as a result of their unsustainable exploitation throughout the Indian Ocean. These species include Reef Manta Ray (*Mobula alfredi*), Sicklefin Devil Ray (*Mobula tarapacana*), Bentfin Devil Ray (*Mobula thurstoni*), and Spinetail Devil Ray (*Mobula mobular*) that the MPA is believed to provide essential refuge for (Carlisle et al., 2019; Andrzejaczek et al., 2020; Harris et al.,2021; Harris & Stevens, 2024; Harris et al., 2024a). However, with the recent increase in demand for Mobulidae gill plates (O'Malley et al., 2017), illegal fishing potentially poses a significant threat to the Chagos Archipelago as a refuge (Harris & Stevens, 2024; Harris et al., 2024b).

The Chagos Archipelago contains 60,000 km² of shallow limestone and reef (Sheppard et al., 2012), of which 15,000 km² is coral (Andrefouet et al., 2006); these corals possibly act as a suitable habitat for reef sharks (Ferretti et al., 2018). The archipelago contains four atolled ecosystems, which have been shown to be important habitats and foraging grounds for Reef Manta Ray (Harris et al., 2021). Individual mantas have been shown to have high levels of residency around these atoll systems (Andrzejaczek et al., 2020; Harris et al., 2024b), likely associated with topographical retention of planktonic prey (Letessier et al., 2016; Harris et al., 2021).

In addition, the MPA contains 74 seamounts (Yesson et al., 2021) and 243 knolls (Sheppard et al., 2012), which are important hotspots for several species of demersal and pelagic sharks (Tickler et al., 2015; Curnick et al., 2020) because of associated lee waves, which regularly flood the seamounts with turbulent and energetic currents, promoting prey productivity and therefore shark aggregations (Hosegood et al., 2019).

FISHERIES

Fleets

Since the Chagos Archipelago was designated as a no-take MPA in 2010, no commercial fisheries have been licensed or operated. However, illegal fisheries conducted by foreign vessels, primarily from Sri Lanka and India, have persisted. From MPA implementation to 2020, it was conservatively estimated from enforcement data that one vessel per month fished illegally in the MPA (Collins et al., 2021). However, this is likely a significant underestimate, due to considerable gaps in the detection of illegal vessels and difficulties ascertaining vessels' activity whilst in the MPA, as innocent transit is permitted and occurs regularly (Ferretti et al., 2018). The number of illegal vessels appeared to surge in 2022, with 19 vessels on average per month in the first third of 2022 alone (Collins et al., 2023). This was potentially owing to changes in management of the MPA due to COVID-19, as vessels were no longer boarded which reduced the likelihood of vessels being sanctioned for illegal activity (Collins et al., 2023). Since then, enforcement data suggests that illegal vessel activity is still higher than in previous years at six vessels on average per month, but that it has decreased relative to the start of 2022.

From April 2010–2020, illegal vessels were primarily of Sri Lankan origin (72%), although Indian vessels (28%) were also recorded (Collins et al., 2021). Since 2020, this has shifted with Indian vessels now the predominant flag (72%) compared to Sri Lanka (28%). Research within fishing communities in Sri Lanka suggested that sharks are the primary target for Sri Lankan vessels and data from interviews with fishers suspected of illegal activity suggested that 73% were targeting sharks (Collins et al., 2021). In contrast, enforcement data suggests that Indian vessels appear to target a broader diversity of reef-associated species, with mostly teleosts in their catches (Collins et al., 2021). Sharks are typically targeted in inner reef areas using primarily longline gears, although vessels typically also have gillnets onboard. In this time period, the size of vessels averaged 14.8±3.5 m (range=12.4–16.1) and crew size averaged 6±1 people (range=4–8; Collins et al., 2021).

Data on catch were only available for 30% of all vessels suspected or detained for illegal activity and for only 12% of Indian vessels. Thus, understanding the potential impact of illegal fisheries on sharks and rays around the Chagos Archipelago is limited. Fisheries-independent data from acoustic telemetry around the Chagos Archipelago suggests that short-term fishing events by Indian vessels may have a substantial impact on reef shark populations across the MPA (Tickler et al., 2019). Mantas and devil rays are also targeted by Sri Lankan fishing vessels (Harris & Stevens, 2024).

A small recreational fishery also operates in the 3 nautical mile (nm) zone around the only inhabited island of Diego Garcia, which is thought to have some impact on overall fish biomass compared with the rest of the MPA (Samoilys et al., 2018). Primarily engaged in by military personnel and contractors, fishing effort is split into shore-based and boat-based fisheries. Targeted species for shore-based fisheries is primarily reef-associated species such as snappers (Lutjanidae) and Serranidae species which are targeted by rod and line and handline gears, with sharks rarely caught as bycatch. In boat-based fisheries, trolling, handlining, and rod and line gears are all used to target similar reef-associated species as well as pelagics such as Istiophoriformes with bycatch of juvenile sharks occurring more frequently than for shore-based fisheries. Rules prohibit the landing of any sharks and rays, and all sharks caught are to be released alive. Further, there is no evidence that sharks and rays are landed illegally on Diego Garcia. Data on recreational fisheries effort and landings are incomplete with shore-based fisheries unmonitored and no data on bycatch of sharks and rays available.

Gear

Data from enforcement of the MPA suggest that vessels fishing illegally in the Chagos Archipelago typically use both longlines and gillnets with 76% of vessels recorded as multi-gear (typically longline and gillnets in combination), 7% as using longlines only and 17% with gillnets only, in the period from MPA implementation (April 2010) to April 2023. Almost all (98%) of the vessels that had sharks and rays in their catch had a combination of gears onboard.

Low resolution in data on catches of illegal vessels and lack of data on fishing effort of illegal vessels means that ascertaining catch rate by gear type is not possible (Collins et al., 2021),

PRODUCTION

Overall landings

In the absence of any official landings data for sharks and rays from the Chagos Archipelago, data from enforcement of the MPA is included here. These data primarily originate from vessels suspected of illegal activity that have been intercepted and escorted to the inhabited island of Diego Garcia where their catches are unloaded and sampled. From 2010–2020, catch data were available for only 61 vessels apprehended, primarily due to enforcement strategies and resource constraints. In addition, recording format varied and catch was recorded using either specimen number or specimen weight and, in some cases, either a mix of the two or both were used. The number of sharks was most consistently recorded, therefore, to estimate total shark take, estimates for numbers of sharks were calculated for each vessel based on average weight of sharks for all vessels where weight data was present (Collins et al., 2021). Average number of recorded sharks per vessel according to flag country was then used to estimate the likely total take for all illegal vessels since April 2010.

Overall, 6,655 sharks were estimated to have been taken by vessels from which there were catch data between 2010–2020, averaging 109±132 sharks per vessel. Estimates suggest that Indian vessels have on average 62±96 sharks onboard compared to 129±140 sharks in Sri Lankan vessels. Overall, it is estimated that the 111 Sri Lankan and 102 Indian vessels are suspected of illegal activity and may have had 14,319 and 6,324 sharks onboard overall, respectively. Extrapolated data suggest that 480 kg of mobulid rays (*Mobula* spp.) have been found onboard vessels from implementing the MPA in 2010–2020 (Collins et al., 2021). Although gill plates (sieve-like structures used to filter their zooplankton prey from the ocean) have been found on vessels, and it is unlikely that the rays they were collected from were discarded (due to the high value of their meat), these were not included in catch data (Collins et al., 2021).

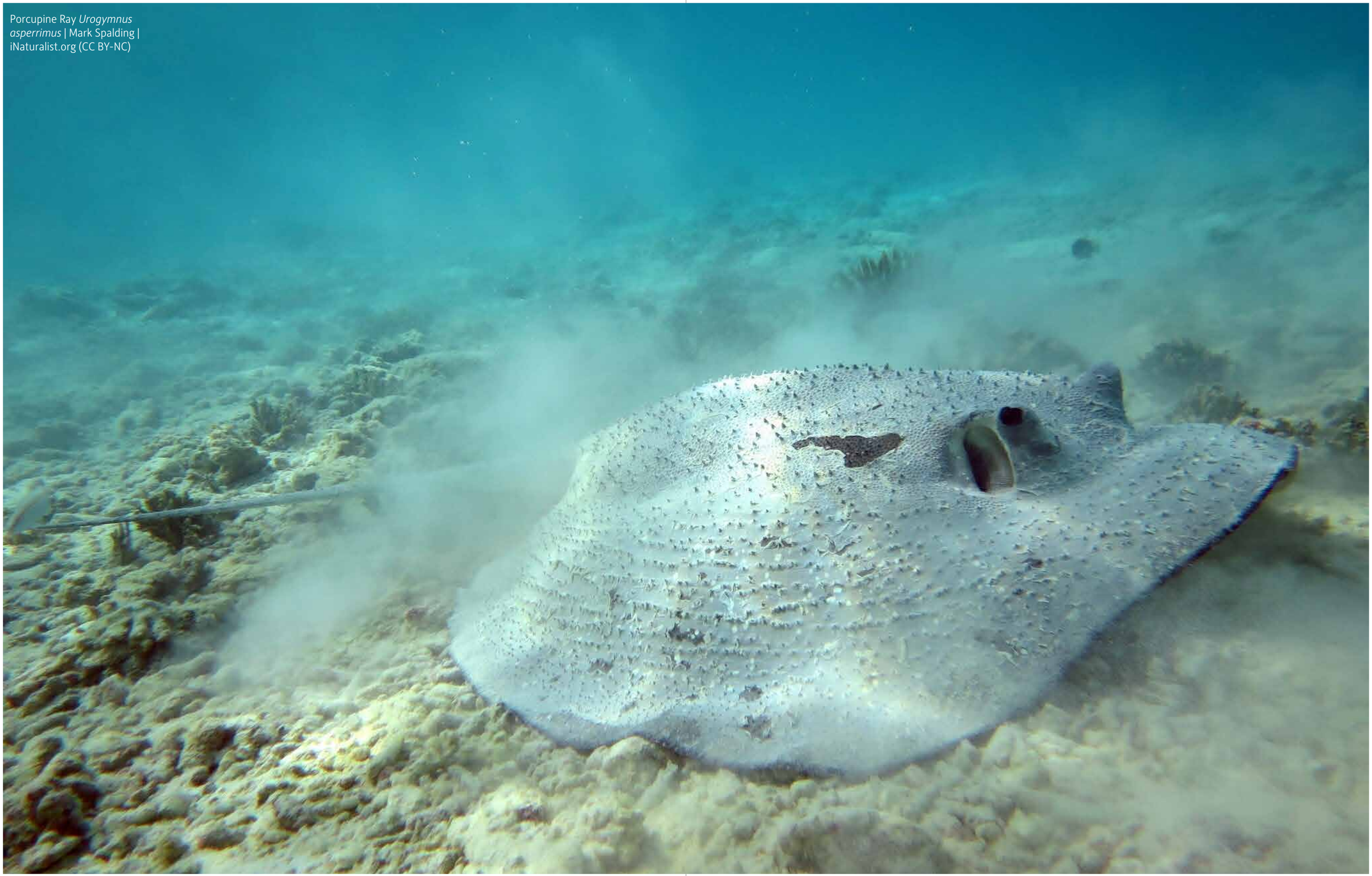
Importantly, these data represent a small proportion of vessels suspected of illegal activity (30%), and it is highly likely that a substantial proportion of illegal activity has gone undetected or unsanctioned due to issues relating to enforcement of such a large MPA with limited resources for determining legality of activity. The total number of sharks extracted annually by illegal vessels has been predicted for 2010–2020 by multiplying the number of boats arrested each year by ten, based on previous analysis of the success rate of the patrol vessel used for enforcement (Price et al., 2010; Ferretti et al., 2018). Thus, between 1996–2015, an estimated 20–120 boats fished illegally in Chagos MPA each year and estimated annual catches for all species of sharks ranged from 1,745–23,195 individuals (Ferretti et al., 2018). For 2010–2020, based on the number of Sri Lankan (two to 14) and Indian (zero to 66) vessels detected per annum multiplied by ten, annual shark take is estimated between 4,040–53,520 sharks, averaging 15,617±12,427 sharks per annum.

No data on bycatch of sharks and rays by recreational fisheries are available although observations suggest that mortality rate is low due to short soak times for fishing gear.

Species-specific

Taxonomic identification of illegal catches is not always possible, and catch has been reported to different phylogenetic levels. Catch data from enforcement suggest that vessels fishing illegally in the MPA were doing so in different habitats, with reef-associated and pelagic species both recorded in catches. The following sharks and rays have been recorded as being caught by vessels illegally fishing in the MPA: Blacktip Reef Shark (*Carcharhinus melanopterus*), Blacktip Shark (*Carcharhinus limbatus*), Whitetip Reef Shark (*Triaenodon obesus*), Silvertip Shark (Carcharhinus *albimarginatus*), Sandbar Shark (*Carcharhinus plumbeus*), Blue Shark (*Prionace glauca*), Bull Shark (*Carcharhinus leucas*), Copper Shark (*Carcharhinus brachyurus*), Grey Reef Shark (*Carcharhinus amblyrhynchos*), Oceanic Whitetip Shark (*Carcharhinus longimanus*), Silky Shark (*Carcharhinus falciformis*), Spinner Shark (*Carcharhinus brevipinna*), Tiger Shark (*Galeocerdo cuvier*), Scalloped Hammerhead (*Sphyrna lewini*), Smooth Hammerhead (*Sphyrna zygaena*), Longfin Mako (*Isurus paucus*), Shortfin Mako (*Isurus oxyrinchus*), thresher sharks (Alopiidae), and Whitespotted Wedgefish (*Rhynchobatus djiddensis*). A review of photographic evidence collected during boarding of illegal vessels has revealed catches have also included Bentfin Devil Ray (*Mobula thurstoni*), Sicklefin Devil Ray (*Mobula tarapacana*), and Spinetail Devil Ray (*Mobula mobular*; Harris et al., 2024a), all of which are listed as Endangered on the IUCN Red List of Threatened Species (IUCN, 2024). Furthermore, there were images of several Mobulidae gill plates which have not been identified to species level.

Previous analysis of enforcement data identified that Grey Reef Shark and Silvertip Shark were the most caught species by vessels; an estimated 402–5,241 Silvertip Shark and 369–4,471 Grey Reef Shark were taken per year (Ferretti et al., 2018).



Porcupine Ray *Urogymnus asperrimus* | Mark Spalding | iNaturalist.org (CC BY-NC)

TRADE

Processing

No trade of sharks and rays has been documented across the Chagos Archipelago as there was no human resident population or landing sites at the time of writing. Instead, illegal vessels primarily land to the south coast of India (Kerala or Tamil Nadu state) or south and west coasts of Sri Lanka (Collins et al., 2021). In both areas, there is strong domestic demand for shark meat which is primarily sold dried (Herath et al., 2019; Peiris et al., 2021). Export of shark fins is an important contributor to livelihoods in both India and Sri Lanka, despite being banned in India. The demand for mobulid products has increased dramatically in recent years, and Sri Lanka and India are known to be amongst the top catching nations globally (Heinrichs et al., 2011). *Mobula* meat is consumed in both India and Sri Lanka and all species are exploited for their cartilaginous gill plates (O'Malley et al., 2017). *Mobula* gill plates are typically dried and sold in China and Southeast Asia, where they are marketed for purported medicinal properties, claimed to treat a wide range of health issues ranging from acne to cancer, and can fetch over USD 400 (O'Malley et al., 2017).

Domestic

Officially, no sharks or rays are processed domestically within the Chagos Archipelago. However, it is likely that some animals are processed whilst onboard vessels fishing illegally within the MPA. Both shark fins and gill plates, that have been separated and sun-dried have been found onboard vessels in the MPA, with 139 shark fins found onboard a Sri Lankan vessel in 2020. Full searches of vessels are often not possible as only some vessels have their catch confiscated and sampled so determining presence and abundance of processed shark and ray products is often constrained.

Export

No sharks and rays are landed around the Chagos Archipelago and no import or export data are recorded as all exploitation is illegal.

CULTURAL SIGNIFICANCE

As of 2023, there is no residential population around the Chagos Archipelago and there are very little data on the historical significance of sharks and rays.

RESEARCH

Research on sharks and rays across the Chagos Archipelago has been conducted via numerous academic and research organisations globally. Much of this recent research has been conducted via the Bertarelli Programme in Marine Science which is a multi-organisational initiative. Other research includes tagging of Silky Shark (Carlisle et al., 2019; Curnick et al., 2020), Silvertip Shark (e.g., Tickler et al., 2023), Reef Manta Ray (e.g., Harris, 2019; Harris et al., 2021), and reef-associated sharks (e.g., Jacoby et al., 2020); stable isotope analysis for reef associated shark species (e.g., Curnick et al., 2019) and Reef Manta Ray (e.g., Harris et al., 2023); baited remote underwater video systems (BRUV; e.g., Ticker et al., 2017, Letessier al., 2019; Letessier al., 2024); environmental DNA (e.g., Dunn et al., 2020, 2023); and drones (Schiele et al., 2023).

MANAGEMENT

Governance framework

Currently, conservation and management of sharks and rays is enforced through the British Indian Ocean Territory Administration (BIOTA) which is delivered by Marine Resources Assessment Group (MRAG) Ltd., a consultancy that oversees enforcing fisheries ordinance and patrolling and enforcing the MPA. The fisheries (conservation and management) ordinance 2007, amended in 2013, prohibits any fishing in the MPA outside of the 3-nm zone around Diego Garcia. However, in October 2024, the UK and Mauritian governments issued a joint statement confirming that the UK recognises Mauritius's sovereignty over the Chagos Archipelago (FCDO, 2024). This agreement marks a shift in the region's governance, with both nations committed to jointly protecting the environment and combating illegal fishing. There is a stated commitment to a continued level of protection from the Mauritian government but a treaty and the laws that underpin it are still to be written and ratified. A key part of this effort will be the creation of a Mauritian Marine Protected Area to safeguard one of the world's most important marine ecosystems. At the time of writing, no further details are available.

Policy

BIOTA currently complies with all Conservation and Management Measures of the Indian Ocean Tuna Commission (IOTC).

Enforcement and monitoring

As of October 2024, all enforcement and monitoring outside of the 3-nm zone around Diego Garcia are carried out by MRAG Ltd. on behalf of the BIOTA.

Community involvement

There is a lack of community involvement due to the absence of a residential population. However, members of the military community and contractors on Diego Garcia have been previously engaged in shark and ray research.

Gaps

There are significant gaps in the data collected from enforcement of Chagos Archipelago, particularly on catch composition, gear types, and boat and crew data. Identified knowledge and research gaps focus on understanding the amount and diversity of sharks and rays taken in illegal fisheries as well as understanding the value of the MPA for both resident and migratory populations. Filling these gaps should be a priority to understand diversity and abundance of sharks and rays within the Chagos MPA. In addition, there are gaps in understanding the awareness and deterrence effect of MPA management and policy on illegal fishing for both Sri Lankan and Indian vessels.

RECOMMENDATIONS

Identified priorities for research are establishing the impact of changes in illegal fishing pressure on shark and ray populations as well as better monitoring of the level and nature of illegal fishing. To address illegal fishing, assessing the deterrence effect of current policy and management should also be prioritised.

Policy

To address gaps in knowledge of fishing pressure on sharks and rays, there should be an increase in resources and personnel capacity around sampling and documenting catches of illegal vessels. Updating data-sharing policies to allow for wider analysis of data from enforcement may improve understanding and could facilitate the use of data platforms, such as Spatial Monitoring and Reporting Tools (SMART), to improve management of the Chagos Archipelago.

Science/knowledge/research

The impact of the illegal fishing pressure on shark and ray communities across the Chagos Archipelago has not been directly assessed. A recent eDNA study suggests that reef shark numbers are significantly lower compared to the better protected Diego Garcia (Dunn et al., 2023). Quantifying the impact of the illegal fishing in the northern atolls on shark and ray abundance, diversity, and function should be a research priority and be used to inform management and enforcement. As of 2023, this is being conducted via baited underwater camera surveys, as part of the UK's Blue Belt Programme (Global Ocean Wildlife Analysis Network). Continuing this work over a longer period will allow for monitoring of the impact of changing fishing pressure on shark and ray populations.

To understand more about the efficacy of MPA management and policy, data from the patrol vessel including spatiotemporal movement and number of detections should be analysed. Understanding could be further enhanced through use of remote sensing data such as Synthetic Aperture Radar and other satellite imagery as well as data from fisher communities in India and Sri Lanka.

Management/governance/conservation

In October 2024, the UK and Mauritian governments released a joint statement confirming that the UK would hand sovereignty of the Chagos Archipelago back to Mauritius. As such, the management and governance of the archipelago is subject to considerable change over the coming years. Given the clear ecological significance of the area, it is important to ensure that the management and enforcement of the area is continued and improved upon, with the effective conservation and management of its vital elasmobranch populations as a key management objective. MPA management and enforcement in Chagos involves collaboration across multiple partners, that include UK governmental departments, the Mauritian government, consultancies, and NGOs. This is subject to change given the aforementioned sovereignty discussions, but effective coordination across these stakeholders would be markedly improved by having a central node of contact.

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Reef Manta Ray *Mobula alfredi* | Simon Hilbourne | The Manta Trust

DJIBOUTI

DJIBOUTI

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INTRODUCTION

Djibouti is a small country located in the horn of Africa, whose coast lies on the Gulf of Aden, and is bordered by Eritrea to the northwest, Ethiopia to the southwest, and Somalia to the south. It has a coastline of 314 km and an Exclusive Economic Zone (EEZ) of 7,190 km².

In 2023, the Gulf of Tadjoura was designated as an Important Shark and Ray Area (ISRA) due to its diverse habitat (such as coral reefs, mangroves, and sea grass) that supports sharks and rays during feeding and reproduction (Robinson et al., 2023). The Gulf of Tadjoura, serves as a priority area for juvenile male Whale Shark (*Rhincodon typus*), considering that it is a place with high, and seasonal, food availability (Rowat et al., 2007; Boldrocchi & Bettinetti, 2019a; Boldrocchi et al., 2020; IUCN 2022; Robinson et al., 2023). There are upwellings after the southwestern monsoon season (from July–September), that provide rich nutrients (Rowat et al., 2007; Boldrocchi & Bettinetti, 2019; Boldrocchi et al., 2020; IUCN 2022). This causes a bloom of zooplankton to arise during October–February, with Whale Shark and manta rays (Mobulidae) aggregating along Djibouti's coastline during that period (Rowat et al., 2007; Boldrocchi & Bettinetti, 2019; Boldrocchi et al., 2020; IUCN 2022; FAO, 2023). Furthermore, the Gulf of Tadjoura is known as a reproductive area for Scalloped Hammerhead (*Sphyrna lewini*), and there have been undefined aggregations of Bowmouth Guitarfish (*Rhina anclystomus*; Robinson et al., 2023).

The Gulf of Aden possibly serves as a nursery area, as it is known that newborn and young-of-the-year (YOY) Blacktip Shark (*Carcharhinus limbatus*) and juvenile Scalloped Hammerhead are present (Bonfil, 2003). There is no information on chimaeras within Djibouti's waters.

FISHERIES

Fleets

An estimated 300 boats were used in artisanal fisheries in 2016 (FAO, 2023). Of these, 60% are 7–9 m long wooden boats with 45-horsepower (hp) outboard engines (FAO, 2023). The remaining 40% are 9–14 m long boats equipped with inboard engines, and fibreglass boats fitted with 25–40 hp outboard engines (FAO, 2023). There are no industrial fleets operating in Djibouti.

Gear

The fishing gear used in Djibouti consists of spears, traps, long-lines, hand lines, gill nets, trammel nets, tangle nets, cast nets, and set nets (FAO, 2023). Sharks are specifically captured (targeted and incidentally) in gillnets and longlines (Bonfil, 2003; FAO, 2023). While Whale Shark are not targeted, they are commonly seen with scars, likely due to interactions with boats or propellers (Rowat et al., 2007). There is limited information available on gears used to catch rays but it is likely that they are also incidentally captured in gillnets targeting mackerel.

PRODUCTION

Overall landings

Djibouti has targeted shark fisheries, and all incidentally caught sharks are retained and landed. However, limited data were available prior to 2010. Since then, there has been a fluctuating trend of shark captures reported to the Food and Agriculture Organization of the United Nations (FAO). Based on FAO data, a total of 164.3 metric tonnes (mt; live weight) of sharks were landed in 2020, compared to 92 and 47 mt recorded in 2015 and 2010, respectively (FAO, 2022). Furthermore, in 2020, sharks and rays made up 7.07% of total fish catches in the country (FAO, 2022).

Species-specific

Scalloped Hammerhead and Milk Shark (*Rhizoprionodon acutus*) are especially valuable targets for artisanal fisheries as they are either consumed locally or exported (Boldrocchi et al., 2019). Grey Reef Shark (*Carcharhinus amblyrhynchos*), Bull Shark (*C. leucas*), and Blacktip Shark are also frequently targeted primarily for their fins (Bonfil, 2003).

There are several species of sharks that are incidentally caught in fisheries targeting other species such as mackerel. This includes Blacktip Shark, Blacktip Reef Shark (*Carcharhinus melanopterus*), Spottail Shark (*C. sorrah*), and Scalloped Hammerhead (Bonfil, 2003). In 2003, 1 mt of Blacktip and Spottail Shark were landed and shipped from Mokha; while 10 mt were observed in an eastern processing plant (Bonfil, 2003).

Data on ray landings are often unreported, however, they are frequently landed along the coast of Djibouti (R.W. Jabado, personal communications, 2023).

TRADE

Processing

Shark fisheries in Djibouti are important for subsistence as a source of food during certain seasons and for income (Jabado & Spaet, 2017). Sharks have their fins removed, dried, and exported to east Asian markets, and their carcasses were frequently discarded in the past (Sachithananthan, 1983; Bonfil, 2003; FAO, 2023). However, shark meat is also either sold fresh at local markets or as dried/ frozen/ salted/ smoked fillets then exported, albeit to a lesser degree than fins (Sachithananthan, 1983; Jabado & Spaet, 2017). Occasionally shark teeth are sold as jewellery (Jabado & Spaet, 2017).

Domestic

Locally, sharks are sold for direct consumption, especially between December and January when other fish species landings are low (Sachithananthan, 1983; Colléter et al., 2015). Shark dishes are also served in certain hotels and Chinese restaurants (Jabado & Spaet, 2017). In 2018, a reported 97 mt of sharks were sold for consumption (Colléter et al., 2015). Less information is available on the quantities of rays landed and consumed but they are often also recorded at landing sites (R.W. Jabado, personal communications, 2023).

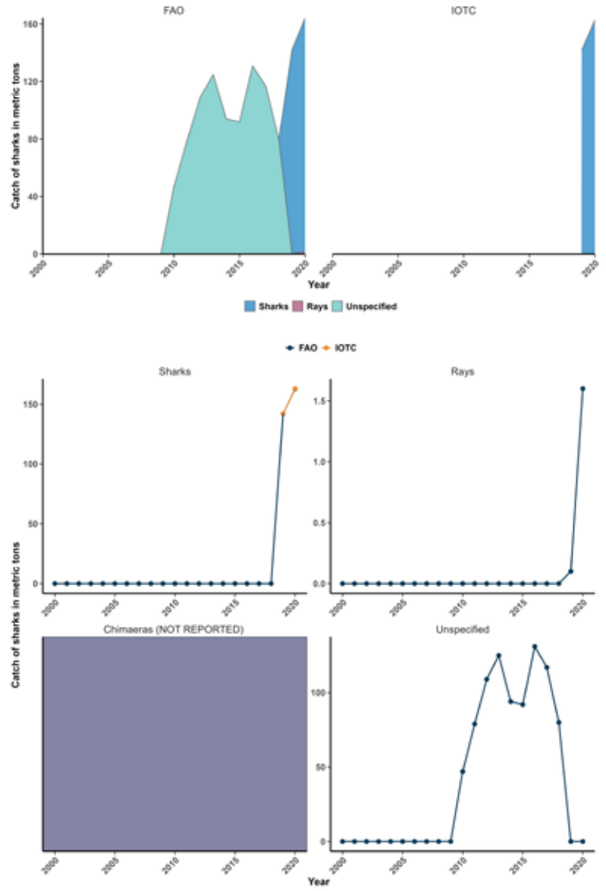
Export

Shark fins are exported to the Gulf States and east Asia markets, but primarily to Yemen and Somalia by fishers (Bonfil, 2003; Colléter et al., 2015). The value of sharks currently is unknown, but during the 1980's shark purchase price was DJF 100 (then ~USD 0.56/kg), and their fillets DJF 500/kg (then ~USD 2.83/ kg), at the time a low market value (Sachithananthan, 1983).

CULTURAL SIGNIFICANCE

Information on the cultural significance of sharks, rays, and chimaeras in Djibouti is unavailable.

Djibouti's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



RESEARCH

- The Institut Supérieur d'Etudes et de Recherche Scientifiques et Techniques (ISERST; Higher Institute for Scientific and Technical Studies and Research) conducts fisheries research in Djibouti.
- Primature, Service de l'AmÈnagement et de l'Environnement (SAE; Service for Management and Environment) is responsible for environmental conservation.

MANAGEMENT

Governance framework

Regulation of fisheries and related topics fall under the jurisdiction of the Directorate of Fisheries within the Ministry of Agriculture, Livestock and the Sea.

Policy

Decree No. 2004-0065 /PR / MHUEAT Wearing protection of biodiversity is the primary law dedicated to species conservation, including measures for manta rays, Spinner Shark (*Carcharhinus brevipinna*; originally listed as 'Grey' or 'Gray' Shark), and Whale Shark (Ministry of Agriculture Livestock & the Sea 2007; Djibril, 2015). This law prohibits the hunting, capturing, trading, exporting, and importing of these species and their products (Ministry of Agriculture Livestock & the Sea 2007; Djibril, 2015).

There are several articles decreed in Djibouti's fishing code that apply to fishing vessels and gear, such as Article 6: "The characteristics of gillnets, drifting, rotating, sliding nets and traps will be defined by regulation" , and Article 7 which prohibits the use of trawling, except for scientific purposes (Ministry of Agriculture Livestock & the Sea 2007). While spearfishing is banned, it is known to still be practised illegally. Vessels for commercial fishing must be registered in Djibouti or by Djiboutian nationals. Other relevant measures implemented include closed seasons and fishing zones, catch limits, and prohibition of harmful fishing devices and techniques (Ministry of Agriculture Livestock & the Sea 2007).

Furthermore, Djibouti has prepared national fisheries-specific management plans to regulate fisheries resources although their impact on shark and ray conservation has not been assessed (Jabado & Spaet, 2017).

Enforcement and monitoring

There is a need to improve data collection of sharks and rays being landed as well as support for the implementation of species listings on international conventions such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Training courses on shark identification have been provided to various agencies across the Gulf of Aden in the past (Bonfil, 2003) but need to be kept up to date.

Community involvement

There is no information available on community involvement. Although the few dive centres operating from Djibouti tend to collect some data on aggregations of Whale Shark or records of other species such as the Bowmouth Guitarfish (Bolrocchi et al., 2023).

Small scale fishing boats in Djibouti | Rima W. Jabado

Small scale fisher with shark catch in the Gulf of Tadjoura, Djibouti | Rima W. Jabado

Fishing harbour in Djibouti | Rima W. Jabado

Gaps

- Limited enforcement measures in place to regulate illegal, unreported, and unregulated (IUU) fishing;
- Lack of available data on shark, ray, and chimaera landings; and
- Specimens caught are identified to a high taxonomic level, e.g. 'Sharks, rays, skates, etc. nei [not elsewhere included]', 'Rays, stingrays, mantas nei', and 'Requiem sharks nei' (FAO, 2022).

RECOMMENDATIONS

There are few actions taken towards controlling IUU fishing, despite it being known that species such as sharks are heavily fished illegally, often have carcasses discarded, and no monitoring system exists (FAO, 2023).

While there is information available on important shark nursery areas in Djibouti (e.g., one ISRA was delineated for the Gulf of Tadjoura in 2023; Robinson et al., 2023), there are no actions in place to protect species. It is known that fishers exploit large numbers of newborns and juvenile sharks, especially Spottail and Blacktip Sharks (Bonfil, 2003).

Policy

There is a need to develop legislations specific to sharks, rays, and chimaeras.

Science/knowledge/research

It is urgent to work towards improving monitoring efforts and providing training in shark and ray identification.

Management/governance/conservation

The Gulf of Aden serves as a high priority area for several species, notably requiem sharks (Carcharhinidae), Whale Sharks, and manta and devil rays; there are even potential nurseries existing within Djibouti's waters (Bonfil, 2003). Yet there is limited action taken towards protecting those areas; it would be ideal to identify where these high-impact areas are and prioritise protecting those areas.

Additionally, there is no enforcement of fisheries regulations or efforts to control IUU fishing. A monitoring system needs to be implemented to support shark, ray, and chimaera conservation.

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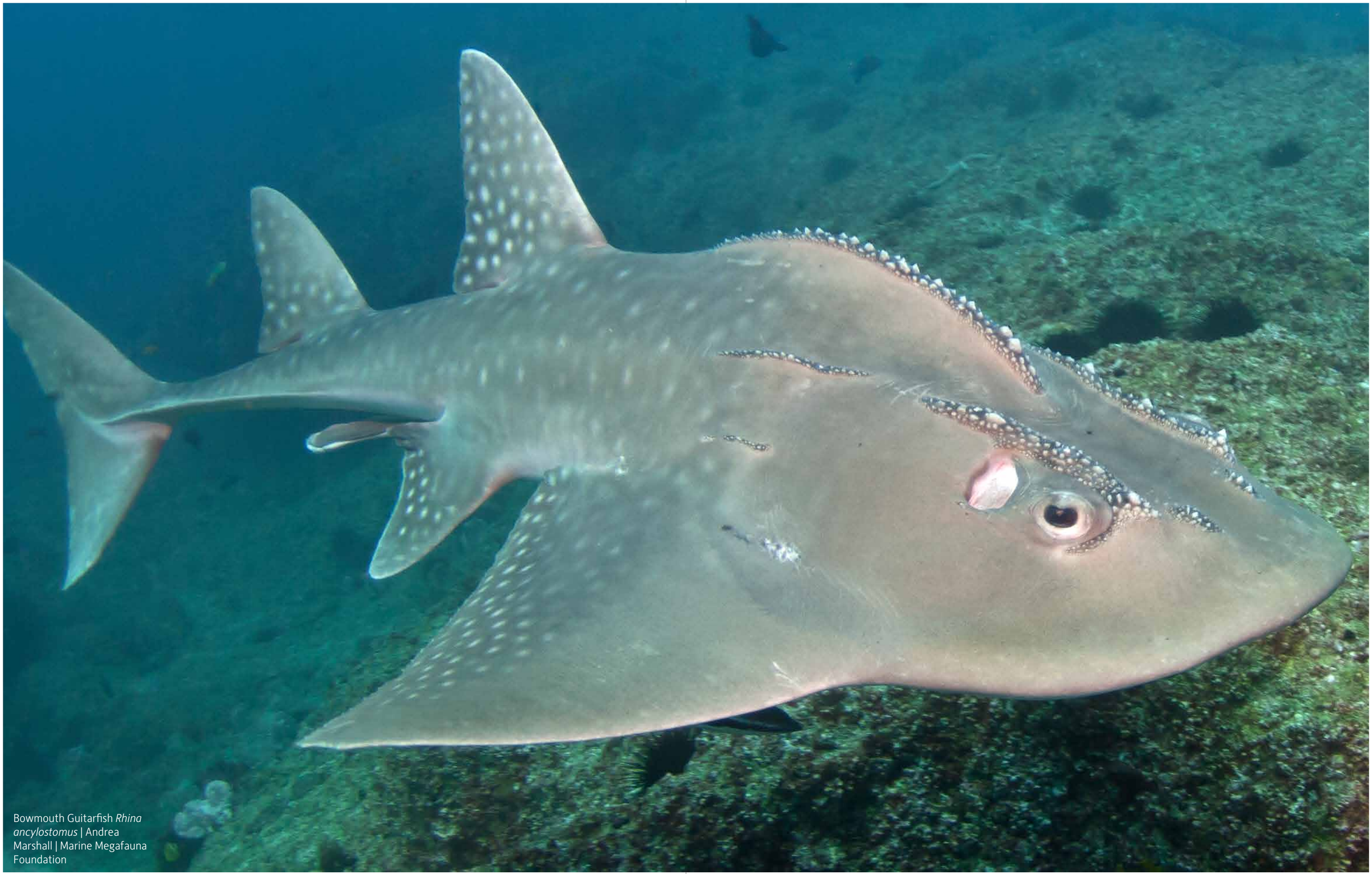

Bowmouth Guitarfish *Rhina ancylostomus* | Andrea Marshall | Marine Megafauna Foundation

EGYPT

EGYPT

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INTRODUCTION

Egypt's Exclusive Economic Zone (EEZ) is 263,451 km² and is split between the Red Sea and Mediterranean Sea. The Mediterranean Sea coast covers ~950 km in length from Rafah in the east to Sallum in the west, while the Red Sea coast extends over ~1,500 km of coastline and includes the Gulfs of Suez and Aqaba and the intervening Sinai Peninsula (Bird, 2010). The Red Sea harbors extensive and diverse coral reef ecosystems with the total area of coral reef flats estimated at 1,760 km² (Attalla, 2012).

Egyptian Red Sea reefs are home to around 1,000 species of fishes and 365 species of scleractinian corals, of which 14% and 5.5% are endemic, respectively (DiBattista et al., 2016). Red Sea tourism is a major sector of Egypt's tourism economy. However, exact estimates are difficult to access, especially given wide fluctuations in overall tourism income due to global and political events. Extensive mangrove ecosystems exist within the Nabq Protected Area (~600 km²) along Egypt's Gulf of Aqaba coast .

There are also several brackish coastal and inland lakes that are important for fisheries and aquaculture. Information on these smaller water bodies is summarized in Samy-Kamal (2015). There are no reports of sharks and rays in Egypt's freshwater ecosystems.

FISHERIES

Fleets

Prior to 2011, there were 6,480 fishing boats registered and operating in the Mediterranean Sea and Red Sea. Of these, 4,089 were equipped with inboard engines, with more than 50 up to 1,000 horsepower (hp; CIHEAM - MAIB, 2011). In 2008, more than 4,500 vessels using a variety of gear operated in the Mediterranean Sea with an average crew size of two to three individuals, of which 1,379 were small-scale sailboats, 1,095 trawlers (average crew size of six to eight individuals), 1,267 pelagic longliners (for tuna and Swordfish, *Xiphias gladius*), 529 trammel nets, and 238 purse seiners (average crew size of 17–23 people; CIHEAM – MAIB, 2011).

In 2019, there was a total of 1,512 fishing vessels along the Egyptian Red Sea coast, of which 1,447 were motorised and 65 non-motorised (CAPMAS, 2020). Of these motorised vessels, it included 119 trawlers (200–800 hp), 122 purse seiners (150–800 hp), 925 longliners (10–250 hp), 246 using trammel nets (10–188 hp), and 35 Karkaba and crab nets (20–50 hp; GAFRD, 2020). However, a single vessel may operate multiple gear types.

Gear

Egyptian Mediterranean fisheries consist predominantly of trawlers, but fishing gears also include longlines, purse seines, and multi-species/multi/gear traditional fisheries (Khalfallah et al., 2023). One major fishery is also the sardine (*Sardinella* spp.) fishery that deploys trammel nets, gillnets, throw nets, and longlines.

The main fishing gears deployed in the Red Sea are bottom trawl and purse seine nets in industrial fisheries, and handlines, longlines, and gillnets in artisanal fisheries. Traditional subsistence fisheries use a variety of gears (Tesfamichael & Mehanna, 2012). Industrial fisheries operate mainly in the Gulf of Suez and its adjacent areas, as well as in Foul Bay, bordering Sudan (Tesfamichael & Mehanna, 2012). Semi-industrial fisheries operate around Ataka, Salakhana, Sakkala, and El-Tor. In Foul Bay, boats may operate several different gear types interchangeably, e.g., the same boat can be involved in trawling, purse seining, and handlining (Sanders et al., 1984).

Most sharks and rays are landed by longline, bottom trawl, small-scale gillnets, mostly as incidental catch (e.g., Mediterranean Sea; Farrag, 2016; Ragheb & Hassan 2021; Farrg et al., 2019; Farrag, 2022).

PRODUCTION

Overall landings

Between 1975–2019, it was estimated that 3,066 metric tonnes (mt) of sharks and rays were caught by the total fleet, of which the greatest contribution was from small-scale gillnets (1,228 mt), closely followed by bottom trawls (1,225 mt), and purse seines (612.5 mt).

Overall reported landings of shark and ray species were estimated at 2,338 mt in 2012 and 1,050 mt in 2021 along the Mediterranean coast (LFRPDA, 2022). In the Red Sea, reported catches were 1 mt in 2018, 2 mt in 2020, and 3 mt in 2021, despite the shark fishing ban (CAPMAS, 2020; FAO, 2022; LFRPDA, 2022). The catch variations between the Red and Mediterranean Seas are due differences in fisheries operations (LFRPDA, 2022).

Species-specific

Information on catches is not available at the species-level.

TRADE

Processing

Sharks, rays, and their products are not known to be processed as they are generally not offered for sale. In the case of sharks, this is due to the ban on fishing and selling, as well as trading whole specimens. Most fish landed is channelled directly through auction and wholesale markets with a very small fraction sold directly to consumers or fishmongers (Khalfallah et al., 2023).

Domestic

There is no information on domestic consumption patterns as sharks, rays, and derivative products are generally not offered for sale.

Export

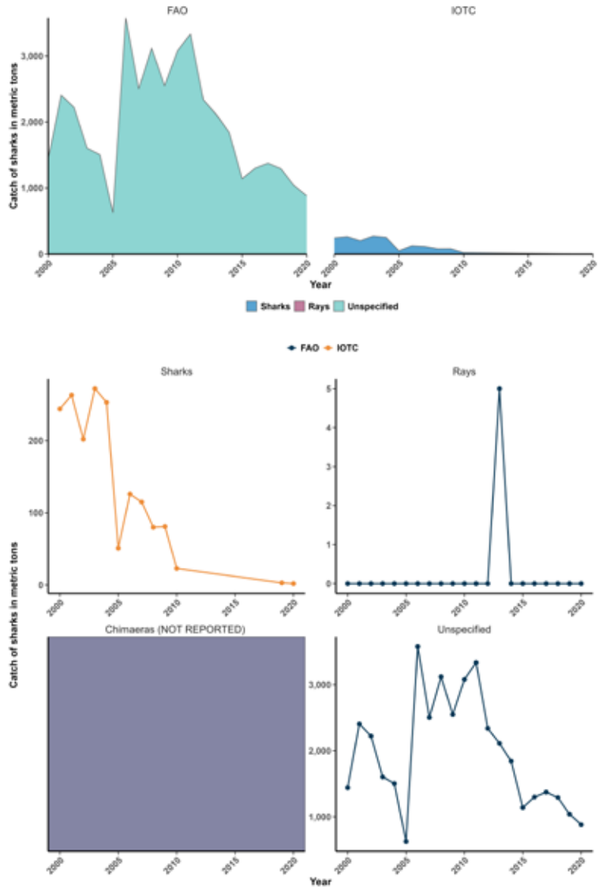
Egypt does not export large quantities of seafood, with most catches consumed within the country. Seafood is also imported from other countries. Overall, imports of fish products exceeding 40,000 mt have been reported from Yemen and other countries in the region (De Young, 2006; Alabsi & Komatsu, 2014). Furthermore, selling and trading of whole sharks is prohibited (see 'Policy' section).

CULTURAL SIGNIFICANCE

Public perceptions and beliefs about sharks in Egypt are heavily influenced by regional media, which are often inaccurate and highly sensationalised. Most articles, videos, and television programmes covering sharks only do so in response to a 'shark attack' and do very little, if anything, to present basic scientific facts about shark behaviour or to correct public perceptions of sharks as dangerous creatures.

Fishing communities tend to regard sharks (and the ocean in general) with respect and fear. Some fishers seem to have a rudimentary, intuitive understanding of sharks as being important in the marine food web, while others believe that sharks compete with them over fish and decrease their fishing yields. However, it is difficult to assess how widespread these beliefs are without carrying out socioeconomic surveys.

Egypt's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



RESEARCH

In 2012, the Red Sea Shark Trust was established. The general aim of this institution is to collect information for the conservation and protection of sharks in the Egyptian Red Sea. Ongoing research projects include monitoring programmes and photo-identification for Oceanic Whitetip Shark (*Carcharhinus longimanus*), Grey Reef Shark (*C. amblyrhynchos*), and Silky Shark (*C. falciformis*), as well as the collection of species-specific sighting data by dive guides.

In 2021, as part of the Mainstreaming Biodiversity in Egypt's Tourism project, a large-scale satellite tagging project targeted at Oceanic Whitetip Shark, Tiger Shark (*Galeocerdo cuvier*), and Shortfin Mako (*Isurus oxyrinchus*) was initiated to better predict future risks of human-shark interactions.

MANAGEMENT

Governance framework

All fisheries in Egypt are managed by the General Authority for Fish Resource Development (GAFRD) under the Ministry of Agriculture and Land Reclamation (MoALR). Enforcement of regulations, collection of data, and training are also among the responsibilities of the authority.

Moreover, the Egyptian Environmental Affairs Agency (EEAA) together with the protectorate sector under the Ministry of the Environment has issued laws for the protection of sharks.

Policy

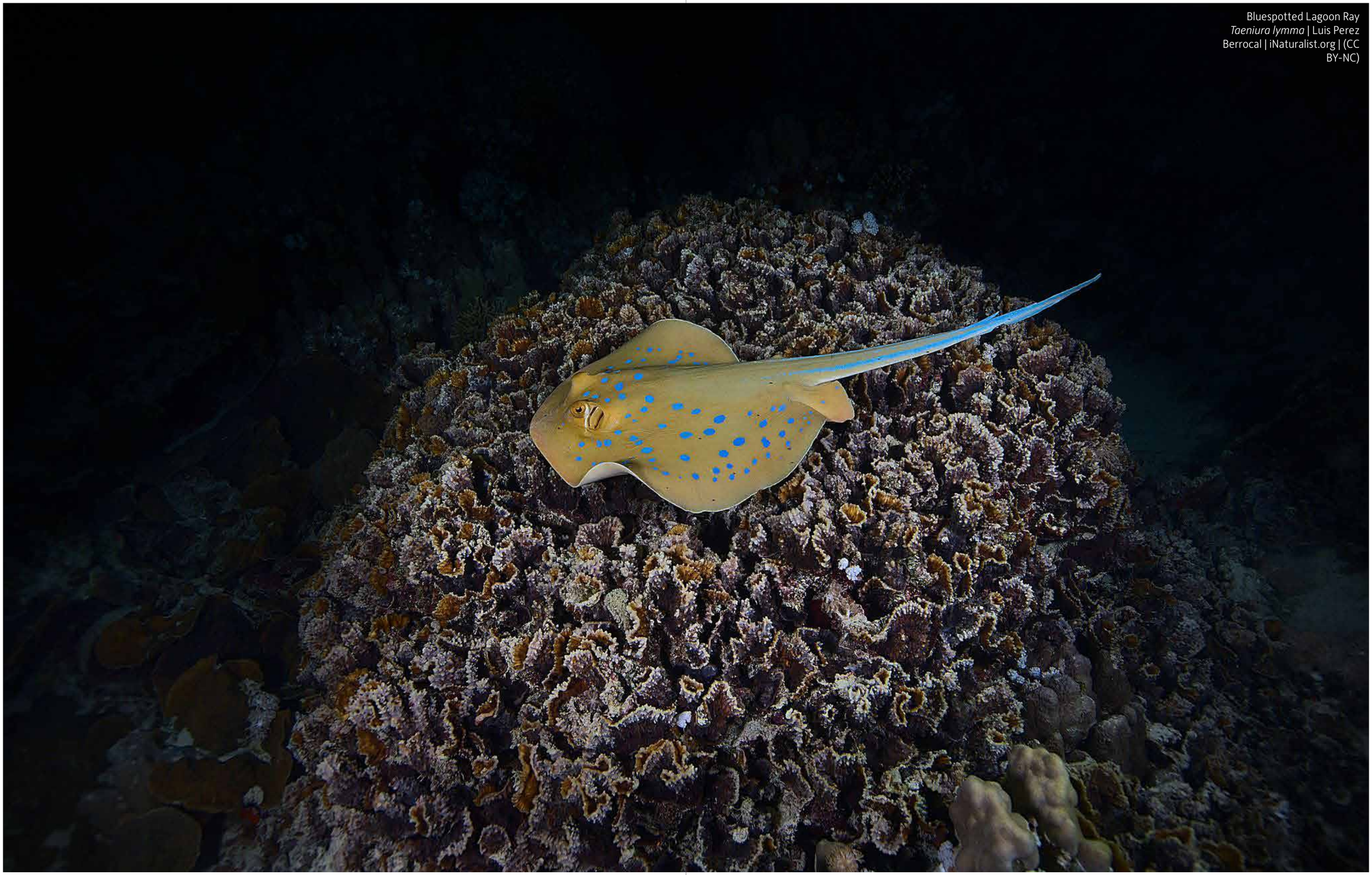
Shark fishing in the Egyptian Red Sea is completely banned. Decree 79 (2004) prohibits displaying, fishing, moving, or trading of sharks. Decree 448 (2005) prohibits the fishing and sale of sharks in the Red Sea. Decree 119 (2009) prohibits selling, fishing, or trading of live or dead whole sharks in all Egyptian waters. This does not include any protection for rays or chimaeras.

Enforcement and monitoring

It is difficult to get an accurate picture of enforcement and monitoring efforts and their effectiveness in Egypt with regards to shark fishing, because both tend to fluctuate widely depending on the country's political and economic circumstances.

Community involvement

Community involvement in shark and ray conservation in the Egyptian Red Sea is relatively high. Active environmental organisations (e.g., the Hurghada Environmental Protection and Conservation Association [HEPCA] and the Red Sea Shark Trust) frequently run outreach programmes and awareness campaigns. These groups also report violations of environmental law, such as 'illegal fishing' or 'sale/possession of endangered species' to the Ministry of Environment. Such activities can also be reported directly by any member of the public through HEPCA's website.



Bluespotted Lagoon Ray
Taeniura lymma | Luis Perez Berrocal | iNaturalist.org | (CC BY-NC)

Gaps

Information on stock status and catch per unit effort (CPUE) data of potentially exploited shark and ray resources and/or detailed data on fishing fleets are largely missing or inaccessible. Moreover, fisheries legislation does not cover Egyptian vessels operating outside Egyptian waters. For example, Egyptian industrial trawlers operate under licences in Yemeni waters and, until 2010, these vessels were licensed to trawl and use purse seine nets in Sudanese waters (Hariri, 2000; IOTC, 2013). In 2002, Eritrea implemented charter agreements allowing trawlers from Egypt to operate in its waters (De Young, 2006). Egypt has also reported illegal fishing activities within their EEZ by Yemeni trawlers (Hariri, 2000; De Young, 2006). Information on these catches is not available and is a major gap in understanding the status of species.

RECOMMENDATIONS

It appears that compliance with the ban on shark fishing in the Red Sea is higher than in the Mediterranean Sea. This may be due to higher community engagement with environmental issues in Red Sea cities and more government attention being focused on the Red Sea as a major attraction for water-based tourism. HEPCA also has a strong presence in the Red Sea Governorate as a force for local environmental justice and nature preservation.

Policy

Legislation on shark fishing in the Egyptian Red Sea is already strong considering the fisheries prohibition. To help monitor the effectiveness of this legislation, better and more stable data collection is necessary (see below).

Science/knowledge/research

To improve understanding of the impact of fisheries on sharks and rays (including bycatch), there should be stock assessments, collection of CPUE data, implementation of a national database of shark and ray sighting data, fisheries-independent monitoring surveys, and research on critical habitats (e.g., nursery areas).

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Fishing boats in Hurghada (Red Sea), Egypt | Rima W. Jabado

Fishing boats in Alexandria's harbour, Egypt | Travel Aficionado | Flickr.com (CC BY-NC 2.0.)

ERITREA

ERITREA

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INTRODUCTION

Eritrea's total coastline is about 3,300 km long, of which 1,350 km lie along the continental shore, and 1,950 km surround over 350 islands. The total area of Eritrea's Exclusive Economic Zone (EEZ) is about 120,000 km². This part of the Red Sea is known for its wide continental shelf, which is dotted by a large number of low-lying coralline islands. Eritrea's continental shelf area is about 56,000 km², which is the largest of all the countries bordering the Red Sea. The Eritrean Red Sea has relatively unexploited fisheries resources.

The relatively extensive continental shelf and coral reefs along the coastline and islands form a compact and complex mix of interlacing ecosystems offering several ecological niches for marine organisms, including many endemic species. The Eritrean Red Sea is characterised by a lesser upwelling phenomenon and lack of permanent streams that flow into the sea. Consequently, the waters are nutrient limited with low primary productivity. However, in the Indian Ocean, water exchange due to the monsoon winds occurs more in the southern part than in the northern region. This phenomenon results in higher nutrient availability, primary productivity, and species abundance in the south. The Eritrean coastal area is best known as a highly favourable ecosystem for the development of fisheries. Essential reef areas, extensive surface, numerous shelters of the Dahlak Archipelago plateau, and aggregates of islands are indicative of a potentially prosperous fishery (Zekaria, 2003; Tesfamichael & Mahmud, 2016). However, shark and ray habitat use in this area is poorly studied and needs further surveys to determine which species of sharks and rays occur in each specific habitat type.

FISHERIES

Fleets

Generally, fishing vessels can be classified as artisanal, semi-industrial, or industrial. Semi-industrial vessels are under 18 m in length overall (LOA), fitted with fixed operating gear, and powered by means of hydraulic, mechanical, or electrical power. If a vessel is over 18 m in LOA, fitted with fixed operating gear, and powered with hydraulic, mechanical or electrical power, it is considered an industrial vessel. Artisanal and semi-industrial fishing vessels are used by locals, while most industrial vessels are foreign licensed, usually from Egypt.

Semi-industrial vessels target both pelagic and coral reef fishes using longlines. Industrial vessels target soft bottom demersal species including lizard fish (Synodontidae), threadfin (Polynemidae), catfish (order Siluriformes), grunts (Haemulidae), shrimp, and cuttlefish (*Sepia* spp.) using bottom trawling.

Industrial fishing vessels are permitted to carry out fishing activities in waters further than 8 nautical miles (nm) from the main coast and 4 nm from the islands in order to protect and conserve sensitive areas and resources such as coral reefs, sponges, and sea grass beds in closer proximity to the shore. Regarding depth, industrial fishing vessels are allowed to fish in depths greater than 30 m for fish and 20 m for shrimp. The fishing season for trawlers is from October–May.

Artisanal boats

The artisanal fishery is conducted by local traditional fishers along the coast in relatively shallow waters. It involves wooden or fibreglass boats with a maximum length of 15–18 m. Artisanal fishers can employ a combination of different gears (e.g., beach seine, gillnet, and hook and line) and can stay at sea over a period of eight to ten days per trip. The majority of artisanal fishers currently operate canoes, *Houris*, and *Sambuks*, defined below:

- Canoes are non-motorised, double-ended small craft with a flat bottom and vertical sides; they are normally paddled by one person for one day of fishing. These are made of wood or fibreglass.
- *Houris* are medium-sized wooden or fibreglass boats with open decks and cut off sterns which enable the use of one or two outboard engines. Their typical size is 15 m in length by 2.5 m wide, usually powered by a 40-hp (horsepower) petrol engine. This fishing operation is usually performed by a crew of four to six people.
- *Sambuks* are larger, traditional, local wooden boats generally decked and equipped with 30-hp inboard diesel engines. The shape of the hull is pointed and high in bow and stern which makes it a good boat for rough weather conditions in the Red Sea. The average dimensions are 15 m by 4 m with a length range from 11–18 m, and crew numbers of 9–15 people. The most commonly used fishing gear and techniques are handlines, gillnets, beach seines, scuba diving and mask diving for sea cucumber, lobster fishing, cast nets and traps to some extent.

Gear

Eritrea's artisanal fishers use a variety of gears such as beach seines, handlines, gillnets, and longlines. The semi-industrial and industrial vessels are equipped with longlines, purse seines, and bottom trawls. In industrial fishing vessels, the authorised fully stretched cod-end mesh size for fish trawl nets is restricted to a minimum of 6 cm. For nets for other purposes, the fully stretched mesh size should be above 10 cm. The authorised fully stretched cod-end mesh size for shrimp trawl nets should be a minimum of 4.5 cm, and for any part of the net the minimum should be above 7 cm. Double netting and double tow fishing is also not allowed.

PRODUCTION

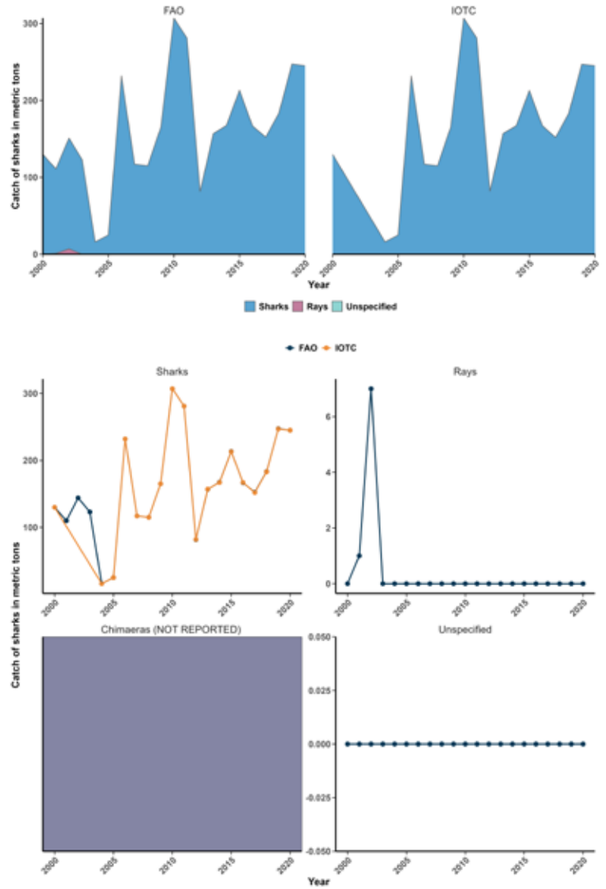
Overall landings

Annual landings of retained sharks recorded by the Ministry of Marine Resource (MMR) indicates that catches of sharks increased from 75.3 metric tonnes (mt) in 2007 to 307.4 mt in 2010, then decreased to 156 mt in 2017. However, the catch increased again to 237.4 mt in 2019. Catches of sharks constitute more than 4% of the total marine fisheries catch. Of the total annual catches of sharks, 66%, 20%, and 14% are contributed by artisanal, industrial, and semi-industrial vessels, respectively (MMR, 2019). Rays are discarded and recorded in a mixed group with other species.

Species-specific

Species-level catch data are not recorded for sharks at landing sites and are, therefore, not available in the official database of the Ministry. However, some surveys with fishers indicated that landings were dominated by certain shark species including Blacktip Shark (*Carcharhinus limbatus*), Silky Shark (*C. falciformis*), Sliteye Shark (*Loxodon macrorhinus*), Scalloped Hammerhead (*Sphyrna lewini*), and Milk Shark (*Rhizoprionodon acutus*). Surveys on trawl vessels conducted from 8–25 May 2022 indicated that the dominant sharks caught were Blacktip Shark (36.0% of total shark catch), Scalloped Hammerhead (30.8%), Milk Shark (15.4%), and Silky Shark (9.4%). During surveys on semi-industrial longliners conducted from 2–12 April 2023, Blacktip Shark (57%), Tiger Shark (*Galeocerdo cuvier*, 15%), Sliteye Shark (9%), and Silky Shark (7%) were the most commonly caught. Another survey on trawl vessels conducted from 31 March to 28 April 2023 recorded Sliteye Shark (40.5%), Silky Shark (33.8%), Milk Shark (11.8%), Scalloped Hammerhead (5.0%), and Blacktip Shark (4.2%) in their catches.

Eritrea's total catch of shark, ray, chimaera, and unspecified species reported to the Food and Agriculture Organization of the United Nations (FAO) and Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



TRADE

Processing

Fresh shark meat is consumed domestically but is not a popular item. Historically, shark flesh was salted and sun dried after gutting and finning, and both dried meat and fins were exported to Aden, Yemen, where they were re-exported to East Asian markets (Tesfamichael & Mahmud, 2012). Rays are usually discarded, thus not commonly consumed.

Domestic

Fresh flesh and salted, sun dried shark meat is locally known as *Lekem*, which is consumed by coastal communities.

CULTURAL SIGNIFICANCE

Fishers traditionally do not discard unwanted catch or carcasses of sharks back into the water because they believe this will contaminate the sea and scare off the fish they target (Tesfamichael & Mohamud, 2012). According to respondents, most fishers (88.3%) said they eat sharks and prefer newborn sharks which are locally known as *Beni*. Generally, fishing communities regard sharks with importance and fear.

RESEARCH

The main institute responsible for shark and ray research is the Marine Resource and Environment Research Division under the Ministry of Marine Resources (MMR). Other relevant colleges include the College of Science in the Eritrean Institute of Technology (EIT). The general aim of this institution, with regards to sharks and rays, is to collect information for the conservation and protection of sharks and their relatives in the Eritrean Red Sea. Ongoing research and other activities related to sharks include species identification, status of sharks, and the preparation of a conservation and management plan.

MANAGEMENT

Governance framework

The MMR, through the Marine Resource Regulatory Service Department, is the primary body responsible for the conservation and management of sharks and rays. Relevant shark catch information is regularly collected and retained in a fisheries statistics office along with information on other fish catches. Sharks caught during trawl fishing are recorded by onboard inspectors of the Ministry of Marine Resources. Rays, however, are discarded but if recorded are mixed with other species.

Policy

The Fisheries Proclamation No. 104/1998 amended as No. 176/2014 of the Ministry of Marine Resources is the base for any marine resource management. Although there are no specific regulations on catch, size or spatial restrictions for shark fishing, the fisheries proclamation prohibits utilisation or collection of threatened marine resources for any reason without the permission of the MMR.

Eritrea acceded to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on 24

October 1994 and entered it into force on 22 January 1995. However, Eritrea has yet to incorporate CITES listings into their legislation. The CITES draft legislation was prepared, although it needs further refinement and preparation of a national species check list and database. In addition, Eritrea is a member of the Convention in Biological Diversity (CBD) and prepares regular national reports. Eritrea has submitted six CBD reports as of 2020.

Enforcement and monitoring

The MMR is responsible for managing and regulating fisheries resources, with the assistance mandated from the Navy. The mandate of the Navy as a stakeholder of the Ministry is patrolling, surveillance, and combating illegal fishing and trade in fishereis products. However, the enforecement of fisheries regulations is undertaken by the Ministry of Marine.

Gaps

The information regarding biology, distribution, abundance, and conservation status of sharks is minimal in Eritrean Red Sea waters. Some species of sharks and rays occurring in Eritrean waters have been identified but many remain to confirmed. Information on fishing effort and catch of potentially exploited sharks is collected and stored in aggregate form rather than at the species level. Rays that are caught are usually discarded, which results in poor information on their catch per unit effort (CPUE). Many species which may have a threatened status are not being studied well or protected by specific laws.

RECOMMENDATIONS

Policy

Development and enforcement of a more appropriate fishing policy, which incorporates concerns and considerations of fisher communities is important for the sustainable exploitation and conservation of sharks and rays in Eritrean waters.

Science/knowledge/research

Dedicated capacity building and research is needed, especially research to provide information on the distribution, abundance, and biology of sharks and rays, to allow protection and conservation efforts to be based on sound science. Funding is also needed for capacity building and conducting research. Overall, collecting catch per unit effort (CPUE) data of sharks and rays, especially at the species-level, would be beneficial to assess their exploitation status. Finally, involving communities and developing strong fishing policies could be key for effective conservation management of these species.

Management/governance/conservation

The awareness of fisher communities and the public of the impact from fishing and exploiting shark and ray resources without a conservation and management plan should be enhanced.

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Left: Tiger Shark *Galeocerdo cuvier* accidentally caught | MMR-Hagos Zerom

Right: Scalloped Hammerhead *Sphyrna lewini* accidentally caught | MMR-Semir Abdelwahab

Local fishing boats in the Bay of Taulud, Twalet, Eritrea | David Stanley | flickr.com (CC BY 2.0.)

Coach Whipray *Himantura uarnak* accidentally caught in Eritrea | MMR- Tesfahiwet Ambasajer

INDIA

INDIA

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INTRODUCTION

India is situated in the continent of Asia and has a coastline of 7,516.6 km. Its Exclusive Economic Zone (EEZ) is ~2 million km² (Department of Fisheries, 2023) in area, of which 1.64 million km² is from mainland India and the Lakshadweep Islands, and 0.6 million km² is Andaman and Nicobar Islands.

India is a major marine fishing nation (ranked 7th globally) with a reported marine production of 3.6 million metric tonnes (mt) in 2020 (FAO, 2024). In 2016, India had a sizeable fishing fleet consisting of 30,772 trawlers, 6,548 gillnetters, 3,396 bagnetters (fixed bag/funnel net), 49 longliners, 943 ring seiners, 1,189 purse seiners, 88 other mechanised (net hauled with winch) vessels, 97,659 multi-gear motorised vessels, and 25,689 multi-gear non-motorised vessels. This totaled 166,333 vessels operating from mainland India, which excludes Lakshadweep and Andaman and Nicobar Islands, based on the Marine Fisheries Census (CMFRI-FSI-DoF, 2020). The marine fisheries sector employs nearly 927,081 active fishers, including 748,479 full time fishers (90% of their time occupied in marine fisheries during the fishable period of a calendar year) operating from around 1,363 landing sites or harbours centres.

Historically, sharks and rays were caught in small-scale and semi-industrial fisheries, both targeted and incidentally captured, and were fully utilised. Estimated shark, ray, and chimaera landings in mainland India during 2023 totalled 32,035 mt, showing an increase from 2020 (25,910 mt) and 2022 (28,474 mt) when there were fewer fishing trips due to the COVID-19 pandemic. Sharks, rays, and chimaeras made up 3.4% of annual fish landings in 1985, <2% in 2005, and <1% of the annual landings in 2020. This peaked during 1997–1998 when there was shark fishing along Indian waters including Whale Shark (*Rhincodon typus*) hunting along the northwest coast, as well as high meat and fin demand from southeast Asian countries (Akhilesh et al., 2023). The east coast of the country accounts for 47% of shark, ray, and chimaera landings and the west coast accounts for 53%. Of India's nine coastal states and two coastal Union Territories (UT), Tamil Nadu state has the highest landings (30%), followed by Gujarat (23%), Kerala, Andhra Pradesh, West Bengal, and Gujarat (9% each; CMFRI, 2024). Overall, 174 species of sharks, rays, and chimaeras have been documented in India, most of which contribute to the nutrition and livelihoods of coastal communities. There are discrepancies between data reported to the Food and Agriculture Organization of the United Nations (FAO), and that of the Central Marine Fisheries Research Institute (CMFRI) on shark, ray, and chimaera landings. These discrepancies are probably due to inter-agency differences in data sources and because CMFRI data exclude information on catches from the Lakshadweep and Andaman and Nicobar Islands.

India's coastline harbours a diverse range of ecosystems, many of which function as important areas for sharks, rays, and chimaeras. India is home to several important mangrove ecosystems. Some are important habitats for several species of rays and sharks, including the Sunderbans mangroves in West Bengal, Coringa Wildlife Sanctuary in Andhra Pradesh, and Pichavaram mangroves in Tamil Nadu. There also exists several smaller mangrove systems across the coastline of Gujarat, Maharashtra, Odisha, and Andaman and Nicobar Islands.

Major estuaries along the coast of India including that of large perennial rivers like Ganga (Ganges River), Mahanadi, Cauvery, and Thamirabarani, as well as the estuaries of the Krishna and Godavari rivers are recognised sites in which guitarfishes and rays regularly occur.

Coral reefs around the Andaman and Nicobar islands (especially Great Nicobar Island, Car Nicobar Island, and Little Andaman Island), Lakshadweep Islands, Gulf of Mannar, Tamil Nadu, and off the coast of Kakinada and Visakhapatnam in Andhra Pradesh are important for reef sharks and devil rays.

The northeastern and western coasts of India have sandy and muddy seabeds, which are hotspots for several shark species.

The seamounts and island ecosystems in the Arabian Sea are important for Whale Sharks, and the Northern Bay of Bengal for devil rays (Mobulidae) and Whale Shark.

Deepwater ridges, Wadge Bank, Trivandrum Terrace, and abyssal plains off the coast of Lakshadweep, Karnataka, Kerala, Tamil Nadu, and Andhra Pradesh are important for pelagic species such as the thresher sharks (*Alopias* spp.) and deepwater species such as gulper sharks (*Centrophorus* spp.) and chimaeras.

FISHERIES

Fleets

The majority of fisheries are multi-gear and multi-species and operate in coastal and offshore waters within the EEZ. For example, many trawlers also use longlines to target mixed species to cover a wide range of horizontal and vertical ocean space.

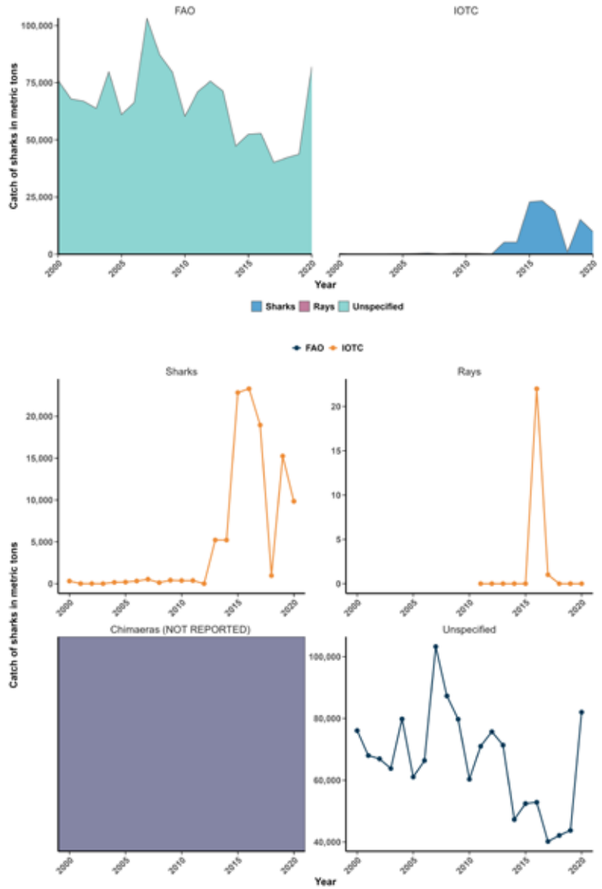
There were 10,071 bottom and pelagic trawlers, 2,563 gillnetters, 191 bagnetters, 47 longliners, 297 ring seiners, 31 other mechanised vessels (hauled with winch), 21,485 inboard multi-gear vessels, and 35,476 outboard multi-gear motorised vessels, with a total of 85,629 fishing vessels operating along India's east coast in 2016. Additionally, there were 15,468 non-motorised multi-gear vessels (CMFRI-FSI-DoF, 2020). Along India's west coast, there were 20,701 trawlers, 3,985 gillnetters, 3,205 bagnetters, two longliners, 646 ring seiners, 1,189 purse seiners, 57 other mechanised (hauled with winch), 9,924 multi-gear, inboard, and 30,774 multi-gear outboard motorised vessels - as well as 10,221 non-motorised vessels operating (CMFRI-FSI-DoF, 2020).

A few fishing operations, specifically targeting tuna, tuna-like species, sharks, and rays operated in the EEZ. In addition, deepwater trawlers and longlines target deepwater sharks and shrimps. Trawls are non-exclusive to shrimps, and with modifications, they target pelagic and demersal fishes such as ribbonfish (*Trichiurus* spp.), threadfin breams (*Nemipterus* spp.), and squid (*Loligo* spp.).

Gear

India's marine fisheries are characterised by a high diversity of craft-gear combinations, with over 30 such combinations in use, with varying vessel and gear specifications. The dominant sector in marine fisheries is the mechanised sector which contributed to 79% of marine fish landings in 2020, followed by the motorised sector (20%), and the non-motorised sector (1%). Trawl fisheries contributed to 62% of the marine fish landings by the mechanised sector, and gillnets 9% (CMFRI, 2024). There are no targeted shark and ray fisheries in trawl gear but incidental catch can be high. Trawling contributes significantly to landings of rays, smaller-sized shark species (e.g., Spadenose Shark, *Scoliodon laticaudus*), or juveniles of large-sized species (e.g., Scalloped Hammerhead, *Sphyrna lewini*). During the early 2000s, deepwater trawls, offshore gillnets, and longlines operating along southern India and Andaman and Nicobar Islands harvested several deepwater shark species, including Bramble Shark (*Echinorhinus brucus*) and gulper sharks (Centrophoridae), and chimaeras (Akhilesh et al., 2011), though the fishery has since slowed down with reduced effort reflecting a decline in catches (Akhilesh & Ganga, 2013).

India's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



PRODUCTION

Overall landings

India has multiple sources of fish landings data including that of Indian Council of Agricultural Research (ICAR)-CMFRI, Department of Fisheries (DoF; which includes data from State Fisheries Departments) and Fishery Survey of India (FSI). Different reasons have been attributed to this (Ansell, 2020), all pointing to the need for concerted national efforts to improve data collection of exploited and threatened marine fauna including sharks, rays, and chimaeras. The marine fish landings data used in this report are research data of ICAR-CMFRI collected through diachronic primary surveys following a stratified multi-stage random sampling design across the coastline of mainland India.

Shark and ray landings in India have ranged from 29,000 mt in 1960 to a peak of nearly 75,000 mt in 1998 (Kizhakudan et al., 2015) and since then have reached 43,736 mt in 2019 (FRAD, CMFRI, 2020). Between 1960–2019, annual shark and ray landings showed intermittent periods of growth and decline, with their contribution to total marine landings ranging from 3.43% in 1985 to 1.2% in 2019. In 2020 there was a 41% decline in shark and ray landings due to the impact of the COVID-19 pandemic on the marine fisheries sector. In 2023, the estimated landing of this group was 32,035 mt (FRAD, CMFRI, 2022), a 21% increase from 2020, indicating a rebound in the fishery's activities.

Species-specific

In 2021, estimated marine fish landing from mainland India was 31,259 mt. Overall, sharks contributed 13,127 mt, 'rhino rays' 1,826 mt (sawfishes, guitarfishes, and wedgefishes), and rays 16,324 mt. The majority of sharks landed were from the Carcharhinidae family (representing 41% of all sharks landed), then *Scoliodon* spp. (Spadenose Shark, *S. laticaudus* and *S.* cf *laticaudus*; 39%), carpet sharks (*Chiloscyllium* spp.; 13%), thresher sharks (*Alopias* spp.; 2%), and hammerheads (*Sphyrna* spp.; 1%; Sukumaran et al., 2023).

Carcharhinidae formed 84.6% of the sharks landed between 2007–2013. Of the 31 species of requiem sharks occurring in Indian waters, at least 21 are regularly fished. Shark landings along the northwest coast are dominated by Spadenose Shark, Grey Sharpnose Shark (*Rhizoprionodon oligolinx*), and Milk Shark (*R. acutus*; CMFRI, 2021).

Over 85% of ray landings were dominated by two families, Dasyatidae and Mobulidae. The main rays landed were *Mobula* spp. (17%), *Himantura* spp. (15%), *Aetobatus* spp. (11%), *Dasyatis* spp. (11%), *Maculabatis* spp. and *Gymnura* spp. (8%), *Brevitrygon* spp. (8%), *Narcine* spp. (5%), *Rhinoptera* spp.

Small-scale fishing boats in Kerala, India | Rima W. Jabado

Small-scale fishing boats | Mayur Arvind | Unsplash

Fishing harbour in Veraval, Gujarat, India | Rima W. Jabado

Sharks and rays for sale at street market in Porbandar, Gujarat, India | RIma W. Jabado

Stingray *Pastinachus* spp. being prepared for local consumption in Porbandar, Gujarat, India | RIma W. Jabado

Milk Shark *Rhizoprionodon acutus* cut into small pieces for sale at local market in Porbandar, Gujarat, India | Rima W. Jabado

(4%), as well as *Urogymnus* spp., *Neotrygon* spp., *Pateobatus* spp., and *Pastinachus* spp. (3% each). For rhino rays, landings comprised mainly of *Glaucostegus* spp. (49%), *Rhinobatos* spp. (33%), *Rhynchobatus* (13%), and Bowmouth Guitarfish (*Rhina ancylostomus*; 6%; CMFRI, 2021).

TRADE

Processing

Sharks and rays that are landed are fully utilised and there is no practice of finning (Kizhakudan et al., 2015, 2024). Sharks landed enter both the domestic as well as export markets. The main products that are traded in/from India are detailed below:

Fresh meat: Fresh shark meat is of high demand in the coastal states (Kizhakudan et al., 2015). In particular, small-bodied sharks, notably Spadenose Shark, Milk Shark, and Grey Sharpnose Shark; juveniles of large-bodied sharks (>1.5 m in total length, TL), particularly Spottail Shark (*Carcharhinus sorrah*), Blacktip Shark (*C. limbatus*), Graceful Shark (*C. amblyrhynchoides*), Scalloped Hammerhead; whiprays, butterfly rays, and manta and devil rays are preferred. Cut meat of large-bodied sharks is usually traded and sold for relatively high prices, for example, Silky Shark (*C. falciformis*), Blacktip Shark, and Oceanic Whitetip Shark (*C. longimanus*). Mako sharks (*Isurus* spp.) and Blue Shark (*Prionace glauca*) receive relatively lower prices. Deepwater species such as bramble sharks, gulper sharks, and dogfishes are also sold for their meat (Kizhakudan et al., 2024).

Dried meat: Usually the meat of large shark is dried for consumption, especially mako sharks, mobulid rays, and requiem sharks are preferred (Karnad et al., 2020; Tyabji et al., 2022). Larger sharks are split open, or cut into chunks, then salted and dried for sale. Dried mobulid meat is also consumed in many regions, particularly in northern Kerala (southwest coast of India). Small- and medium-sized sharks are slit along the stomach in half and dried. The decision to dry the meat is based on volume available, species, meat quality, season, demand from a particular region, and festivals. Chimaera meat is also preferred in dried form but information on the usage of this product is not available (Kizhakudan et al., 2024).

Fins (fresh and dried): The export of shark fins is banned from India. However, shark fins of larger sharks are removed at the landing sites or processing sites, before the rest of the shark body is utilised. These shark fins then enter into international trade through illegal shipments. Several batches of dried and fresh shark fins have been confiscated by government authorities since the shark fin ban (2015). Illegal shipments of shark fins are reported to be exported to Bangladesh and Sri Lanka based on confiscation records from enforcement agencies (Kizhakudan et al., 2024).

Gill plates (sun dried): Mobulids are either targeted or caught as bycatch and the gill plates are dried and exported (e.g., to Sri Lanka; Kizhakudan et al., 2024).

Jaws: Teeth are exported at up to INR 4,000 (USD 48) per jaw set depending on the size and how well preserved the teeth are (Kizhakudan et al., 2015). Nearly 22.3 mt of jaws were exported in 2016, of which 21.5 mt were labelled as Bull Shark (*C. leucas*), while the rest were a mix of Bull Shark, Spinner Shark (*C. brevipinna*), Blacktip Shark, Shortfin Mako (*Isurus oxyrinchus*), and Tiger Shark (*Galeocerdo cuvier*; Kizhakudan et al., 2015, 2024).

Honeycomb Whipray *Himantura undulata* landed in India| Gaurav Patil | iNaturalist.org (CC BY-NC)

Skin: Shark and whipray skins are often removed, dried, and exported to Malaysia and Myanmar. Whiprays are also exported to France (Kizhakudan et al., 2024).

Fishmeal: There are no discards of sharks and rays. Even small-bodied (Scyliorhinidae, Proscylliidae, Triakidae) or non-preferred sharks (Hexanchidae) and small chimaeras are processed for fishmeal along with low-value bycatch (trash fish; Kizhakudan et al., 2024).

Cartilage: Cartilage is exported to Venezuela, United States (US), Côte d'Ivoire, and Kenya. No information is available on usage, but it might be used by pharmaceutical companies (Kizhakudan et al., 2024).

Liver oil (including squalene): Historically shark liver oil was the driver of a targeted shark fishery based in southern Tamil Nadu and Kerala. This fishery continues to target sharks to a reduced extent, but for other supply chains (i.e., meat). Shark liver oil is extracted from large-bodied species in Tamil Nadu, Kerala, and Maharashtra and used by companies domestically (Akhilesh et al 2011; Tyabji et al., 2022). Deepwater species are targeted, and squalene is largely exported from Kerala, Tamil Nadu, and Andaman Islands to Spain, Italy, and Japan. Imports originate from Somalia and Indonesia. Chimaera liver oil is also extracted; however, it is not mixed with oil derived from sharks (Kizhakudan et al., 2024).

Domestic

Domestic demand is not uniform across the country (Hanfee, 1997; Karnad et al., 2024), and certain regions such as Southern India, coastal regions and hilly interiors of Kerala, Tamil Nadu, Karnataka, Goa, and Maharashtra are hotspots for domestic consumption (Kizhakudan et al., 2024).

Shark and ray meat is widely used in coastal cuisines in the country. *Sorrah puttu* or minced shark and ray meat is commonly consumed by coastal communities in Tamil Nadu and Andhra Pradesh. The consumption of shark and ray meat in fresh and dried form is quite high in Kerala. In the Malabar region (north Kerala) it is customary to have shark dishes for weddings, and in Hindu wedding receptions in the region, the only non- vegetarian food served is shark meat (Kizhakudan et al., 2024).

Export

Marine Products Export Development Agency (MPEDA) official statistics are collected based on exporter declaration. However, the use of generic names in exports for dried fish often reduces the quality of data. As per the MPEDA statistics, India exported 195 mt of shark fins worth USD 14.99 million in 2011, compared to 960 mt worth USD 2.74 million in 1998. The quantity of shark fins exported from India in 2013–2014 was about 122 mt. Mumbai, Kochi, and Chennai have been the major centres for the collection and export of shark and ray fins. The trend since 2005, however, indicates an initial increase from 2008–2009 to 2010–2011, followed by a considerable decline in 2013–2014. Information obtained from secondary sources indicates that in the last quarter of 2016, about 2,895 kg of dried gill plates (mostly of Sicklefin Devil Ray [*Mobula tarapacana*] and Spinetail Devil Ray [*M. mobular*; formerly known as *M. japanica*]) were exported from Chennai to Hong Kong Special Administrative Region (SAR). This is only a small portion of the actual exports and some of the traders indicated that the actual quantity could be three to five times higher, which extrapolates into 25–40 mt of dried gill plates, annually, spread over three quarters of the year (giving allowance for annual closure of fisheries; Kizhakudan et al., 2024).

CULTURAL SIGNIFICANCE

Certain shark and ray meat is associated with medicinal properties. Milk Shark and spadenose shark (*Scoliodon* spp.) meat is considered as a health supplement for pregnant and nursing mothers, and is believed to promote lactation, while ray meat is believed to aid postpartum recovery (Karnad et al., 2020; Tyabji et al., 2022). Electric rays are believed to have restorative powers as energisers. Guitarfish and certain other rays are used for joint and hip pain. Bamboo sharks and guitarfishes are believed by coastal and fisher communities to cure joint and back pain. Eagle rays are an important part of festivals among the Koli community of Maharashtra and meat from other shark and ray species are regular components of festive activities and celebrations in north Kerala.

Whale Shark are considered sacred in some parts of the country (Gujarat and Maharashtra), occasionally called *Dev masa* (referring to sacred fish; Hanfee, 1997). Sawfish rostra are often donated to temples, churches, and mosques as a form of protection (Tyabji et al., 2024). The rostrum is also used as an ornamental artefact and a weapon. However, these practices are now limited as sawfishes have become very rare and are protected under the Indian Wildlife (Protection) Act, 1972.

RESEARCH

Most of the research on sharks and rays in India is undertaken by publicly funded organisations (Akhilesh et al., 2023). The CMFRI, under the ICAR - Ministry of Agriculture & Farmers Welfare (MoA&FW) is mandated to monitor and assess marine fisheries resources within the EEZ. This includes monitoring the impact of climate and anthropogenic activities on marine resources, as well as developing sustainable fishery management plans and conducting research on mariculture. The CMFRI undertakes research on fisheries' captures (including sharks and rays), monitoring of commercially landed marine species, research on biology of marine species, stock assessments and population dynamics of major commercial fish species, socioeconomic and human dimensions of the marine fisheries sector, and assessment of marine biodiversity including that of critical and sensitive habitats. The CMFRI also carries out research on conservation of threatened species and provides management advisories for sustainable fisheries and guidelines for policy related to marine resources.

The Central Institute of Fisheries Technology (CIFT), under ICAR, conducts research on fishing and fish processing. CIFT is mandated to work on designing and developing energy efficient fishing systems for sustainable fisheries and developing machinery for fishing and fish processing.

The Centre for Marine Living Resources and Ecology (CMLRE) under the Ministry of Earth Sciences deals with mapping of the marine living resources of the Indian EEZ, inventorying the commercially exploitable marine living resources and their sustainable utilisation through ecosystem management.

The Zoological Survey of India (ZSI) under the Ministry of Environment, Forest and Climate Change primarily deals with exploration, survey, inventorying, and monitoring of faunal diversity in the country; taxonomic studies, bioecological studies, and review the status of threatened and endemic species.

The FSI under the Ministry of Fisheries, Animal Husbandry and Dairying is mandated, primarily, to carry out exploratory surveys, charting of fishing grounds, assessment of fish stocks in the Indian EEZ, periodic re-validation of fishery resource potential, and monitoring surveys of fishery resources.

Shark and ray research in India is also carried out by non-governmental organisations (NGOs) and researchers at universities, primarily focussed on ecology, fisheries, human dimensions, and conservation.

MANAGEMENT

Governance framework

Marine fisheries management, including that of sharks and rays, is a shared responsibility between the Government of India (GoI) and the state governments of the nine coastal states, and four UTs. The jurisdiction of the states and UTs falls inside the territorial sea, with jurisdiction of the GoI being in the EEZ beyond 12 bautical miles (nm), with support from the former (Article 21 of the Indian Constitution; National Policy on Marine Fisheries [NPMF], 2017). States manage their marine fisheries following their respective Marine Fishing Regulation Acts (MFRAs), which are mostly related to operational guidelines for fishing with several provisions such as areas of fishing based on the gear, mesh size regulation, seasonal fishing ban, and minimum landing sizes.

At the national level, fisheries are overseen by the Department of Fisheries under the Ministry of Fisheries, Animal Husbandry and Dairying (MoFAH&D). Each state government will have its own Fisheries Ministry and Department of Fisheries under it.

Shark conservation related to protected shark species in Wildlife

Table 1: Existing national and state regulations and compliance level. | Source: Akhilesh et al. (2023)

POLICY	CURRENT AUTHORITY	CURRENT IMPLEMENTING AGENCY	COMPLIANCE LEVEL	DURATION	REMARKS
Management of fisheries in coastal waters within 12 nautical miles (nm; MFRA)	State government	State Fisheries Department	Limited	Throughout year	Collaboration with other law enforcement agencies to enhance compliance and improve cooperation with fisher communities to implement these.
Closed season in territorial waters	State government	State Fisheries Department	Good	61 days a year (15 April to 14 June along the east coast and 1 June to 31 July along west coast)	
Fisheries spatial zones for mechanised and non-mechanised vessels (MFRA)	State government	State Fisheries Department	Limited	Throughout year	Mechanism of implementation must be participatory, with support of local fisher communities, village level governance mechanisms, and enforcement agencies
Fishing efforts in EEZ; fishing boat license and registration	State government	State Fisheries Department	Limited	Throughout year	Mechanism of implementation must be participatory, with support of local fisher communities, village level governance mechanisms, and enforcement agencies
Closed season in EEZ beyond 12 nm	Central Government	Coast Guard, in coordination with state governments	Excellent	45 days a year (depending on the state but during the summer monsoon season)	
Wildlife Protection Act (WPA), 18 species	Central Government	State forest departments, Wildlife Crime Control Bureau (WCCB)	Limited	Throughout year	Need to consider other high-risk groups and species that are of conservation concern at the regional level
Minimum Legal Size	State government	Fisheries department	Good	Throughout year	Needs to be implemented in all maritime states
Mesh Size	State government	Fisheries department	Limited	Throughout year	To be incorporated across all coastal states and UT
Marine Protected Areas	Central Government	State forest departments	Good	Throughout year	
Marine Protected Area	State Government/ Central Government	State Forest Department	Good	Throughout year	Restricted/no access, zones. Based on ecosystem importance or species.
Awareness	Open	Open	Limited		
Fin attached policy	Central Government	State forest departments, WCCB	Excellent	Throughout year	
Blanket ban on shark fin export	Central Government, Ministry of commerce	Customs, coastguard, navy, other security/ screening agencies	Good	Throughout year	Shark fins are mostly exported to southeast Asian markets as a delicacy. The blanket ban on shark fin exports initiated illegal trade of shark fins. Fisher's share in the domestic sale amount has decreased considerably due to the ban. Providing certificates upon proof of sustainable harvest or if the whole shark is exported could be considered as an alternative to support their livelihood.
Conservation incentives for release of marine WPA species	Maharashtra, Gujarat (restricted to Whale Shark)	State Forest Department	Good	Throughout year	Wider acceptance and documentation of protected fauna

(Protection) Act (WPA), 1972, Wildlife Protection Amendment Act, 2022 is overseen by the Government of India, through the MoEF&CC, which also liaises with international agencies such as Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Biological Diversity (CBD), and other multilateral environmental agreements.

Since 2013, the MoEF&CC (Wildlife Division (vide F. No4-36/2013WL, 21 August 2013)) adopted a policy advisory on shark finning, prohibiting the removal of shark fins from live sharks in the sea and advocated landing of the whole shark with fins attached to the body.

International trade of shark fins is restricted by the Department of Commerce of the Ministry of Commerce and Industry. Notification No.110/(RE-2013)/2009-2014 prohibited the export of shark fins of all species of sharks and further through Notification No.111/(RE-2013)/2009-2014, which prohibited the import of shark fins of all species.

Legal restrictions exist on mechanised vessels. Within territorial waters there is an annual fishing ban with a closed season of around 60 days (April 15– June 15 along the east coast and June 1–July 31 on the west coast).

Overall, 18 species of sharks and rays are protected in India. No chimaera species are protected. According to the Wildlife Protection Amendment Act (2022), the following species (18) are protected in India.

1. Largetooth Sawfish (*Pristis pristis*);
2. Dwarf Sawfish (*Pristis* clavata);
3. Green Sawfish (*Pristis zijsron*);
4. Narrow Sawfish (*Anoxypristis cuspidata*);
5. Bottlenose Wedgefish (*Rhynchobatus australiae*);
6. Whitespotted Wedgefish (*Rhynchobatus djiddensis*);
7. Smoothnose Wedgefish (*Rhynchobatus laevis*);
8. Clubnose Guitarfish (*Glaucostegus thouin*);
9. Widenose Guitarfish (*Glaucostegus obtusus*);
10. Bowmouth Guitarfish (*Rhina ancylostomus*)
11. Cowtail Ray (*Pastinachus sephen*; formerly known as *Himantura fluviatilis*);
12. Giant Freshwater Whipray (*Urogymnus polylepis*);
13. Porcupine Ray (*Urogymnus asperrimus*);
14. Oceanic Manta Ray (*Mobula birostris*);
15. Reef Manta Ray (*Mobula alfredi*);
16. Ganges Shark (*Glyphis gangeticus*);
17. Pondicherry Shark (*Carcharhinus hemiodon*); and
18. Whale Shark (*Rhincodon typus*).

Additionally, the Indian Coast Guard is authorised to deal with any illegal activity in the Indian EEZ. Other agencies like MPEDA are mandated to promote the marine products industry with special reference to exports whereas Customs and Directorate of Revenue Intelligence ensure that legal trade is carried out.

Policy

CITES provisions are considered in India under Schedule IV of the Wildlife Protection Amendment Act, 2022. Schedule IV requires a government issued permit for species listed on this schedule to be exported.

Enforcement and monitoring

The Forest Department oversees protected areas and protected species.

The Fisheries Departments of each state monitor the main harbours, conduct onboard inspections to check violation of illegal fishing, minimum legal-size implementation to reduce juvenile bycatch, and can decide to restrict fishing areas containing protected species.

Enforcement of legal trade mechanisms are undertaken by various agencies including the Indian Navy, Indian Coast Guard, and other security agencies such as Wildlife Crime Control Bureau (WCCB) which has a dedicated wing for wildlife crimes, airport, port, and border security agencies, and coastal police, among others.

Outreach and awareness programmes for various stakeholders are conducted by several institutions including research organisations (like CMFRI), state fisheries departments, and NGOs. With respect to sharks and rays, these programmes include familiarising stakeholders with protected species, importance of conservation, and conservation actions needed.

Currently, landings are monitored, and to some extent, export trade is monitored, but there is very little at-sea or satellite-based monitoring of fishing activities.

Community involvement

Publicly funded organisations undertake mandated awareness activities with fishers related to live release, conservation and fisheries management, sustainability, and best practices. Conservation initiatives initiated by NGOs, such as the Wildlife Trust of India, involve fishers in the live release of Whale Shark, and these initiatives have been spread to other parts of the country through the efforts of NGOs and government agencies, such as CMFRI. Fisher involvement in the conservation of sharks protected under Indian law is also ongoing in some parts of the country, through the work of individuals, conservation NGOs and government agencies.

Gaps

- Knowledge gaps in understanding the ecology of species and human dimensions of shark, ray and chimaera conservation (Gupta et al. 2022);
- Protection of Important Shark and Ray Areas (ISRA);
- Policy gaps in understanding the complexity of conservation in diverse stakeholder groups with diverse socioeconomic considerations (Akhilesh et al., 2023);
- Lack of awareness among fisher and trader communities regarding the legalities of trade in shark and ray products;
- Not many species (only 18) are formally protected by Indian laws;
- Domestic policy alignment with CMS, inclusion of domestic trade regulations to match CITES recommendations; and
- While current policy in India is focussed on protecting species through the Indian Wildlife (Protection) Act, which is enforced by the Forest Department, most harbours and landing sites are monitored by staff from the Fisheries Department.

RECOMMENDATIONS

- Dedicated research is needed on the human dimensions of shark, ray, and chimaera conservation. At-sea research on species distribution, ecology, behaviour, and life-history of species.
- Species-specific conservation programmes.
- The draft National Plan of Action (NPOA) that was developed by an intergovernmental agency has not been formally adopted by the Indian government. The NPOA needs to be officially recognised and adopted. The task of developing India's NPOA-sharks was entrusted by the MoA&FW and GoI to the Bay of Bengal Programme - Inter-governmental organization (BoBP-IGO). In 2015, CMFRI released a guidance document for the NPOA-sharks (Kizhakudan et al., 2015). Several stakeholder consultations were conducted in all the maritime states by CMFRI and BoBP-IGO with the support of fisher organizations like the Association of Deep-Sea Going Fishermen (ADSGF) during the NPOA-development process.
- Shark- and ray-specific management, and enforcement of bycatch reduction measures are needed to ensure conservation.

Policy

- A clear government enforcement agency needs to be identified across the whole country to enforce laws on protected species as well as fishing regulations in marine fisheries.
- Fishing Community involvement - More community involvement and participation is likely to produce better results than top-down policy approaches.
- Capacity enhancement of enforcement agencies for better implementation of regulations and improved monitoring of illegal trade and wildlife crime in marine species, particularly sharks, and the conservation of other vulnerable species, should be prioritised.
- Scientifically supported awareness generation programmes for stakeholders involved in the supply chain, ranging from fishers to traders, exporters, and consumers should be conducted through government departments on a regular basis.
- Update the NPOA-Sharks to suit present-day needs with revised timelines, so that it can be implemented as early as possible within all coastal states and Union Territories and EEZ.

Science/knowledge/research

- Additional funding is required for at-sea research;
- More collaborative fisheries research between government and non-government sector;
- Regional networks to coordinate governance strategies, aligning policies, and implementation of regional and international agreements;
- Key gaps include human-dimensions oriented research (Gupta et al., 2022), so greater effort needs to be focused on conservation-oriented research; and
- Basic behaviour, distribution, and habitat use information is also lacking. More studies based on direct/remote observations and including fishers' local ecological knowledge, such as identification of nursery and aggregation sites, are key (Gupta et al., 2023).

Management/governance/conservation

- Greater awareness and outreach to fishing communities and the public.
- Expanding shark conservation goals to allow for discussion of overall fisheries sustainability. Setting up live-release programmes,
- Improved mechanism for creating temporal fishery closures and community conserved areas (Karnad et al., 2024).
- Understanding and reducing demand for other shark and ray products will have a huge impact, as has been seen with the fin trade (Karnad et al., 2020).

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Habitats like the Godavari-Krishna mangroves are key for sharks and rays along the coast of India | Srikanth Mannepuri | Ocean Image Bank

Smoothback Guitarfish *Rhinobatos lionotus* for sale on the west coast of India | Rohith Srinivasan | iNaturalist.org (CC BY-NC)

Spadenose Shark *Scoliodon laticaudus* | Jessica Luis | iNaturalist.org (CC BY-NC)

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IRAN (ISLAMIC REPUBLIC OF)

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INTRODUCTION

Iran, officially the Islamic Republic of Iran, has a coastline of ~2,250 km along the Persian Gulf and Gulf of Oman. The total Exclusive Economic Zone (EEZ) for Iranian waters is 163,710 km² and includes the Persian Gulf (97,860 km²) and the Gulf of Oman (65,850 km²; Sea Around Us, 2022).

Persian Gulf

Due to its shallow depths (mean depth of 36 m, maximum depth just over 100 m), semi-enclosed environment (Reynolds, 1993), and location in a hyper-arid region, the Persian Gulf consists of coastal habitats with usually high levels of salinity, with sea surface temperatures widely fluctuating between the winter and summer seasons (i.e., 15–36ºC; Sheppard et al., 2010; Riegl & Purkis, 2012). All associated biota, including sharks and rays, have evolved to cope with this extreme environment, which is known as the world's warmest sea during the summer (Riegl & Purkis, 2012). A variety of habitats characterise the unique oceanography of this water body (Naderloo et al., 2023).

Overall, approximately 40 shark and 41 ray species, have been recorded from Iranian waters, of which 75% are categorised as threatened (i.e., 19% Critically Endangered, 28% Endangered, and 28% Vulnerable) in the IUCN Red List of Threatened Species (IUCN, 2023). Specifically, in the Iranian Persian Gulf, there are approximately 38 shark and 37 ray species. Chimaeras have not been recorded and are unlikely to occur in these shallow waters (Rezaie-Atagholipour, personal observation, 2023).

The Iranian coast of the Persian Gulf has a relatively different biological setting compared to the Arabian coast, mainly because the Iranian coast is generally deeper, containing a steeply sloping profile, directly exposed to incoming currents from the Gulf, and affected by river discharge from Iranian highlands (Sheppard et al., 2010; Naderloo et al., 2023). This coastal strip comprises the highest total coral reef extent and coral diversity of this body of water (Sheppard et al., 2010), with about 0.01% of the world's tropical reefs (Sea Around Us, 2022). The Persian Gulf's richest coral fauna is located in Iranian waters close to the Strait of Hormuz, which is extensively influenced by the less saline and nutrient-rich incoming currents (Shokri et al., 2005). Although coral reefs are widespread, surrounding almost all Iranian islands of the Persian Gulf, they are limited to only one section of mainland coast lying at the Nayband National Marine Park (Naderloo et al., 2023). This is mainly because riverine runoff has made the Iranian mainland shores unfavourable for reef-building (Riegl & Purkis, 2012). However, Persian Gulf coral reefs are mostly dead, with declines of over 70% since early 2000s, and the survivors are very fragile, which may be attributable to ineffective management rather than an environmental issue (Sheppard et al., 2016). However, these fragile reef habitats are critical for sharks. For instance, every year from March–April, aggregations (up to >30 individuals) of Blacktip Reef Shark (*Carcharhinus melanopterus*) occur in shallow (<1 m) coastal waters surrounding Iranian small islands with reef communities at the strait (Rezaie-Atagholipour et al., 2023b, c). These aggregations in the eastern side (i.e., Marjan coast) of Kish Island have led the area to be recognized as an Important Shark and Ray Area (ISRA; Rezaie-Atagholipour et al., 2023b). However, the function of these aggregations is still unknown (Rezaie-Atagholipour et al., 2023b, c).

Iranian coastal waters of the Strait of Hormuz (i.e., between Bandar-e-Lengeh in the west to Bandar-e-Sirik in the east) also comprise habitats that are critical for the reproduction of the Critically Endangered Tentacled Butterfly Ray (*Gymnura tentaculata*). The area has been, therefore, categorised as an ISRA (Rezaie-Atagholipour et al., 2023c). Coastal habitats with soft sandy-muddy substrata along the Iranian coastline of the eastern Persian Gulf and Gulf of Oman are probably the last stronghold of this species (Rezaie-Atagholipour et al., 2021, 2023d)

Although Persian Gulf hard substrata are more abundant along its Iranian shelf, the dominant benthic habitat (more than half of the Iranian coast) consists of soft, muddy bottoms (Sheppard et al., 2010; Naderloo et al., 2023). Iran contains most of the Gulf mangrove stands (Price et al., 1993), almost entirely representing the Grey Mangrove (*Avicennia marina*) distributed along the whole coastline, naturally from the Strait northward to Mond Protected Area, and planted along the rest of the coastline up to the northern tip of the Gulf (Naderloo et al., 2023). The Hara Biosphere Reserve, the Gulf's largest mangrove ecosystem with an area of over 850 km², is located at the sheltered channel between Qeshm Island and the Iranian mainland at the Strait (Sheppard et al., 2010). The photic zone in the Persian Gulf is commonly below 10 m (Sheppard et al., 2010). Seagrasses are sparse and patchy along the Iranian coastline, while Emirati shallow waters in the southern Persian Gulf comprise more than 80% of the total approximately 7,000 km² seagrass beds in the sea (Erftemeijer & Shuail, 2012).

Estuarine marshes along Iranian waters, mainly covered by reed grasses (*Phragmites* spp.; Sheppard et al., 2010), are limited to the northern tip of the Persian Gulf (Naderloo et al., 2023), where Gulf hypersaline waters are diluted by Tigris and Euphrates freshwater runoff coming through the Shatt Al-Arab River delta, by far the largest and most important estuary in the region (Sheppard et al., 2010).

Gulf of Oman

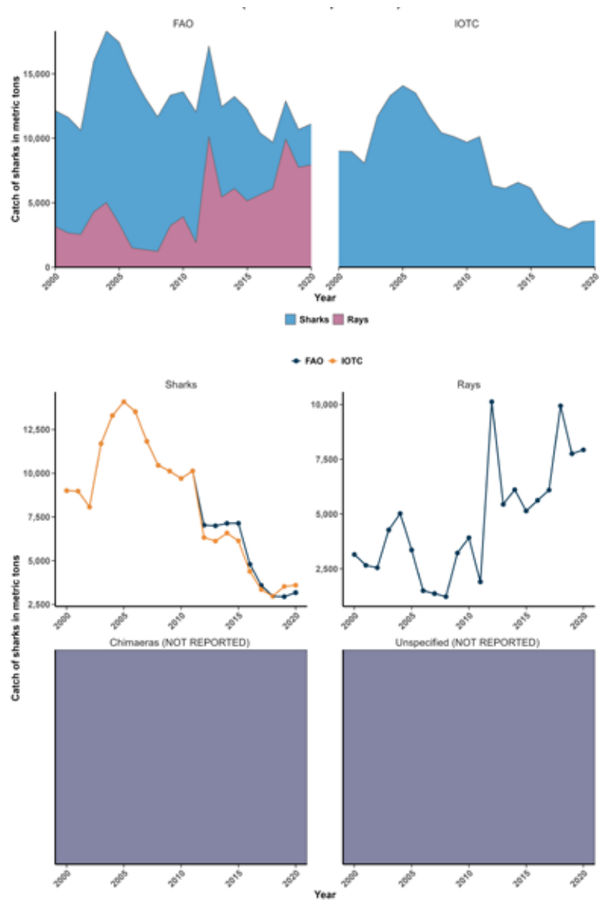
The Iranian Gulf of Oman, with approximately 38 shark species and 41 ray species, represents a relatively different shark and ray assemblage compared to the Persian Gulf (Rastgoo et al., 2020; Bargahi, 2021; Rezaie-Atagholipour, personal observation, 2023). This is probably because the Gulf of Oman is exposed to the open ocean. In contrast to the Persian Gulf, which is a shallow epicontinental sea, the Gulf of Oman comprises deep waters (up to 3,700 m in depth). Sandy-rocky coastal structures are more abundant along the coast of the Gulf of Oman compared to the Persian Gulf (Naderloo et al., 2023). The only coral reef ecosystem is located at Chabahar Bay in the eastern Gulf of Oman (Naderloo et al., 2023). Mangrove stands, representing the common Grey Mangrove, are patchily distributed along the whole Gulf of Oman, while the True Mangrove (*Rhizophora mucronata*) naturally grows in Azini International Wetland (Naderloo et al., 2023). The Rapch (Karati) Estuary, on the boundary of Hormozgan and Sistan-Baluchestan provinces, is the only Iranian estuary in the Gulf of Oman without mangroves. This estuary is a nursery ground for Endangered Sharptooth Lemon Shark (*Negaprion acutidens*). The neighbouring coastal waters at the eastern side of the estuary are also important habitat for Critically Endangered Sharpnose Guitarfish (*Glaucostegus granulatus*). The estuary and its adjacent coastal waters have been, therefore, categorised as an ISRA (Rezaie-Atagholipour et al., 2023a). Although nutrient-rich Arabian Sea upwelling currents mainly impact the Omani coast at the southern Gulf of Oman, they also affect Iranian coastal habitats, leading to planktonic blooms (IFSRI, 2009; Ershadifar et al., 2022).

FISHERIES

Fleets

According to statistics released by Iranian Fisheries Organization (IFO; IFO, 2008, 2022), the total number of licensed vessels fishing along the southern Iranian coastline saw a rise over the last two decades, from 9,977 in 2001 to 10,739 in 2022. In 2022, the fleet comprised 7,230 small boats, less than 15–20 m in length, and usually made of wood or fiberglass; 3,387 artisanal ships locally called Lenj, usually larger vessels that can be over 20 m in length; and 122 industrial vessels. However, the number of illegal vessels is much higher than this official figure. For instance, the total number of licensed small fishing boats for all four southern Iranian coastal provinces in 2015 was about 7,223 (IFO, 2022), whereas it was estimated that around that year at least 3,500 small boats were illegally fishing only in Hormozgan, one of the four provinces (Daliri et al., 2016).

Iran's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the Unted Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



Gear

Persian Gulf

An interview-based survey showed that, although it is illegal, sharks and rays are targeted and landed along the Iranian coastline. Based on the survey, in the Iranian Persian Gulf, sharks and rays are mainly caught incidentally rather than as a target species. About 84% of fishers (n=152) caught sharks incidentally, 10% caught them both incidentally and as a target, and only 6% caught them solely as targets. The proportions in the same order were 91%, 7%, and 2% for guitarfishes and wedgefishes, and 94%, 4%, and 2% for other rays (Rezaie-Atagolipour, personal observation, 2023).

Sharks and rays in the Iranian Persian Gulf are caught using a variety of gears including gillnet, trawl, purse seine, longline, arrowhead-fixed fishing trap (locally called *Moshtah*), and even fish cage trap (locally called *Gargoor*); however, gillnets and trawls are the main shark and ray fishing gears in the area. More than two thirds of fishers (i.e., 70%) caught sharks using gillnets, and more than half caught rays using this gear (i.e., 52% for guitarfishes and wedgefishes and 51% for other rays). Furthermore, over one third of fishers caught rays using trawls (i.e., 35% for guitarfishes and wedgefishes and 38% for other rays), and about one quarter (i.e., 24%) caught sharks using this gear. Note that the percentages are presented as the proportion of total fishers. Therefore, because some fishers used more than one gear, the total proportion exceeds 100%. These two gear types also catch the most sharks and rays in the area.

Gulf of Oman

The results of the above survey also showed that, as in the Persian Gulf, Iranian fishers in the Gulf of Oman catch sharks, guitarfishes, and wedgefishes incidentally (only 1.4% of 75 interviewed fishers in the Gulf of Oman targeted sharks and 1.5% of them targeted guitarfishes and wedgefishes). However, the situation for stingrays (Dasyatidae) is different. About 9% of the fishers stated that they target only stingrays and 38% caught stingrays both incidentally and as a target. This is a result of the stingray gillnet fishery that started in the 2010s along the Iranian coastline of the Gulf of Oman, aiming to trade stingrays to Pakistan (see the 'Tropical Stingrays' section in Chapter 8).

Furthermore, in the Iranian Gulf of Oman, gillnets are considered the main shark and ray fishing gear and the gear that catches the greatest quantity of sharks and rays. About 88%, 90%, and 96% of fishers in the area caught sharks, guitarfishes and wedgefishes, and other rays, respectively. In contrast to the Persian Gulf, trawling does not play a significant role in shark and ray catch in the Iranian Gulf of Oman, because the main demersal shrimp trawling grounds along the southern Iranian coastline operate on shallow coastal habitats of the Persian Gulf (Niamaimandi et al., 2007; Daliri et al., 2015).

A fiberglass boat in the Iranian Gulf of Oman with stingray *Pastinachus* spp. caught using demersal gillnets | Haleh Ali Abedi

Multiple species of rays landed in Iran | Haleh Ali Abedi

PRODUCTION

Overall landings

The first shark landing data for Iran, based on IFO data from 20 main landing sites between 2010–2020, estimated an annual mean of about 10,600 metric tonnes (mt) of landed sharks (i.e., a total amount of 105,875 mt over the whole ten-year period), which does not include illegal, unreported, and unregulated (IUU) fishing landings (Bargahi, 2021).

With regards to rays, the stingray fishery using gillnets in the Iranian Gulf of Oman recorded at least 6,500 mt of rays landed across over 50 Iranian landing sites in the Gulf of Oman, equating to over two million individuals (Rezaie-Atagholipour et al., 2022). No additional data are available for shark and ray landings, and there is no information available on whether chimaeras are being targeted or caught incidentally.

Species-specific

Along the southern Iranian coastline, 34 shark species have been recorded to be landed, of which six species dominated, totalling 84% of landed shark species (Bargahi, 2021). This includes Milk Shark (*Rhizoprionodon acutus*; 21%), Silky Shark (*Carcharhinus falciformis*; 18%), Spottaill Shark (*C. sorrah*; 15%), Grey Sharpnose Shark (*R. oligolinx*; 12%), Whitecheek Shark (*C. dussumieri*; 10%), and Blacktip Shark (*C. limbatus*; 8%). Milk Shark are the most widespread and dominant shark species along the Iranian coastline, caught and landed year-round in all four southern Iranian coastal provinces (Bargahi, 2021; Rezaie-Atagholipour, personal observation, 2023).

Furthermore, in the stingray gillnet fishery along the Iranian coast of the Gulf of Oman, Whitespotted Whipray (*Maculabatis gerrardi*) and Arabian Banded Whipray (*M. randalli*) comprised 76% of stingray landings (see Chapter 8 – 'Tropical Stingrays' section).

TRADE

Processing

There is little information about processing sharks, mainly because they are illegal to catch, and fishers and traders conduct related operations clandestinely, and mostly onboard (Bargahi, 2021). It has been recorded that shark fins are removed onboard. Sharks in local fish markets are sold for meat, sometimes intact, but usually have their fins removed along with their head and are gutted, or filleted. Fins are sold or directly exported by fishers in both fresh and dried forms (Rezaie-Atagholipour, personal observation, 2023).

Non-Dasyatidae ray bycatch (e.g., eagle rays [Myliobatidae], cownose rays [Rhinopteridae], and butterfly rays [Gymnuridae]) from the ray gillnet fishery in the Iranian Gulf of Oman and all ray bycatch from the demersal shrimp trawl fishery in the Persian Gulf are sold at a low price of about USD 0.1 per animal to factories where, along with other commercially unimportant bycatch, they are processed to produce fishmeal (Rezaie-Atagholipour et al., 2022).

While there is no evidence of stingray skin tanning on large scales, a few pieces of stingray leather were displayed in an exhibition that were produced as samples by a small fish tannery (Rezaie-Atagholipour, personal observation, 2023). There have also been some signs of buyers looking for stingray skin on social media. There is no information on chimaeras being used.

Domestic

Shark liver oil is extracted locally, simply by steaming the liver gently with turmeric, and is used by local households or sold in souvenir shops to tourists as a local pharmaceutical product (see 'Cultural Significance' section). Dried shark meat, and sometimes salted, dried ray meat are consumed locally. Originally in Qeshm Island, and some other parts of Hormozgan Province, locals cook a dish with shark meat called Poudeni, which is made by frying minced, boiled shark meat with spices, tomato paste, and aromatic vegetable powder. In Qeshm Island, this dish was popular among tourists until a couple of years ago, when restaurants and ecolodges stopped serving it due to law enforcement and educational programmes. Occasionally, locals of Qeshm island also cook a dish called Haleem-e-Pou (i.e., a type of stew that is widely consumed in Asia), which uses ray (Myliobatiformes) meat; however, it is not as common as Poudeni. Samosas filled with shark meat are also seen on street food menus, primarily in Hormuz Island and some other places. Some fishers, usually when encountering a lot of ray bycatch in coastal fisheries (e.g., in arrowhead-fixed fishing traps), bring them to shore then dry them to be used as fertilizer (Rezaie-Atagholipour, personal observation, 2023).

Export

There are no official statistics for exported shark and ray products from Iran. Only prices and the main destinations derived from an interview-based survey are available (Rezaie-Atagholipour, personal observation, 2023). Based on the survey, fins of sharks and *Rhynchobatus* spp. (wedgefishes, Rhinidae), are mainly exported to the United Arab Emirates (UAE). The mean prices are ~USD 6–19 per kg for fresh and dried shark fins, and ~USD 31 and USD 26 per kg for fresh and dried *Rhynchobatus* spp. fins, respectively. Dasyatidae rays are also exported to Pakistan at a low price of USD 0.8 per kg (Rezaie-Atagholipour et al., 2022).

CULTURAL SIGNIFICANCE

Locals believe that massages using processed shark liver oil help relieve rheumatoid arthritis pains. Thus, it is not surprising that small bottles of shark liver oil are offered for sale in some local souvenir shops, especially on the Qeshm Island Complex (i.e., Qeshm, Hormuz, Larak, and Hengam islands). Furthermore, shark meat is also believed to boost male libido.

The local names for Whale Shark (*Rhincodon typus*) in southern Iran, i.e., *Koulikar* in Hormozgan Province and *Bambak-kar* in Bushehr Province, mean 'the deaf shark', comes from a belief that Whale Shark are deaf and cannot hear the voice of boats approaching them. These gigantic fish used to play an important role in ancestral Iranian fisheries value chains. Ancestral fishers would use Whale Shark liver oil to waterproof wooden lenjs, which drove a huge Whale Shark fishery in southern Iran until the 1970s. The documentary, *Sayd-e Koulikar* (translates to 'Whale Shark hunting'), is one of the oldest nature documentaries in the history of cinema in Iran, and shows a team of fewer than ten fishers in 1975 catching over 40 Whale Shark per year. As there were 280 fishers or so in the village at that time, it could be roughly estimated that the village alone caught over 1,000 Whale Sharks annually.

Although sawfishes are locally extinct along Iranian waters, Green Sawfish (*Pristis zijsron*) and Narrow Sawfish (*Anoxypristis cuspidata*) used to be caught in large quantities decades ago

for their rostra, which are still widely kept as decorations in fisher households, as an inheritance from their ancestors.

Historically, people used to feed dairy cattle with a mixture of dates and powder of dried ray meat to increase milk production. Dried ray meat was historically used as fertiliser, and that continues today (2023), albeit rarely. Local fishers in Sistan and Baluchestan Province used to exchange dried rays with dates, with the meat probably used as fertilisers for palm groves.

RESEARCH

There is no department or research group in any Iranian university or state institute working specifically on sharks, rays, or chimaeras. However, researchers from the Iranian Fisheries Science Research Institute (IFSRI), headquartered in Tehran with centres in all four southern coastal provinces, and IFO have conducted fisheries-related research on commercially important species, including sharks and rays (e.g., Niamaimandi et al., 2014; Rastgoo et al., 2020; Bargahi 2021).

There are few Iranian non-governmental organisations (NGOs) focusing on shark and ray research. For example, the Qeshm Environmental Conservation Institute (QECI), an NGO based on Qeshm Island, works on marine conservation in southern Iran with sharks and rays as their flagship species. Since 2018, QECI has been conducting an ongoing research project on the diversity, distribution, fisheries, and trade of sharks and rays.

MANAGEMENT

Governance framework

The conservation and management of sharks and rays as threatened species are the responsibility of the Iran Department of Environment (DOE; in Persian: *Sazeman-e Mohit-e-Zist*). Furthermore, regulations on fishing activities in Iran are the responsibility of the IFO (in Persian: *Sazeman-e Shilat*). Each organisation has a protection unit responsible for enforcing regulations and prosecuting offenders.

Policy

The only law officially prohibiting shark and ray fishing in Iran is the Hunting and Fishing Law (in Persian: *Qanoun-e Shekar va Seyd*; Ratification No. 168 approved by the Supreme Council of Environment on August 25, 1999). In the latest update (June 3 16, 2023), the DOE has added all sharks and rays in Iranian waters to the law as nationally protected species. Among the nationally protected species, some of them are also categorised as nationally threatened species, which include Longhead Eagle Ray (*Aetobatus flagellum*), Spotted Eagle Ray (*Aetobatus ocellatus*), Ocellate Eagle Ray (*Aetomylaeus milvus*), Wafic's Eagle Ray (*Aetomylaeus wafickii*), Narrow Sawfish, all Carcharhinidae species, Sharpnose Guitarfish, Halavi Guitarfish (*Glaucostegus halavi*), Widenose Guitarfish (*Glaucostegus obtusus*), Tentacled Butterfly Ray, Snaggletooth Shark (*Hemipristis elongata*), Leopard Whipray (*Himantura leoparda*), Coach Whipray (*Himantura uarnak*), Whitespotted Whipray, Shorthorned Pygmy Devil Ray (*Mobula kuhlii*), Green Sawfish, Bowmouth Guitarfish (*Rhina ancylostomus*), Whale Shark, Javanese Cownose Ray (*Rhinoptera javanica*), Oman Cownose Ray (*Rhinoptera jayakari*), Bottlenose Wedgefish (*Rhynchobatus australiae*), Whitespotted Wedgefish (*Rhynchobatus djiddensis*), Smoothnose Wedgefish (Rhynchobatus laevis), all hammerheads (Sphyrnidae), Blotched Fantail Ray (*Taeniurops meyeni*), and Porcupine Ray (*Urogymnus asperrimus*). Based on the latest update added to the law regarding the fines (approved by the Supreme Council of Environment on June 6, 2022), IRR 500, 350, 250, 100, and 50 million IRR fines (i.e., USD 1≈IRR 480,000 at the time of writing of this report) are issued for catching Whale Sharks, hammerhead sharks, rhino rays and sawfishes, other sharks, and other rays, respectively.

Enforcement and monitoring

Public awareness about sharks and rays at the national level has increased steadily. News online for 'shark' and 'ray' (in Persian کوسه and سفره ماهی, respectively) and their threats was non-existent for Iranian waters until 2014. The number has sharply increased from one news article in 2015 to 18 in 2022 with a total number of 60 news articles during this period, based on interviewing experts from government (e.g., DOE, IFO, and IFRSO) and NGOs (e.g., QECI, Koulikar, and Iranian Society of Ichthyology, IRSI). In 2022, experts from QECI and IRSI presented a one-hour television programme (one episode of Tabiat360, which means Nature360), which was the first programme on national television wholly dedicated to the status and threats to sharks and rays in Iranian waters. In addition, there have been several blogs and social media campaigns aimed to raise public awareness about shark and ray conservation in Iran, but their statistics have not been analysed.

Efforts for enforcement and official monitoring are increasing. For example, in 2022, two large, illegal cargoes of shark fins were discovered and seized, including over 2,500 fins in Kish Island (Talebi, 2022) and over 16,000 in Chabahar (Tasnim News, 2022). The DOE, as of 2023, supported all sharks and rays by law (see Policy section).

Another critical advance is developing Iran's National Plan of Action for Conservation of Sharks and Rays under the umbrella of DOE with the cooperation of Shahid Bahonar University of Kerman, QECI, and IFRO, which was released in September 2024. It is the first national shark conservation policy roadmap for decision-making and law enforcement in Iran.

Community involvement

Examples of involving local communities in shark and ray research and conservation in Iran are extremely rare, and to the best of our knowledge, limited to two cases. QECI interviewed hundreds of local fishers from the whole Iranian coastline to fill the shark and ray research gap along extremely data-poor national waters. Koulikar, a local NGO on Qeshm Island has successfully worked with local fishing communities, restaurants, and eco-lodges on the island aiming to safeguard sharks by reducing catch and meat consumption.

Gaps

There are four notable gaps in shark and ray management in Iranian waters. First, despite all the efforts that have been made during recent years (see 'Enforcement and Monitoring' section), public awareness about the status of sharks and rays in Iranian waters and their threats could be further encouraged. Threatened sharks and rays in Iranian waters have generally been neglected by the public, while the primary attention has been directed towards threatened terrestrial species (e.g., Asiatic Cheetah [*Acinonyx jubatus venaticus*] and Persian Leopard [*Panthera pardus tulliana*]), and more charismatic marine species (e.g., cetaceans and sea turtles). Threats to both of these species groups tend to be uptaken by the media faster and generate more viral responses compared to sharks and rays.

The second gap is the lack of national coordination and shared goals among all stakeholders (i.e., governmental institutes, NGOs, and local communities), specifically at the intra-governmental level (e.g., between DOE and IFO), aiming to manage shark and ray stocks along Iranian waters.

The third significant gap is a paucity of research focusing on shark and ray conservation and management along national waters. Despite all the research that has been carried out, shark and ray science in Iran is a relatively new field with limited data, especially regarding diversity, distribution, and shark and ray fisheries, compared to the rest of world or even generally in the northwest Indian Ocean.

The last notable gap is a general lack of funding. Needless to say, filling the vast research gap mentioned above and developing educational and management programmes requires funding, especially in Iran, where political sanctions and having the world's lowest value currency are severe challenges for scientists and conservationists.

RECOMMENDATIONS

Policy

Undoubtedly, safeguarding sharks and rays along national waters needs efficient collaboration between two state organizations, DOE and IFO, fishing communities, and NGOs through developing a national plan for shark and ray conservation, which has now developed (see 'Enforcement & Monitoring' section).

Science/knowledge/research

Due to the high diversity of habitats in both gulfs, which host a variety of shark, ray, and chimaera species with a range of ecological niches and requirements, further studies must focus on habitat-specific (e.g., coral reefs and mangroves), and species-specific research, especially for the stocks of threatened species (e.g., Tentacled Butterfly Ray, guitarfishes, and wedgefishes). Furthermore, studies on socio-economic drivers of shark and ray fisheries and trade in the country are just beginning and detailed research is needed to answer several key questions aiming to fill this knowledge gap.

Management/governance/conservation

A comprehensive national shark and ray conservation plan needs to be compiled aiming to undertake conservation measures and for effective monitoring and enforcement by engagement of all stakeholders (e.g., policy makers, including IFO and DOE, fishing communities, and NGOs), which was released in September 2024 (see 'Enforcement & Monitoring' section).

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A sample of tanned dasyatid ray skins at an exhibition of fish leather in Iran | Mohsen Rezaie-Atagholipour

Shark fillets without fins and head on a fish vendor in Asaluyeh, Bushehr, Iran | Mohsen Rezaie-Atagholipour

A local shark meat dish from Hormozgan Province, locally called *Poudeni* | Mohsen Rezaie-Atagholipour

IRAQ

Haryad Art Np | Unsplash

IRAQ

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INTRODUCTION

Iraq is known to have one of the most abundant freshwater resources in the Middle East. This is due to the merging of the Tigris and Euphrates rivers in the south of the country and the Karun River (of Iran) draining into the Persian Gulf through the Shatt Al-Arab, which is by far the Gulf's largest estuary. Despite its developed river system, Iraq's maritime Exclusive Economic Zone (EEZ) is the smallest in the Gulf (~540 km^2) with a coastline of about 50 km. The coastline includes extensive Mesopotamian marshes, which are strongly influenced by the Shatt-al-Arab's freshwater discharge (Khalfallah & Pauly, 2021). A total of 159 fish species were recorded in a survey of fish structure on Iraqi marine waters, including six shark and 11 ray species (Yaseen et al., 2024). However, historically, only four sharks, including Bull Shark (*Carcharhinus leucas*), Milk Shark (*Rhizoprionodon acutus*), Great Hammerhead (*Sphyrna mokarran*), and Arabian Carpetshark (*Chiloscyllium arabicum*); and three rays: Sharpnose Guitarfish (*Glaucostegus granulatus*), Coach Whipray (*Himantura uarnak*), and Cowtail Ray (*Pastinachus sephen*) were caught in Shatt Al-Arab (Freyhof et al., 2021).

Iraq's tiny coastal habitat has significantly changed due to the long-term damming trend along the Tigris and Euphrates rivers (Al-Yamani et al., 2007). Consequently, Iraqi southern marsh ecosystems, which used to support significant fisheries in the past (up to 60% of landings) and provide a nursery area for some commercial species, have been extensively reduced by 90% to an area of around 1,700 km^2 (FAO, 2004).

The euryhaline Bull Shark has been recorded as repeatedly occurring in the Shatt Al-Arab estuary and the Iraqi coast. This species has been involved in many human-shark interactions in both Iraqi and Iranian parts of Shatt Al-Arab (Coad & Papahn, 1988; Coad & Al-Hassan, 1989; Hussain et al., 2012; Moore, 2018). Including Bull Shark, records of at least 17 shark and 18 ray species are confirmed from Iraqi marine and estuarine waters; however, some are misidentified, questionable, and synonymous records (Ali, 2013). Nonetheless, the abundance, population trends, and fisheries interactions of these species along Iraqi waters are unknown. Overall, across studies, 23 shark and 19 ray species have been recorded so far from Iraq (Ali et al., 2018). Further to this, an additional ray species was added to this list (Al-Faisal & Mutlak, 2020).

FISHERIES

Fleets

There two main types of fishing fleets. First, small fibreglass boats, which are most common with 731 vessels reported in 2019. This small scale fishing fleet usually targets species migrating from salt to freshwater habitats to spawn, such as Hilsa (locally called Sabour in Iraq, *Tenualosa ilisha*), during their breeding migration to Shatt Al-Arab. Secondly, artisanal vessels locally called Lenj (215 vessels recorded in 2019) operate in the open sea (Qasim, 2021).

Gear

Marine fishers in Iraq use a variety of gears including gill nets, beach seines, trawls, hand lines and long lines, cage traps (locally called *Gargoor*), and different types of fixed fishing traps, e.g., valve room trap, milan trap, and hadra trap (Jawad, 2006; Nasir & Khalid, 2013). Nonetheless, no data are available on shark and ray catch using any of these gears.

PRODUCTION

Overall landings

There are little shark– or ray-specific data available, even in the grey literature. Much of the historical information available from Iraq dates back at least several decades, and there have been significant changes to shark and ray taxonomy in this time. Data on shark and ray landings are not collected for official statistics.

Species-specific

The most frequently caught shark species are Arabian Carpetshark, followed by Whitecheek Shark (*Carcharhinus dussumieri*). For rays, the Sharpnose Guitarfish has the highest catch frequency, followed by the Bengal whipray (*Brevitrygon imbricata*), and the Longtail Butterfly Ray (*Gymnura poecilura*; Ali et al., 2018; Ali, personal observation).

TRADE

Processing

There are no data available on the processing of sharks and rays in Iraq. Since the 2010s, fishers have shown an increasing interest in buying sharks for several reasons, including the use of fins in making surgery threads or to sell to foreign companies for shark fin soup. Shark meat is also sold locally for human consumption or as food for domestic animals.

Domestic

There are no data available on domestic utilisation of sharks and rays in Iraq.

Export

There are no data available on the export of sharks and rays in Iraq.

CULTURAL SIGNIFICANCE

There are no data available on the cultural significance of sharks and rays.

RESEARCH

There were two main official fishery research centers in Iraq (the Fish Research Centre in Zaafaraniyah and the Marine Science Centrr in Basra). However, there are currently no government or independent research organisations undertaking research on sharks and rays in Iraq.

MANAGEMENT

Governance framework

There are no data available on the management of sharks and rays in Iraq. Due to political circumstances, the General Authority for the Development of Fish Resources was closed in 1989 by an arbitrary decision that led to the dissolution of its specialists. There is still no adequate re-established organizational structure for the Development of Fish Resources in the Iraqi Ministry of Agriculture (Harlıoğlu et al., 2023).

Gaps

Iraq has the smallest EEZ in the Persian Gulf with active fisheries in its marine and Lower-Mesopotamian waters. Nonetheless, no statistics are available for shark and ray fisheries and landings for the country. Therefore, the largest gap is the lack of a scientific baseline for sharks and rays in Iraqi waters.

RECOMMENDATIONS

Science/knowledge/research

The highest priority is to develop shark and ray specific surveys in Iraqi waters to understand species diversity and the impact of fisheries on their populations, as well as collect landing data on sharks and rays.

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Arabian Carpetshark
Chyloscyllium arabicum |
Philippe Lecomte

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Longtail Butterfly Ray *Gymnura poecilura* | Philippe Lecomte

Top and bottom | Locals fishing in Chibayish, up the Euphrates and Tigris RIver in Iraq, at the remains of the Mesopotamian Marshlands | Hasan / Shot By Sahnicc | Unsplash

JORDAN

Rita | Unsplash

JORDAN

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INTRODUCTION

Jordan is located in the northern Arabian Peninsula and is almost entirely surrounded by land, with Syria to its north, Iraq to the northwest, Saudi Arabia to its south and southwest, and Israel to its east. Jordan has a relatively short coastline of 27 km overlooking the Gulf of Aqaba in the Red Sea (Morgan, 2006; FAO, 2024c). It has an Exclusive Economic Zone (EEZ) of approximately 97 km² and shelf area of 28 km² (Sea Around Us, 2016).

Although data on sharks and rays have been collected from other parts of the Red Sea, little information is available from Jordan. There appears to be a relatively low diversity of species and no chimaeras confirmed in Jordanian waters. According to the IUCN Red List of Threatened Species, only 17 sharks and rays (seven and ten species, respectively) are confirmed to occur here, of which 88.2% (15/17) are threatened with extinction (two Critically Endangered, eight Endangered, and five Vulnerable); the remaining two are Least Concern and Data Deficient (IUCN, 2024).

Within the EEZ there are coral reefs and seagrass beds, prevalent in the north and south (i.e., Big Bay), which may be important nursery areas for rabbitfishes (family Siganidae), goatfishes (family Mullidae), and parrotfishes (family Scaridae; Morgan, 2006), but further research is needed to confirm this. Jordan has one Marine Protected Area (MPA), the Aqaba Marine Reserve, a 1 km², no-take, area covering ~0.81% of the total marine and coastal area that was designated in 2020 (UNEP-WCMC, 2024).

FISHERIES

Fleets

The Jordanian fishing industry is primarily artisanal, with no industrial fishing. This is due in part to its small EEZ and Jordan's emphasis on protecting its coral reef habitats. In 2004, there were around 85 fishers using 40 boats (5.5–11 m in length) powered with an outboard motor. This number has however since risen to 540 fishers and 220 vessels in 2017 (PERSGA, 2002; Morgan, 2006; FAO, 2024c). Given the limited areas available, fishers have been reported to operate beyond territorial waters, expanding to neighbouring countries such as Saudi Arabia (PERSGA, 2002).

Separate from the artisanal fishery is the subsistence fishery using vessels that can be broadly divided into two types: 'small' and 'large' (the sizes are not defined; Tesfamichael et al., 2012). Both types target their catches for direct consumption and sell a portion of it for their livelihood (Tesfamichael et al., 2012). The catches from 'small' vessels are intended to feed fishers and their families and their catches are not reported. Catches from 'large' vessels can feed the crew, their families, and friends, with estimated catches averaging 24 mt annually (Tesfamichael et al., 2012).

Recreational fishing also occurs, and is generally increasing (Morgan, 2006; Tesfamichael et al., 2012) and largely unregulated, posing as an increasingly concerning threat to marine fauna. Catches from this fishery are not reported.

Gear

Artisanal fisheries use a variety of gear including baited cage traps (used between 5–15 m in depth), baited hooks, beach seines (mesh size of 1–2 mm), handlines, bottom gillnets (used 60–100 m deep), longlines (~800 m long with hooks spaced 2 m apart), pots (use 400–600 m deep), trammel nets, and trawl lines (El-Zibdeh et al., 2006; Morgan, 2006; Tesfamichael et al., 2012). Reef and pelagic species are targeted, such as snappers (family Lutjanidae), groupers (family Serranidae), emperors (family Lethrinidae), and tunas (e.g., Skipjack Tuna [*Katsuwonus pelamis*] and Kawakawa [*Euthynnus affinis*]), but incidental catch of other species is also common (Morgan, 2006; Tesfamichael et al., 2012).

Based on a survey of deepwater (60–700 m depth) fishes along the coastline, Bigeye Houndshark (*Iago omanensis*) appeared to be susceptible to short hook and lines (20–25 hooks 10/0 or 12/0 in size), comprising 28.09% of all catches with this gear (6.78% of all catches) from 2014–2015 (Khalaf et al., 2018). No rays were observed in this study.

PRODUCTION

Overall landings

There are limited data available on sharks and rays being landed in Jordan, in part because of the lack of monitoring and reporting. Due to the small length of the coastline, most marine fish products, including sharks and rays, are imported rather than captured or landed (Morgan, 2006). In 2001, 98% of the total fish supply were imported products. However, this dropped to ~50% by 2004 as a result of developing aquaculture production (Morgan, 2006). Fish production predominantly comprises of freshwater species, reaching two-thirds of total catches in 2017 (FAO, 2024c). In reports to the Food and Agriculture Organisation of the United Nations (FAO), from 2012–2022, between 0.57–6.77 mt of 'Sharks, rays, skates, etc. nei [not elsewhere included' were landed, averaging 2.94 mt annually (FAO, 2024a).

Species-specific

A study of commercial catches from 1999–2000 recorded Triakidae sharks making up 6.46% of the total marine catches. Although they were surveyed year-round, the bulk of these catches were caught in August, but the exact species were not identified nor the explanation of this seasonality (El-Zibdeh et al., 2006). Other sharks (locally known as *Qersh*) commercially valued include Sandbar Shark (*Carcharhinus plumbeus*), Spottail Shark (*Carcharhinus sorrah*), and Tiger Shark (*Galeocerdo cuvier*; El-Zibdeh et al., 2006). For rays (Salfooh), this included Spotted Guitarfish (*Rhinobatos punctifer*; El-Zibdeh et al., 2006).

TRADE

Processing

The limited catches landed are essentially all sold fresh for direct consumption or to local hotels and restaurants (Morgan, 2006). Sharks and rays were known to be sold between JOD 1–1.5/kg (~USD 1.4–2.1) in 1999–2000 under the local names of Qersh and Salfooh, respectively (El-Zibdeh et al., 2006).

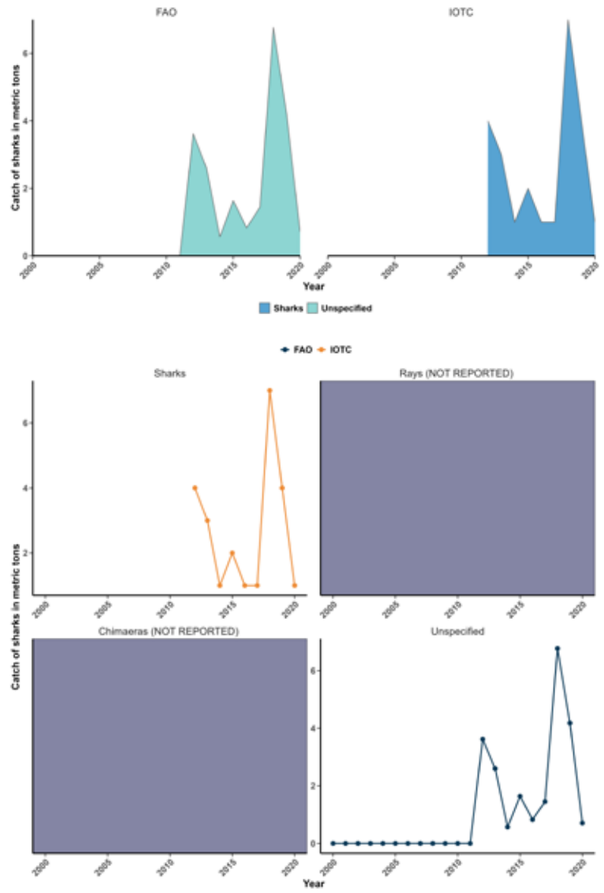
Domestic

There is no known use for sharks and rays other than local consumption.

Export/import

No sharks or rays are known to be exported from Jordan and based on reports to the United Nations (UN) Comtrade, Jordan has not reported any shark or ray products being imported or exported either (UN Comtrade, 2024). However, in reports to FAO, Jordan reportedly imported 17 mt (USD 24,000) of dogfish and other sharks (FAO, 2024b). According to Hong Kong Special Administrative Region (SAR) trade statistics, 'Shark fins, dried, whether or not salted but not smoked, with or without skin, with cartilage' (Harmonised System [HS] code 03057111) are being traded from Hong Kong (SAR) to Jordan (Hong Kong Census and Statistics Department, 2024). In 2023, a total of 29.4 mt worth HKD 7.55 million (~USD 968 thousand) of shark fins were exported from Hong Kong SAR to Jordan (Hong Kong Census and Statistics Department, 2024). From January–July 2024, 64.2 mt worth HKD 12.4 million (~USD 1.6 million) of shark fins were reportedly exported from Hong Kong SAR to Jordan as well (Hong Kong Census and Statistics Department, 2024). Furthermore, freshwater rays (Potamotrygonidae) listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) are also imported, mostly from Thailand (captive-bred) and small quantities from Colombia (wild specimens; UNEP-WCMC, 2024). Colombia reported exporting four live specimens in 2020, while Thailand reported exporting a total of 154 specimens from 2018–2022, peaking with 50 and 60 individuals in 2022 and 2019, respectively (UNEP-WCMC, 2024). These imports are likely for the aquarium trade.

Jordan's total catch of shark, ray, chimaera, and unspecified species reported to the Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



CULTURAL SIGNIFICANCE

There is no known cultural significance attached to sharks and rays.

RESEARCH

The Marine Science Station of Jordan University is the main institution conducting research on marine life and fisheries but has not undertaken any work focusing on sharks or rays.

MANAGEMENT

Governance framework

There is no Ministry for fisheries per say, but the Ministry of Agriculture broadly manages the fishing industry (Morgan, 2006). Fisheries activities and marine protection in the Gulf of Aqaba, including Jordanian waters, is overseen by the Aqaba Regional Authority (ARA). The ARA has the capability to enforce marine environmental protection and resolve conflicts between fisheries and other stakeholders (Morgan, 2006).

Policy

There are no regulations in place for shark and ray conservation. There is, however, the broader 'Fishing Regulation No. 1 of 1944' which aims to protect corals and may indirectly benefit sharks and rays. This regulation mandates that all fishers and fishing vessels acquire a license, and it bans the use of harmful substances, spearguns, and explosives as a means of fishing to protect corals (Morgan, 2006).

Fisheries are managed on a regional scale through ARA or joint initiatives such as a bilateral cooperation agreement with Egypt (Morgan, 2006).

Enforcement and monitoring

As there is no focused fisheries authority based in Jordan, there is limited information available on the effectiveness of existing fisheries regulations or monitoring of marine habitats and species. Monitoring of fisheries occurs primarily on a regional scale, for example the Comprehensive Fisheries-Ecosystem (CoFE) Management Program of the Red Sea Marine Peace Park Co-operative Research, Monitoring and Management Program

(RSMMP Program), agreed with Israel, aims to direct sustainable fishing efforts into deeper waters to protect coral reefs (Morgan, 2006).

Community involvement

There is no community involvement for shark and ray conservation.

Gaps

Data on catches/landings are generally not recorded, posing challenges to assessing stock status, biology of marine fauna, impact of fisheries on sharks and rays, etc.

RECOMMENDATIONS

Policy

Developing additional policies that are species-focused would be beneficial in addition to the environmental regulations in place.

Science/knowledge/research

Data collection on fisheries' catches are needed to fill the knowledge gap, assess population stocks, and identify what areas could be of importance to sharks and rays.

Catches from recreational fisheries are currently not reported, so it would be useful if these fishers were obligated to record this.

Management/governance/conservation

A clearly defined entity is needed to manage the fishing industry and enforce fishing regulations, especially considering that recreational fishing efforts are increasing and there is no system in place to enforce marine regulations at the national level.

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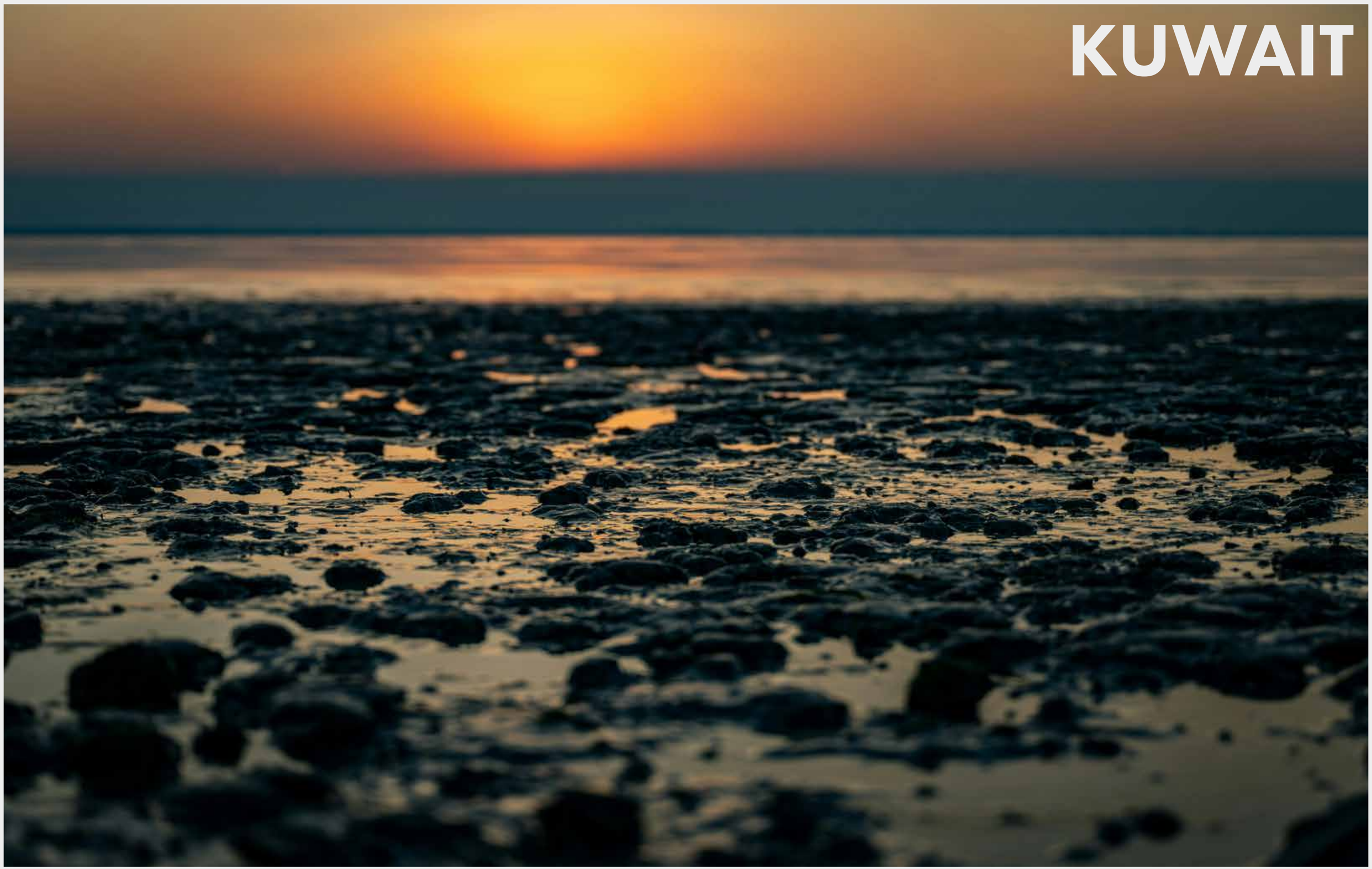
Small scale fishing boat in Aqaba, Jordan | Hisham Zayadneh | Pexels.com

Panther Torpedo *Torpedo panthera* | Claudia Pogoreutz | iNaturalist.org (CC BY-NC)

KUWAIT



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KUWAIT

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INTRODUCTION

Situated on the Arabian Peninsula, Kuwait faces the northern point of the Arabian/Persian Gulf, bordering Iraq to its west and Saudi Arabia to its south. It has a coastline of 195 km and an Exclusive Economic Zone (EEZ) of approximately 11,786 km² (Seas Around Us, 2016; FAO, 2024).

According to the IUCN Red List of Threatened Species, there are 57 species of sharks (n=28) and rays (n=29) that occur in Kuwaiti waters (IUCN, 2024). Of these, 73.7% (n=42) are threatened with extinction, with nine considered Critically Endangered, 19 Endangered, and 14 Vulnerable (IUCN, 2024). There are no shark or ray species that are endemic to Kuwait, but there are species endemic to the Arabian region, including the rarely seen Smoothtooth Blacktip Shark (*Carcharhinus leiodon*; Moore et al., 2011, 2013, 2015). Chimaeras have not been reported from the Arabian/Persian Gulf.

Kuwait has five Marine Protected Areas (MPA) registered officially by the Environmental Public Authority (three coastal and two offshore; A. Alzaidan, personal communication, 2024). The Mubarak-Al-Kabeer Natural Reserve is the largest protected area (510.22 km²; UNEP-WCMC, 2024) comprising lagoons and salt marshes; it is the only Ramsar site in the country (Khalfallah et al., 2020; Marine Conservation Institute, 2024).

Kuwait shares the Bubyan Island and adjacent rivers (i.e., Tigris, Euphrates, and Karun rivers) ecosystem with Iran and Iraq, and this area was designated as an important shark and ray area (ISRA) in 2023 as it is a reproductive area for Bull Shark (*Carcharhinus leucas*; IUCN SSC Shark Specialist Group, 2023).

The spring and summer seasons appear to be an important period for sharks in Kuwaiti waters, with a greater abundance of individuals seen historically in this period, including carcharhinids (Moore, 2011 and references therein; Bishop et al. 2016). For example, pregnant Smoothtooth Blacktip Shark have been observed in spring (April) and newborns (up to a few months old) in summer (August; Moore et al., 2013). Whale Shark (*Rhincodon typus*) have been observed in the spring (February–May) and summer (June–October) months (Papathanasopoulou & Zogaris, 2015 in Al-Yamani, 2021) off the reef areas in Al-Khiran, Qaruh, and Umm Al-Maradim. Anecdotal information suggests that reef areas are also hotspots for Arabian Carpetshark (*Chiloscyllium arabicum*) during the warmer spring season (Carpenter et al., 1997; Goubanov & Shleib, 1980), and Blacktip Reef Shark (*Carcharhinus melanopterus*) during the summer season (Almojil & Papathanasopoulou, 2011; Almojil, personal observation, 2024). Historically, sawfishes were observed in Kuwaiti waters in the early summer (until the 1980s; Clayton & Pilcher, 1983), but are now extremely rare and considered functionally extinct in the Gulf region (Moore, 2015).

FISHERIES

Fleets

The fisheries in Kuwait can be primarily divided into artisanal and industrial, although there are also small subsistence and recreational fisheries.

The artisanal fishery can be categorised into three types: 1) the shrimp fishery using dhows (wooden vessels >10–20 m in length) and small, fibreglass vessels powered by an outboard motor (7–10 m in length); 2) the finfish fishery using wooden dhows (120 vessels were reported in 2006) and speedboats (748 vessels in 2006); and 3) the traditional, fixed, intertidal, stake trap (*Hadhra*) fishery (Al-Abdulrazzak, 2013). In 2002, at least 522 *Hadhra* were licensed to operate, but this number has since dropped and was reported at ~140 in 2021, due to the restrictions placed to limit this type of gear. *Hadhras* are known to catch small sharks that are <1 m in total length (TL; Al-Yamani, 2021) as well as rays of various sizes (R.W. Jabado, personal communication, 2024).

The industrial fishery is comprised entirely of trawlers, reaching 35 vessels in 2006, and targeting shrimp, primarily Green Tiger Prawn (*Penaeus semisulcatus*), Jinga Shrimp (*Metapenaeus affinis*), and Kiddi Shrimp (*Parapenaeopsis stylifera*; Al-Abdulrazzak, 2013). Trawlers operate seasonally from August, in the special economic zone of Kuwait (SEZ), and September, in territorial waters (Al-Husaini et al. 2015), to January or February depending on the shrimp catch rate of the season (D. Almojil, personal observation, 2024) from 5–35 m in depth (Al-Abdulrazzak, 2013). However, illegal trawling is known to occur within territorial waters during the closed season (1 February–31 July); from 1960–2010, approximately 10% of total shrimp catch were illegally caught (Al- Abdulrazzak, 2013). Trawlers have high bycatch rates, with bycatch to target ratios as high as 30:1 (Ye et al., 2000). Sharks and rays are known to be retained by trawlers with fish discards as bait (Clayton & Pilcher, 1983) and were historically reported at an estimated catch rate of 10.9 kg/hour during the 1980s to 0–10 kg/h in the late 2000s, with the greatest abundance during summer and autumn (Goubanov & Shleib, 1980; Moore, 2011; Bishop et al. 2016). In 1984, the estimated quantity of shark and ray bycatch landings was around 4,000 metric tonnes (mt)/year (KSIR, 1989; Al-Husaini et al., 2015). Surveys in the late 1980s showed that the dominant sharks and rays' bycatch species were of Arabian Carpetshark (14%) and mixed guitarfishes (35%; Ye et al., 2000).

In 2006, the total number of vessels were estimated to be >900 from both the artisanal and industrial fisheries (Abdulrazzak, 2013). This number had decreased to 838 vessels in 2015, including eight steel-hulled boats, 158 wooden dhows (using trawls, gillnets, and traps), and 672 speed boats (gillnetters and trap setters; FAO, 2024). Furthermore, there has been a decrease in employment (directly and indirectly) within the fishing sector, from ~3,500 individuals in 2013 to ~370 in 2015 (FAO, 2024).

The recreational fishery also uses speedboats to target demersal species. Little is known about the catches from recreational fisheries, given that most information is not reported. However, it is assumed that the main species targeted are Brownspotted Grouper (*Epinephelus chlorostigma*), Sobaity Seabream (*Sparidentex hasta*), Tigertooth Croaker (*Otolithes ruber*), and Yellowfin Seabream (*Acanthopagrus latus*; Al-Abdulrazzak, 2013).

Limited information is available on the activities or species targeted in the subsistence fishery.

Gear

The gears used in artisanal fisheries include bag nets, cast nets, lines, pots and traps, *gargoor* (wire traps), fixed gillnets (with varying mesh sizes), and other type of nets (Morgan, 2006; Al-Abdulrazzak, 2013). Gillnets (~300 m in length with stretched mesh sizes between 4–5.75 inch or 10.16–14.60 cm) and trawls (e.g., otter trawls 5 m long, stretched mesh of 34 mm, and 20 mm cod end) are especially known for incidentally catching a variety of shark and ray species (Bishop et al., 2016). This primarily includes Longhead Eagle Ray (*Aetobatus flagellum*) and Sandwich-tail Whipray (*Brevitrygon manjajiae* formerly known as *Himantura imbricata*; Last et al., 2023), followed by Milk Shark (*Rhizoprionodon acutus*) and Arabian Carpetshark, as well as the rare Smoothtooth Blacktip Shark (Moore et al., 2011, 2015; Bishop et al., 2015). The finfish fishery was reportedly the primary sector catching sharks incidentally, generally by speedboats using gillnets (and gargoor but to a lesser extent), of which 746 and 122, respectively were reportedly licensed in 2006 (Al-Abdulrazzak, 2013). In general, fishers report a significant increase in their fishing effort, this includes increase in number of hooks, horsepower used, and travelled distance to fishing grounds (Almojil, 2021).

PRODUCTION

Overall landings

There are limited data available on sharks and rays captured and landed. Sharks and rays are not targeted but are caught incidentally. However, generally across the Arabian/Persian Gulf, mature, small sharks (<100 cm total length [TL]) dominate landings, with significant numbers of immature specimens of larger species (*Carcharhinus* spp.) in Kuwait before the fishing ban for sharks, sea turtles, shellfish, and other rare species in 2008 (Moore et al., 2012). Most animals captured are discarded, especially sharks and rays, as they are generally not consumed for religious reasons, and the few that are landed are usually not reported (Murad, n.d.; Al-Abdulrazzak, 2013). Despite shark and ray consumption being prohibited under Shia Islam, there are still small quantities being consumed locally. It is estimated that from 1950–2019, only 5.8% of shark and ray catches were landed, and the remaining 94.2% discarded (Al-Abdulrazzak, 2013; Khalfallah et al., 2020). There are no data to indicate whether these were released dead or alive. No shark or ray catch data are available from the Food and Agriculture Organization of the United Nations (FAO) or other Regional Fisheries Bodies (RFBs).

Based on historical data from 1950–2019, it is estimated that shark and ray catches during this time period fluctuated between 1,305–9,188 mt. Of these catches, 53.5%, 46.5%, and <1% were from the artisanal, industrial, and subsistence fisheries, respectively (Al-Abdulrazzak, 2013; Khalfallah et al., 2020). Since the 1990s, it has been estimated that shark and ray catches are showing a downward trend due to overfishing (Al-Abdulrazzak, 2013; Khalfallah et al., 2020). Given the lack of historical records on shark and ray catches, a study used local ecological knowledge of fishers to quantify the scale and time of decline in shark abundance in Kuwait (Almojil, 2021). Results showed a significant reduction in the abundance of sharks started around 1999and scaled to an average reduction of 76%, and up to 80% for the Great Hammerhead (*Sphyrna mokarran*) in specific. Fishers reported that the main reason for the observed decline is from trawling and corruption (Almojil, 2021).

Species-specific

Limited research has been conducted on sharks and rays caught as target or incidental capture at the species-level. A short-term study was conducted in 2008 (prior to/ at the start of the fishing ban) and in 2011 (post-ban; Moore et al., 2012). Surveys of fish markets and landing sites were undertaken, and a total of 1,516 and 699 sharks and rays were recorded, in 2008 and 2011, respectively. The majority of landings were attributed to incidental catch in gillnet fisheries (Moore et al., 2012). Sharks comprised >70% of landings, this primarily consisted of carcharhinids, especially Whitecheek Shark (*Carcharhinus dussumieri*), Spottail Shark (*C. sorrah*), Milk Shark, and Grey Sharpnose Shark (*Rhizoprionodon oligolinx*; Moore et al., 2012). While the implementation of the shark fishing ban took time, the number of carcharhinids landed had decreased in 2011 compared to 2008 (422 versus 1,095 individuals; Moore et al., 2012). However, more carpet sharks (20% of total shark and ray landings in 2011 compared to 1% in 2008), such as Arabian Carpetshark; and guitarfishes (from 1% to 15%; (e.g., Sharpnose Guitarfish [*Glaucostegus granulatus* at the time reported as *Rhinobatos granulatus*]) were landed (Moore et al., 2012). Sharks and rays are often discarded. For example, in the 1990s, it was estimated that ~13.7% (between 4,680–7,460 mt) and ~3.1% (1,050–1,670 mt) of total discards annually were of Arabian Carpetshark and guitarfishes, respectively (Ye et al., 2000).

TRADE

Processing

Prior to the shark fishing and trading ban in 2008, sharks and rays would be landed whole and could be found for sale at markets such as Sharq market (Moore et al., 2012), and Fahaheel and Mubarakiya market (Almojil, personal observation, 2024). There were no indications of finning (removal of fins at sea with body discarded), however, once landed larger sharks and guitarfishes had their fins removed for sale and their meat consumed (Moore et al., 2012). Pre-ban, shark and ray prices were not defined but were generally valued less than teleost species; rays (apart from guitarfishes) especially were of such low value that they were considered 'unmarketable' and fishers tended to discard them at-sea or after landing (Moore, 2011; Moore et al., 2012). Presumably, post-fishing ban, if any incidental captures were landed, they would be for direct consumption only.

Import and export

There are limited reports of sharks or rays, whole or their derivative products, being exported from Kuwait. There was a single record reported to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) of Smalltooth Sawfish (*Pristis pectinata*) being exported from Australia to the United States through Kuwait in 2011 (CITES Secretariat & UNEP-WCMC, n.d.).

Fishing harbour of Al-Kout Souk, Fahaheel, Kuwait | Ken Doerr | flickr.com (CC BY 2.0.)

Dhow fishing boat in Kuwait | Tayssir Kadamany | Pexels.com

Small quantities of rays (including skates [Rajiformes]) and sharks are, however, known to be imported. In 2019, 0.02 mt (worth USD 670) of frozen dogfish and other sharks were imported from Iran (FAO, 2023). For rays, imports reported to FAO included 0.75 mt of fillets (worth USD 2,880) from the Philippines in 2019; in 2020, 0.03 (USD 620), 0.1 (USD 640), and 1 mt (USD 3,480) of frozen rays were imported from Argentina, Republic of Korea, and the United Arab Emirates, respectively; and 0.93 mt (USD 520) of chilled rays from Egypt in 2021 (FAO, 2023).

However, reports to the United Nations (UN) Comtrade indicate higher quantities of sharks and rays being imported compared to FAO. From 2019–2022, a total of 0.77–2.39 mt, at a value of USD 521–10,435, of shark and ray products were imported globally (UN Comtrade, 2024). Products include 4 mt (USD 10,762) of fresh/chilled rays (Harmonised System [HS] code 030282 and 030448), 1.32 mt (USD 6,153) of frozen sharks and rays (HS Code 030381 and 030382), and 0.04 mt (USD 2,340) of shark fins (HS code 030571; UN Comtrade, 2024).

CITES-listed species have also been imported - other than the single Largetooth Sawfish (*Pristis pristis*) being imported from the United Kingdom (UK) in 2012 - all other specimens were freshwater stingrays (*Potamotrygon* spp.; CITES Secretariat & UNEP-WCMC, n.d.). Between 2017–2022, 7–50 live, captive-bred, freshwater stingrays were imported from Thailand (CITES Secretariat & UNEP-WCMC, n.d.). These were likely to supply the aquarium trade.

CULTURAL SIGNIFICANCE

Regional utilisation of shark parts dates to at least the Iron Age. Remains of different types of sharks, including carcharhinids and sphyrnids, were recorded in archaeological findings along the coasts of the Arabian Peninsula (Beech, 2001).

In certain cases, sharks and rays are not consumed in Kuwait as it is prohibited in Shia Islam (Al-Abdulrazzak, 2013) and were historically considered food for the poor (Moore, 2011). However, a portion of locals do consume small sharks in a local dish called *Myaddam*. The most important parts of sharks that are consumed locally are the meat and liver. The meat of small shark species (known collectively in Kuwait as *Wallad*) is believed to cure impotency in men, a belief that dates to Medieval Persia (Ghadiri & Gorji, 2004). Shark meat is still regarded as poor-quality meat but was mostly used for its good preservation properties. Once the meat is sundried, it can be stored for many months, even extending to years. This made it suitable for consumption on long seafaring trips, and as a fish supply for residents of inland deserts. The extracted liver oil (known locally as *Sell*) was also used to coat the hull of wooden boats to protect it from marine fouling (Shamlān, 2000). Liver oil was also used in cosmetics (i.e., to produce *Kohl*, a dark material used to contour the eye) and as a healing product for skin and joints (Almojil, personal observation, 2024).

There are no regular eco-tourist activities related to sharks and rays, with only a few occurrences of snorkelling with this species group on occasion (Moore, 2011).

RESEARCH

The Kuwait Institute for Scientific Research (KISR) is the primary institution that oversees research conducted on fisheries and aquaculture. Other institutions such as the Shark Conservation Society (SCS) undertook short term surveys on sharks and rays in a few countries across the Gulf. This organisation supported the work in Kuwait (e.g., Moore et al., 2011). More recently, two studies were conducted to provide empirical data underpinning the conservation of sharks along the Arabian coasts, including Kuwait. The first study documented the historical trend in shark abundance using local ecological knowledge (Almojil, 2021), and the second study supported significant evidence of recent bottleneck and fine-scale population structure in both the Blacktip Shark (*Carcharhinus limbatus*) and Spottail Shark using molecular tools (Almojil et al., 2018).

MANAGEMENT

Governance framework

The Public Authority for Agriculture and Fisheries Resources (PAAF) oversees management of the country's fisheries activities and collaborates with local municipalities, such as the Kuwait Environment Protection Authority (EPA), to manage fisheries' infrastructure (i.e., landing sites, markets, and fishers' co-operatives; Morgan, 2006).

Policy

In 2008, the PAAF implemented a ban on the fishing and selling of sharks (as well as sea turtles, shellfish, and other rare species) to regulate fishing and to support certain species with breeding. If incidentally caught, fishers are obliged to release the animals back into the wild. The only exception is if the specimen is caught for scientific/research purposes. Furthermore, fishing for Graceful Shark (*Carcharhinus amblyrhynchoides*) and Grey Sharpnose Shark is allowed, although the reasoning for these species' exemption is not clear (KUNA, 2008; Moore, 2011). There are no legislations in place for rays.

Due to the high levels of incidental catch observed in Kuwaiti waters, including for sharks and rays, the PAAF had initiated a policy on bycatch. The aim of this policy is to develop a monitoring system to estimate bycatch, set a fish catch quota system, enforce an observer scheme onboard, establish a closed season for shrimp fishing, and using more selective gear types (Murad, n.d.). Part of this has been enforced, such as the closure of the shrimp fishery from February or March to September (Morgan, 2006). In 2001, a Marine Strategy was published to manage marine areas, including fisheries (Moran, 2006). It is unclear if either have been fully implemented yet as of 2024.

Other measures in place that could indirectly benefit sharks and rays are: bans on fishing within 3 nautical miles (nm) from the coastline (i.e., Kuwait Bay and Islands); limiting the number of industrial and artisanal dhows in the shrimp fishery to 35 and 33 vessels, respectively; the mandate for shrimp trawls to have a minimum mesh size of 45 mm when stretched; and set minimum mesh sizes for gillnets depending on the species targeted (Morgan, 2006).

Enforcement and monitoring

The PAAF oversees enforcement, and when the shark fishing ban was first implemented in 2008, they actively spreaded awareness to enforce this (Moore et al., 2012). However, enforcement is often sporadic, with illegal, unreported, and unregulated (IUU) fishing frequently occurring (Morgan, 2006). The shark ban prohibits their landing or selling in local fish markets.

Community involvement

There are no known community engagement programmes in relation to shark and ray conservation.

Gaps

While there have been some efforts towards shark conservation, there have been limited actions on rays. This is concerning considering the high levels of incidental catch of rays including discards where post-release survivorship is unknown. Furthermore, even some of the conservation measures initiated in the early 2000s have yet to be enforced (Morgan, 2006).

There are limited data available on shark and ray catches, with most existing information collected from a few research papers (e.g., Ye et al., 2000; Moore et al., 2012; Al-Husaini et al., 2015; Bishop et al., 2016).

RECOMMENDATIONS

Policy

- Extending the existing fishing ban to rays would further supplement their conservation;
- Introduce species-specific management measures, with a priority given to manage the highly depleted Great Hammerhead and Blacktip Shark. This includes introducing minimum landing sizes for all Gulf Cooperation Council countries (GCC); and
- Involve highly experienced representatives from local fisher communities in designing resource management plans.

Science/knowledge/research

- Sharks and rays captured and/or landed should be monitored to ensure adequate fisheries data are available;
- As most sharks and rays are incidentally caught and often discarded, it would be beneficial to develop and implement a guide on handling these species, and to record if catches are released dead or alive;
- Additional research should be conducted on their biology, habitat use, etc. to understand what areas could be important for sharks and rays, which in turn would inform policy on which locations to prioritise for future conservation actions; and
- More research should be conducted to provide the ecological data needed to base effective management plans. In particular, species-specific data from the region are required to use models to assess the sustainability of the shark fishery. This includes information about age at maturity, gestation period, and average number of pups per female. Moreover, identification of critical habitat along the region that is important for sharks and rays at different life stages (i.e. mating, pupping, and nursery grounds) is also important at this stage.

Management/governance/conservation

- To reduce bycatch, the use of more selective gear types such as turtle excluder devices (TEDs) and Bycatch Reduction Devises (BRDs) in trawl fisheries would be beneficial (Murad, n.d.; Eayrs, 2004); and
- Spottail Shark should be treated as independent management units in each of the following countries: Bahrain vs. Oman vs. UAE and Yemen. While Blacktip Shark should be treated as an independent management unit in these group countries: Kuwait and Bahrain vs. UAE, Oman, Yemen, and Pakistan vs. Saudi Arabia and South Africa.

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MALDIVES

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MALDIVES

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INTRODUCTION

The Maldives, situated in the Chagos-Laccadive ridge, is an archipelago of 1,192 islands grouped into 26 distinct reef systems (Stevens & Froman, 2018). The Maldives has a large Exclusive Economic Zone (EEZ) of 916,000 km² and territorial waters of 67,000 km².

The coral reefs encompass an area of 21,596 km² and make up 3.1% of the worlds' coral reefs (Naseer & Hatcher, 2004). These coral reef systems are extensive and comprise unique formations such as ring-shaped faros with lagoons unexposed to open ocean, platform reefs, and numerous oval or circular reefs at varying depths. These reef structures contribute a high diversity of corals and fauna (Stevens & Froman, 2018). Outside the atoll rims, reefs slope to depths of 3,000 m, providing a narrow habitat range for deepwater fishes which are largely unexplored. Coastal waters surrounding the outer and inner atoll reefs and lagoonal habitats are home to a large variety of marine fauna ranging from reef fishes, reef-associated sharks and rays, to invertebrates, and sea turtles. Some coastal habitats, including mangrove areas, are important nurseries for many reef fishes and reef-associated sharks. Although seagrass pastures are scattered and patchy, they serve as important foraging grounds for Green Turtle (*Chelonia mydas*). Offshore waters provide habitats for tuna, billfishes, and oceanic sharks. The Maldives has about 34 seamounts in offshore waters that host a rich diversity of marine life, where large schools of tuna and sharks are known to aggregate.

FISHERIES

Fleets

The Maldives fisheries sector is mainly divided into tuna fisheries and reef-based fisheries.

Tuna fisheries operate exclusively within the EEZ and are categorised by gear and target species. There were 655 licensed tuna fishing vessels primarily targeting Skipjack Tuna (*Katsuwonus pelamis*) and Yellowfin Tuna (*Thunnus albacares*) using pole and line and handlines, respectively (Ahusan et al., 2021). Due to the ease of switching between these gears, both are often used on the same vessels. Unlike tuna, reef resources were largely unexploited until the 1980s.

The rapid economic growth from tourism, newer market opportunities, and improved air and sea transport have stimulated the development of several reef-based fisheries for both local consumption and export markets (Adam, 2004). Reef-based fisheries mainly compose of general reef fisheries and an export-oriented sea cucumber (Holothuriidae) and grouper (Epinephelinae) fishery.

Prior to the 2009 and 2010 bans on shark fishing, three distinct shark fisheries existed: deepwater, reef-associated, and oceanic. In 2004, 132 shark fishing boats were operated by 528 fishers, a significant decrease compared to 1993, when there were 437 shark longline vessels, 417 gillnet vessels, and 305 vessels engaged multi-hook fishing across the three shark fisheries (Anderson & Ahmed, 1993).

Gear

Among the various methods employed for shark fishing prior to shark fishing bans, the most distinct gears used were drift longlining, bottom-set gillnetting, deepwater multi-hook handlining, and simple handlining.

Drifting longlines were used to target oceanic sharks and were set outside of the atolls, with significant quantities of tuna caught incidentally. Bottom-set gillnets were also a major gear used to target reef sharks, and large reef fish were common bycatch. The deepwater shark fishery used multi-hook handlines to target gulper sharks (*Centrophorus* spp.). Several small hooks were used on a single line and set at depths of 250–800 m on the outer atoll slopes (Anderson & Ahmed, 1993). There were no targeted ray or chimaera fisheries.

PRODUCTION

Overall landings

Compared to tuna fisheries, the shark fishery was considered a minor fishery, hence little importance was given to collecting catch and effort information. Any catch information available on sharks were grouped with reef fish data under the fishery data collection system. For more accurate representation of shark catch statistics, shark catch data were estimated from trade data.

In the early 1980s, the deepwater shark fishery began, primarily targeting gulper sharks (*Centrophorus* spp.). Deepwater sharks were targeted for their squalene-rich liver oils which were in great demand from Japanese buyers. Catch estimates were derived from trade-based estimates of shark liver oil. This fishery saw a boom in catches in 1980 and reached its peak around 1982–1984, then had significant declines in catches and eventually collapsed by the mid-1990s (Figure 1). The sudden drop in catches was attributed to two main factors: 1) as gulper sharks inhabit cold, deep, nutrient deficient waters, their growth rates are much slower compared to sharks inhabiting shallow waters; 2) gulper sharks inhabit depths of 250–800 m, and in the Maldives, as atoll slopes are very steep, there are limited habitats at this depth. Therefore, it was believed gulper sharks were of a very small stock, which high fishing pressure exhausted (Anderson & Ahmed, 1993).

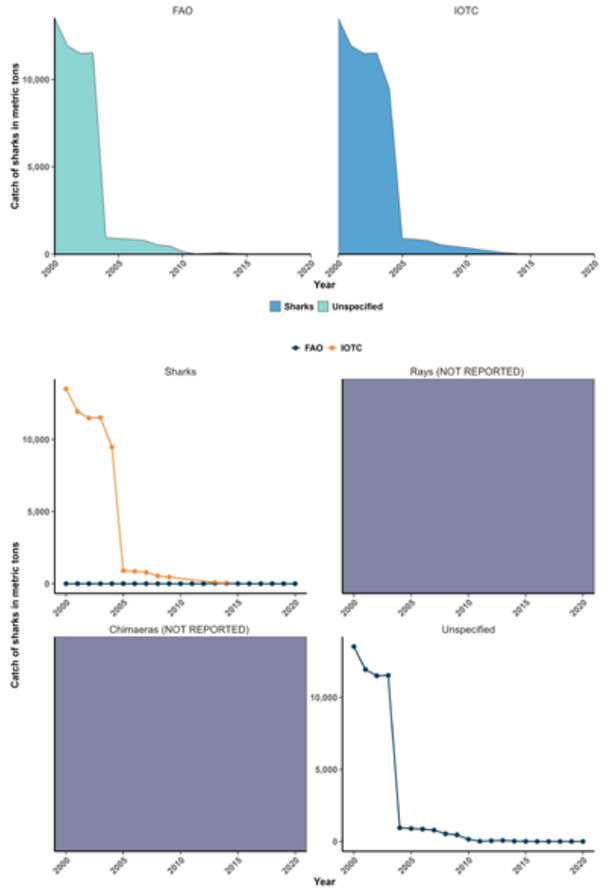
Since there was no mechanism to distinguish between sharks caught in coastal waters versus offshore waters, all oceanic and reef-associated shark catches were aggregated. Trade data were used to estimate catch information. Prior to 1970s, shark catches were estimated to be roughly 500 mt (Figure 2). From the late 1970s, a steep rise in shark catches was seen; this was when commercial shark fisheries developed. For most of the years, the average annual catch was 1,400 mt with 1,000–2,000 mt of inter-annual variations in the catch. The differences in shark catches between the years could be due to the demand for fins in the export market (MRC, 2009). In 2004, shark fisheries peaked at 2,700 mt. From then, shark catches significantly declined, and by 2008 dropped to <500 mt.

Data were not collected on rays or chimaeras that might have interacted with the fishery.

Species-specific

Prior to the shark fishery closing, in offshore drift longlining from 1987–1991, Silky Shark (*Carcharhinus falciformis*) were the main catch (n=222) and Oceanic Whitetip Shark (*Carcharhinus longimanus*; n=60) and Blue Shark (*Prionace glauca*; n=17) were also captured (Anderson & Ahmed, 1993). When fishing closer to the atolls, Blue Shark were caught to a lesser extent and more Tiger Shark (*Galeocerdo cuvier*) and Silvertip Shark (*Carcharhinus albimarginatus*) were caught. In bottom-set gillnets, a large quantity of reef-associated sharks were caught. Catch composition differed by habitat types. In lagoons, Blacktip Reef Shark (*Carcharhinus melanopterus*) dominated the catch, and in atoll basins Grey Reef Shark (*Carcharhinus amblyrhynchos*), Silvertip Shark, Spottail Shark (*Carcharhinus sorrah*), Whitetip Reef Shark (*Triaenodon obesus*), and Tawny Nurse Shark (*Nebrius ferrugineus*) were caught. When these gears were set on outer atolls, large bottom-dwelling species like Smalltooth Sandtiger Shark (*Odontaspis ferox*) were caught. In deepwater multi-hook fisheries, species such as the Gulper Shark (*Centrophorus granulosus*), and Mosaic Gulper Shark (*Centrophorus tessellatus*) were caught (Anderson & Ahmed, 1993).

The Maldives' total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tons (mt) | Source: FAO (2022) and IOTC (2022)



Rays were hardly exploited in the Maldives and were among the marine species whose export was banned from the 1990s.

TRADE

Processing

In the 1990s, apart from shark liver oil being used to coat wooden boats, most shark products were exported. The main shark products were fins, meat, liver oil, and jaws. Except for few shark fishing communities where fishers sold sharks whole to local buyers for processing, most fishers processed the sharks themselves (Anderson & Ahmed, 1993).

Domestic

Sharks and rays were rarely used for local consumption. The Maldives is largely a tuna fishing nation; thus, mainly tuna is consumed. Before the commercialisation of shark fisheries, a traditional shark fishery existed where large sharks such as Tiger Shark and Bluntnose Sixgill Shark (*Hexanchus griseus*) were caught for their large livers. Crude liver oil was the only shark product domestically used, and it was applied to wooden boats to prevent the wood from decaying.

Export

Since sharks were rarely consumed locally, it is assumed that most shark products were exported. Ray exports have been banned since the 1990s (see Governance Framework section). Dried shark fins, salt-dried shark meat, and deepwater shark liver oil were exported. Jaws of large sharks were dried and occasionally sold in souvenir shops. On average 15–25 metric tonnes (mt) of shark fins were exported annually since the 1980s, except post-2000 where fin exports decreased (Figure 3; MRC, 2009). This reflects the decreased shark catches in this time period. Despite shark fin exports remaining relatively constant throughout the years, prices fluctuated, but increased overall until 2004, when a substantial drop in prices was seen. Prices per kilogram of shark liver oil also fluctuated between the years, but generally kept increasing. Although all shark catches kept decreasing, the high demand and high prices per kilogram of shark products in international markets were an incentive to continue fishing, until the prices dropped post 2000 (MRC, 2009).

CULTURAL SIGNIFICANCE

For pole and line tuna fishers, Silky Sharks had a significance in their fisheries. It was believed that when Silky Sharks were near a tuna school, it would be easier to catch large quantities of tuna.

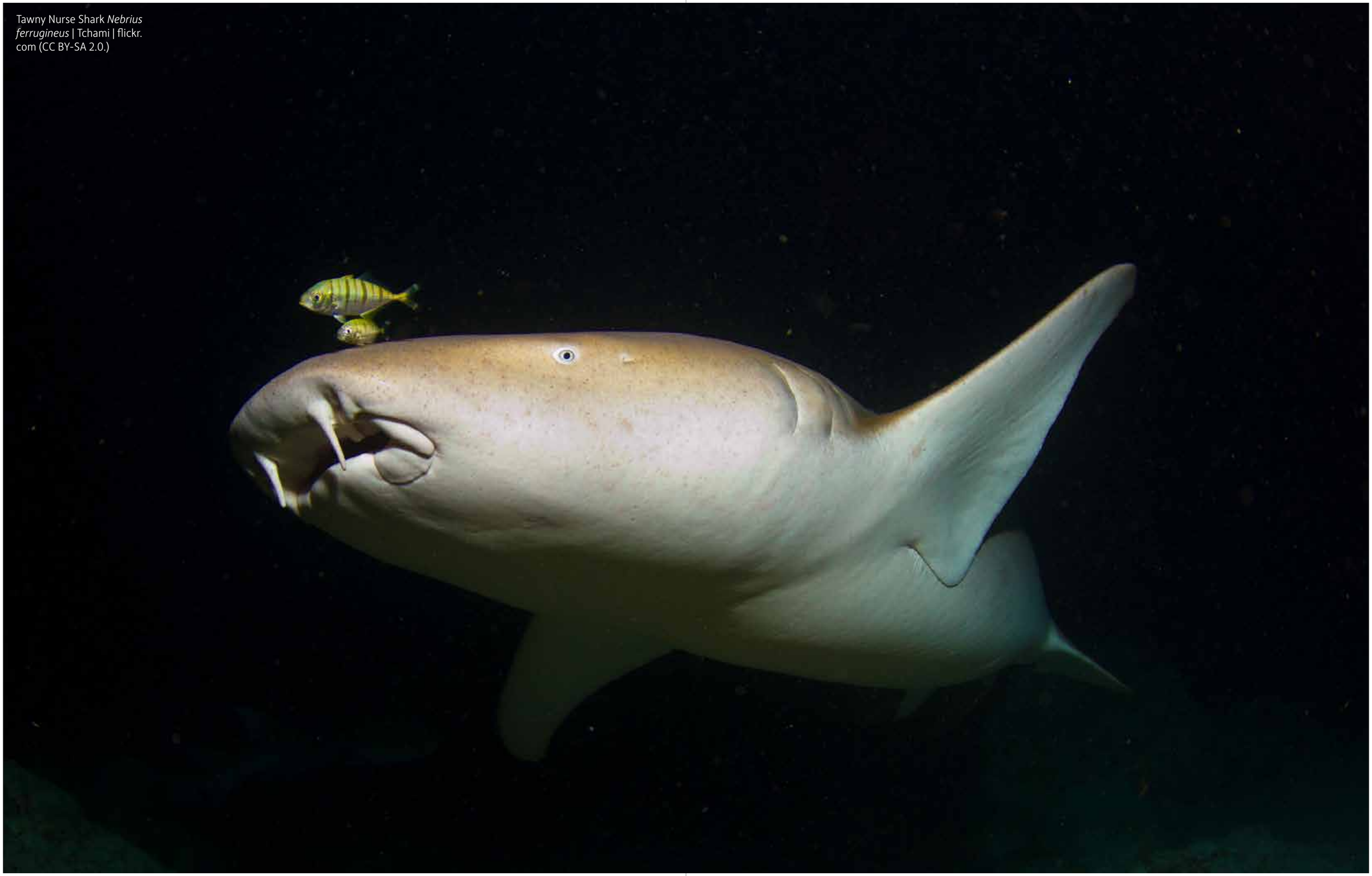
Sharks and ray watching is a major tourism attraction in the Maldives. Direct revenue from shark watching is estimated to be USD 14.4 million/year (Zimmerhackel et al., 2019). For manta ray (*Mobula* spp.) watching, it is estimated USD 8.1 million/year revenue is generated each year (Anderson et al., 2011).

RESEARCH

The Maldives Marine Research Institute (MMRI, the research arm of Ministry of Fisheries, Marine Resources and Agriculture) conducts shark research relevant to mandates of the Ministry.

Prior to the shark fishing ban, MMRI provided insight on the

Tawny Nurse Shark *Nebrius ferrugineus* | Tchami | flickr.com (CC BY-SA 2.0.)



status of shark fisheries to inform policies. In 2009, when shark fishing was banned in all the atolls of the Maldives, MMRI started a citizen-science programme with tourist resorts to study reef-associated shark populations through recreational diver surveys. Maldives was also part of the Global Finprint Project, the largest reef-associated shark assessment. Since 2015, MMRI have started using baited remote underwater video (BRUV) surveys to assess the status of shark populations of the Maldives. Various shark related research has been conducted by individual researchers, private parties, and non-governmental organisations (NGOs) under research permits issued by the Ministry of Fisheries and Ocean Resources.

MANAGEMENT

Governance framework

Sharks are protected under the General Fisheries Regulation (2020/R-75) under the Fisheries Act of the Maldives (Act no. 14/2019). Shark management is overseen by the Ministry of Fisheries, Marine Resources and Agriculture. Under the Fisheries Act of the Maldives (Act no. 14/2019), the Coast Guard of Maldivian National Defence Force, Maldives Police Services, and the Maldives Customs Services are mandated to enforce fisheries regulations. The conservation and management of rays is the mandate of the Ministry of Environment, Climate Change and Technology under the Environment Protection and Preservation Act of the Maldives (Law no. 4/93). Since 2021, all rays are declared as protected species under the Protected Species Regulation (R-25/2021).

Previously, trade of all fishery commodities was regulated under the mandate of the Ministry of Economic Development. However, in 2019, the Fisheries Act of the Maldives (Act no. 14/2019) permitted the Ministry of Fisheries and Ocean Resources to regulate trade of fishery products and impose bans on marine species protected under the Fisheries Act.

Policy

Since 1981, the Ministry of Fisheries and Ocean Resources enacted various measures (Table 1) to manage shark fisheries and resolve conflicts of interest between different resource users. However, management measures prior to 2009 were

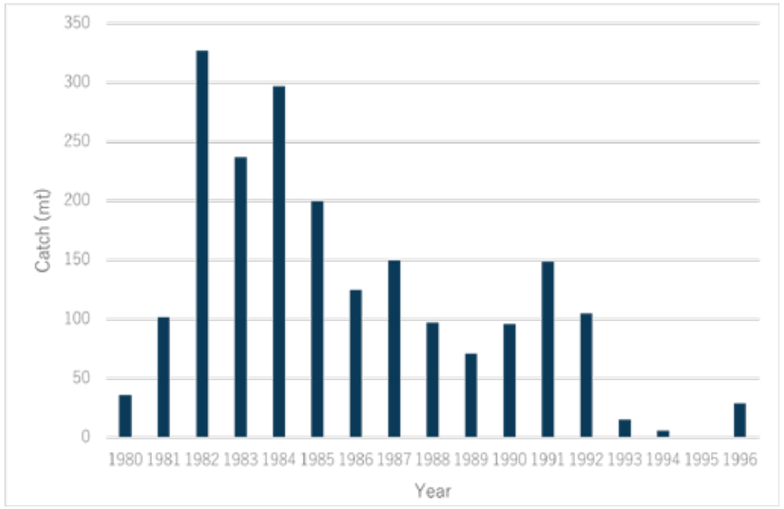


Figure 1: Estimated annual catches of gulper sharks | Source: Anderson & Waheed (1999)

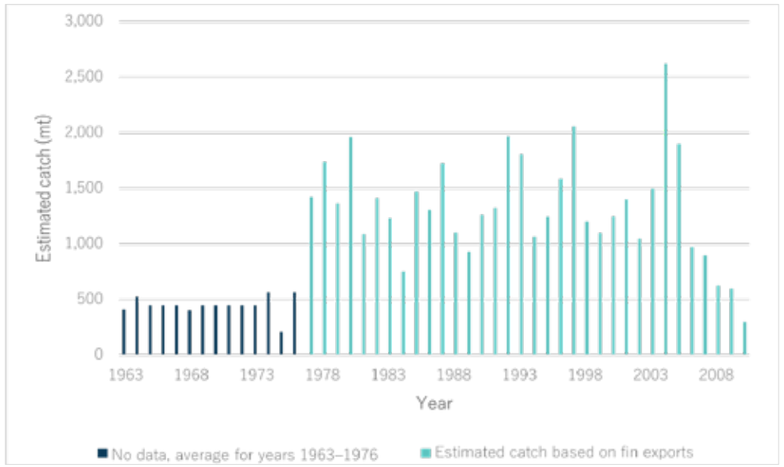
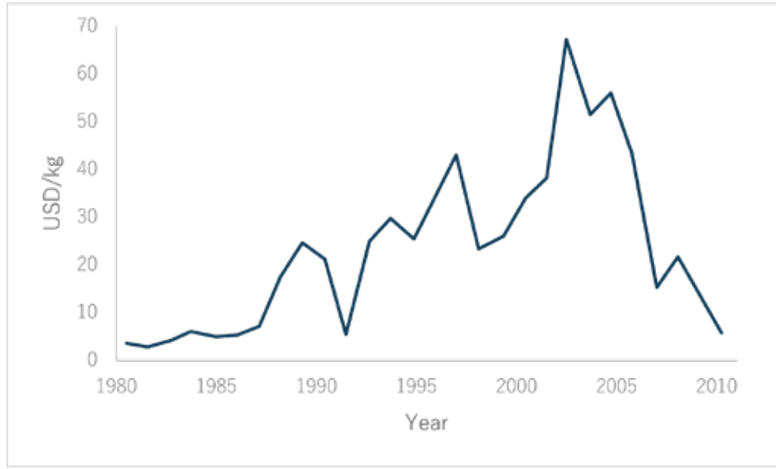
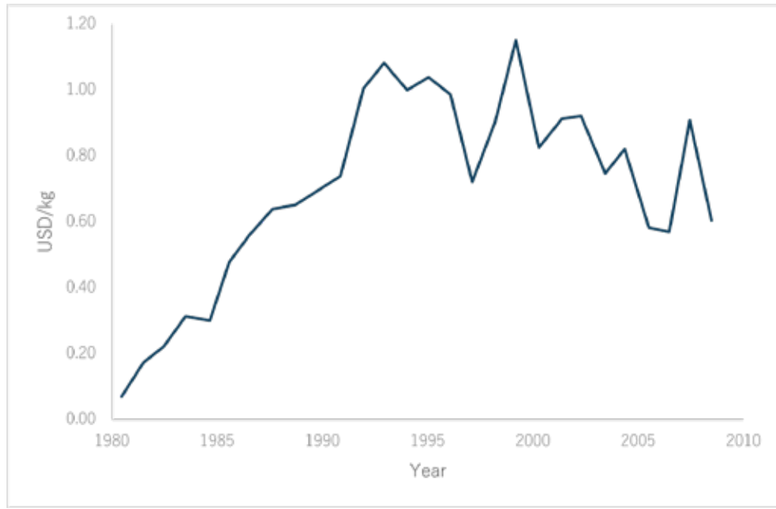


Figure 2: Shark catch data for both reef-associated shark fishery and oceanic shark fishery combined | Sinan et al. (2011)





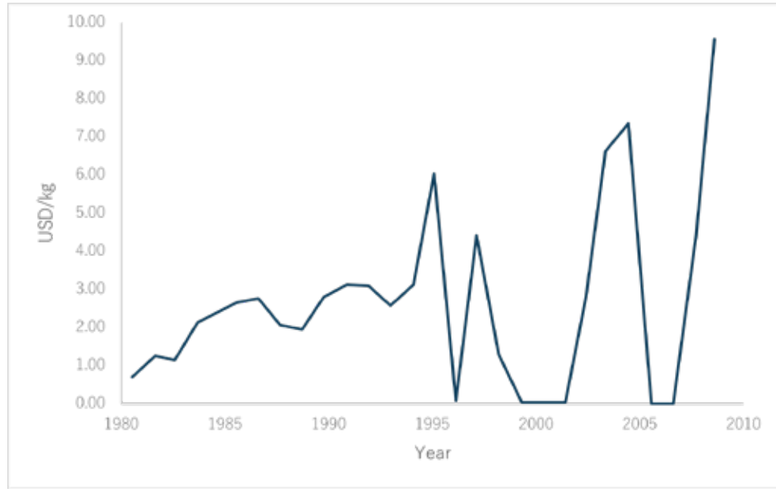


Figure 3: Export prices per kilogram of shark fins, meat, and liver oil (top to bottom) from 1980–2009 | Source: MRC (2009)

not adequate at resolving conflicts between pole and line tuna fishers and the dive-tourism sector. This, coupled with decreased catches of sharks in the 2000s, called for newer management actions. As the Maldivian shark fishery was considered a minor fishery, and due its detrimental nature to important sectors of the country, the government of the Maldives prohibited all types of shark fishing within 12 nautical miles (nm) from any atoll in 2009 and extended the ban to the entire EEZ in 2010.

Previously, a lack of legislation on explicit trade bans on shark and ray products was a major loophole in the conservation and management of sharks. When the 2010 shark fishing ban was implemented, an explicit trade ban on shark products was not announced, as regulations on the trade of all commodities including marine products was under the jurisdiction of the Ministry of Economic Development. However, the General Fisheries Regulation (R-75/2020) under the renewed Fisheries Act of Maldives (Act No. 14/2019) prohibits trade of marine species protected under this regulation, including sharks. In 2022, the Maldives ratified the International Trade Controls on Endangered Species Act (Act No. 13/2022), which implements trade controls on Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed species.

Enforcement and monitoring

Implementation and observation of the shark fishing ban has been effective, but there have been cases of illegal fishing and trading of sharks and their products. The Maldives Coast Guard, Maldives Police Services, and Maldives Customs Services have a joint responsibility in enforcing fisheries regulations and combating illegal trade of protected species. The Coast Guard is responsible for monitoring any contraventions to regulations and laws within the EEZ; the Maldives Police Service monitors illegal fishing-related activities in coastal waters; and the Maldives Customs Service monitors illegal trade of protected species.

Community involvement

Previous efforts on community involvement focused on the dive-tourism sector, where divers contributed greatly to citizen-science research by engaging in shark count surveys during recreational dives. Despite Maldives being one of the worlds' first nations to prohibit shark fisheries, the engagement of local communities in shark and ray conservation efforts has been minimal. Except for the initial years since implementing the shark fishing ban, government-led efforts on educational and outreach activities on shark conservation have become limited. As a result, in local communities where fishing is still important, the acceptance of shark conservation measures is low. However, recently more local NGOs have started initiatives on outreach, education, and research activities on sharks and rays. For example, the Manta Trust worked across several atolls in close collaboration with hotels and dive operators to collect data on manta and devil rays that aggregate in Maldivian waters.

Gaps

Fishing is important for subsistence in many local communities. Since the enaction of the shark fishing ban, the tourism sector has generated increasing revenues from shark dive tourism, but the communities that previously benefited from shark fishing are now facing losses due to shark depredation (sharks taking entire or part of the catch). This has further escalated the disapproval for shark protections among many fishing communities (Sinan et al., 2011; Ali & Sinan, 2014; Chapman et al., 2021).

There is lacking capacity to identify CITES-listed sharks and rays during seizures of illegal shark fin exports. In cases where fin shipments are confiscated by authorities, penalties as of 2023 are only for catching and trading protected species. Due to lack of trained personnel, identification of CITES-listed species through fin inspections is lacking, hence penalties pertaining to export of a CITES-listed species are rarely implemented.

RECOMMENDATIONS

The MMRI undertakes most marine scientific research, including research on sharks. There is no research on rays or chimaeras as of 2023. MMRI, formerly known as the Marine Research Centre, started citizen-science programmes with dive centres at tourist establishments to conduct surveys on sharks in recreational dives. However, due to it being a citizen-science project, it lacks systematic data collection, storage options, and adequate personnel. The programme was discontinued after ten years in 2019. MMRI plans to re-establish another programme with more streamlined and systematic data collection by using an online data repository to submit data, as well as collect data on shark and ray abundance using BRUVs. The MMRI has started observer trips for reef-based fisheries to study the rates of shark and ray interactions and subsequent catch depredations by sharks.

Policy

Incidents of illegal fishing and trade of shark and ray fins and meat do occur and are investigated under the Fisheries Act. However, the prosecution processes are lengthy and penalties for such offenses are relatively minor. The Maldives currently lacks the capacity to identify sharks and rays at the species level, hence penalties pertaining to this are rarely being exercised. For effective enforcement of CITES obligations, authorities need to be trained in shark and ray fin identification and the use of genetic tools in species identification needs to be explored.

Science/knowledge/research

- Government-led research on sharks would benefit from understanding the extent of catch depredation and gear loss caused by sharks in reef fisheries and should identify methods to mitigate shark and ray interactions in fisheries.
- Studies to establish a baseline of shark and ray abundance and understand the status of these populations is also a priority.
- Since there are difficulties in identifying shark products to the species-level during seizures of illegal shark fin exports, there is a need to explore the use of genetic tools for strengthening the implementation of CITES.

Management/governance/conservation

The Maldives formulated its first National Plan of Action on Sharks (NPOA-Sharks) in 2014, with the aim of 'implementation and observation of total shark ban'. The NPOA-Sharks identified key areas that required work and identified required actions. Among key areas that still hold importance are:

- Improving data collection and monitoring in fisheries;
- Researching shark populations;
- Raising awareness and sensitizing local communities on shark conservation measures; and

Table 1: Shark-specific management measures | Source: Sinan et al. (2011)

DATE	MANAGEMENT MEASURE
10 November 1981	Longlining prohibited during daytime in tuna fishing areas (Ministry of Fisheries and Agriculture [MOFA] Iu'laan 48/81/34/MF).
19 May 1992	Longlining with live bait prohibited in vicinity of other vessels fishing for tuna schools (Ministry of Fisheries and Agriculture Iu'laan 16/92/29FA.A1). Superseded MOFA Iu'laan 48/81/34/MF.
5 June 1995	First Marine Protected Areas (MPAs) declared (15 dive sites were protected, nine of which were well-known for reef sharks; Ministry of Planning, Human Resources and Environment Iu'laan E/95/32).
24 June 1995	Prohibition on Whale Shark (*Rhincodon typus*) fishing (MOFA Iu'laan FA-A1/29/95/39).
8 October 1996	Within 3-mi (~4.82 km) radius of all fish aggregating devices, shark fishing or any type of fishing that can harm pole-and-line tuna fishing were prohibited (MOFA Iu'laan FA-A1/29/96/39).
28 November 1996	Prohibits longlining in vicinity of seamount between Hadhdhunmathi and Huvadhoo Atolls (MOFA Iu'laan FA-A1/29/96/43).
10 December 1997	Prohibits longlining in vicinity of seamount south of Addu Atoll (MOFA Iu'laan FA-A1/29/96/54).
8 September 1998	Ten-year (1998–2008) moratorium on shark fishing within 12 nm of seven atolls (MOFAIu'laan-FA-A1/29/98/39).
1 March 2009	Bans shark fishing within 12 nm of any atoll (MOFA Iu'laan FA-D/29/2009/20).
11 March 2010	Bans shark fishing throughout Maldives from 15th March 2010 (MOFA Iu'laan 30-D2/29/2010/32).

- Improving coordination between relevant authorities to monitor the ban and illegal trade.

As all rays are managed under the Environmental Protection and Preservation Act (EPPA; Act no 4/93), the above-mentioned national plan on sharks does not address rays. All species of rays are protected in the Maldives under the Protected Species Regulation (R-25/2021) and under this regulation, conservation and best practice guidelines are being developed at the time of writing. An updated National Plan is needed and could address actions focusing on these key areas.

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Reef Manta Rays *Mobula alfredi* at Hanifaru Bay in the Maldives | Vincent Kneefel | Ocean Image Bank

Neonate Blacktip Reef Sharks *Carcharhinus melanopterus* in Maldivian lagoons | David Robinson | Ocean Image Bank

Tiger Shark *Galeocerdo cuvier* in the Maldives | Vincent Kneefel | Ocean Image Bank

Pink Whipray *Pateobatis fai* at Reethi Falhu in Baa Atoll, Maldives | Guy M. W. Stevens | Manta Trust

OMAN

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INTRODUCTION

Situated in the Arabian Peninsula, The Sultanate of Oman (hereafter 'Oman') is a large country comprised of 11 governorates (NCSI, 2021). It is neighboured by the Kingdom of Saudi Arabia (KSA) to its west, the United Arab Emirates (UAE) to its northwest, and Yemen to its southwest. Oman's coastline is roughly 3,165 km long (NCSI, 2021) and faces the Sea of Oman to its northeast and the Gulf of Aden to its south. Oman has an Exclusive Economic Zone (EEZ) and shelf area of approximately 529,559 km^2 and 47,854 km^2, respectively (Seas Around Us, 2016). Upwellings occur within Oman's waters as a result of the summer and winter monsoon seasons, leading to highly productive waters (Morgan, 2006). The summer monsoon, locally called the *khareef*, is typically during the months of May–August whilst the winter monsoon, or Shamal, is from December–March (Claereboudt, 2019).

The fishing industry plays a significant role in the Sultanate's economy. In the early 2000s, the fishing industry contributed approximately 54% of the agricultural gross domestic product (GDP) and about 1.1% of the nation's GDP (Morgan, 2006). There are 11 families of commercial interest in demersal and pelagic fisheries, of which the most commonly landed include barracudas (Sphyraenidae), croakers (Sciaenidae), emperors (Lethrinidae), groupers (Serranidae), grunts (Haemulidae), jacks and scads (Carangidae), seabreams (Sparidae), snappers (Lutjanidae), threadfin breams (Nemipteridae), cuttlefish (Sepiidae), and ribbon fish (Trachipteridae; Morgan, 2006; FAO, 2024b). The pelagic fishery primarily targets abalone (Haliotidae), lobster (Palinuridae), and tunas (Scombridae; FAO, 2024b).

Sharks and rays are targeted, usually by artisanal fishers. For example, in the Sea of Oman and Arabian Sea, hammerheads (Sphyrnidae) and requiem sharks (Carcharhinidae) are targeted due to their high value in international markets and local traditions (Henderson et al., 2004; FAO, 2024b). Shark fishing is an old tradition that is still ongoing as of 2024, especially in certain fishing communities such as Kumzar in the Mussandam Peninsula (Castelier, 2020; Looker, personal observation, 2024). This tradition is commonplace across the region and has led to significant declines in shark populations since the 1990s (Jabado et al., 2018). For example, in a local ecological knowledge survey in Oman, fishers noted that they perceived an ~75% decline in shark populations since the early 2000s (Almojil, 2021).

Compared to the rest of the Arabian/Persian Gulf, Omani waters have relatively higher species richness (Jabado et al., 2018). According to the IUCN Red List of Threatened Species, 105 sharks (n=55), rays (n=49), and chimaera (n=1) are known to occur in Omani waters (IUCN, 2024). Of these, 73 (69.5%) are threatened with extinction (16 are Critically Endangered, 31 are Endangered, and 26 are Vulnerable), 17 are Near Threatened, 10 are Least Concern, and five are Data Deficient (IUCN, 2024). There are also a few country-endemic species (i.e., Oman Guitarfish, *Acroteriobatus omanensis*) and species endemic to the region (e.g., Harlequin Catshark [*Ctenacis fehlmanni*] and Smoothtooth Blacktip Shark [*Carcharhinus leiodon*]; Moore et al., 2013; Jabado et al., 2018). The only chimaera confirmed in Omani waters is the Sicklefin Chimaera (*Neoharriotta pinnata*), but it is not targeted, nor has it been observed in landings (Looker, personal observation, 2024).

Omani waters serve as an important reproductive area for several species with parturition of sharks (e.g., Blacktip Shark, *Carcharhinus limbatus*) having been recorded during spring and summer (Henderson et al., 2004; Henderson & Reeve, 2014). There are exceptions like the Milk Shark (*Rhizoprionodon acutus*), which appears to reproduce year-round, likely because it is one of the most heavily exploited shark species by fisheries (Henderson et al., 2004; Henderson & Reeve, 2014). There are limited data on important areas for rays, although there have been observations of small Halavi Guitarfish (*Glaucostegus halavi*), Longtail Butterfly Ray (*Gymnura poecilura*), and Sandwich-tail Whipray (*Brevitrygon manajajiae* formerly known as *Himantura imbricata*) at landing sites from late spring to early summer (Henderson & Reeve, 2014). Additional research is required to determine which areas are important and understand seasonal behaviours (Henderson & Reeve, 2014).

Ten Marine Protected Areas (MPAs) have been established 0across the country. The largest, the Marine Mammal Reserve, covers 8.2% of Oman's territorial waters, followed by the Arabian Sea Reserve (6.7%), with the remaining MPAs each covering <1% of territorial waters (MCI, 2024).

There are five areas within Omani waters that were designated as Important Shark and Ray Areas (ISRAs) in 2023: Daymaniyat Islands, Gulf of Masirah, Hallaniyat Islands, Musandam, and Muscat, as well as the Strait of Hormuz Corridor, a transboundary area (Jabado et al., 2023). The Daymaniyat Islands are characterised by sandy and coral areas that support fish spawning events and aggregations of Whale Shark (*Rhincodon typus*; Jabado et al., 2023) from September–November (Hilal, 2023), as well as comprising important sites for threatened species such as the Vulnerable Blacktip Shark and Critically Endangered Bowmouth Guitarfish (Rhina *ancylostomus*; Looker, personal observation, 2024). The Gulf of Masirah contains coral reefs, mangroves, rocky and sandy areas, and seagrass beds where Blacktip Shark is present and reproduction areas for Milk Shark are known to occur (Jabado et al., 2023). Hallaniyat Islands comprise of four islands surrounded by coral reefs, rocky patches, and sandy substrate where the presence of the Vulnerable Blotched Fantail Ray (*Taeniurops meyeni*) and range-restricted Oman Bullhead Shark (*Heterodontus omanensis*) have been confirmed, and where Shorthorned Pygmy Devil Ray (*Mobula kuhlii*) aggregations have been observed (Jabado et al., 2023). Corals, rocky and sandy areas, and upwellings characterise Musandam, where aggregations of Whale Shark and reproductive areas for Indo-Pacific Leopard Shark (*Stegostoma tigrinum*) are found (Jabado et al., 2023). Muscat has a wide continental shelf covered with sandy bays and rocky areas and has seasonal upwellings and phytoplankton blooms, as well as reproductive areas for Bigeye Houndshark (*Iago omanensis*; Jabado et al., 2023). The Strait of Hormuz Corridor is a shallow area where Whale Shark travels between the Arabian/Persian Gulf and the Sea of Oman (Jabado et al., 2023).

Falah Island, also known as 'shark island', was named after the high abundance of Blacktip Shark seen in the 1990s. However, as of 2024 this species' population appears to have drastically declined due to overfishing (Looker, personal observation, 2024).

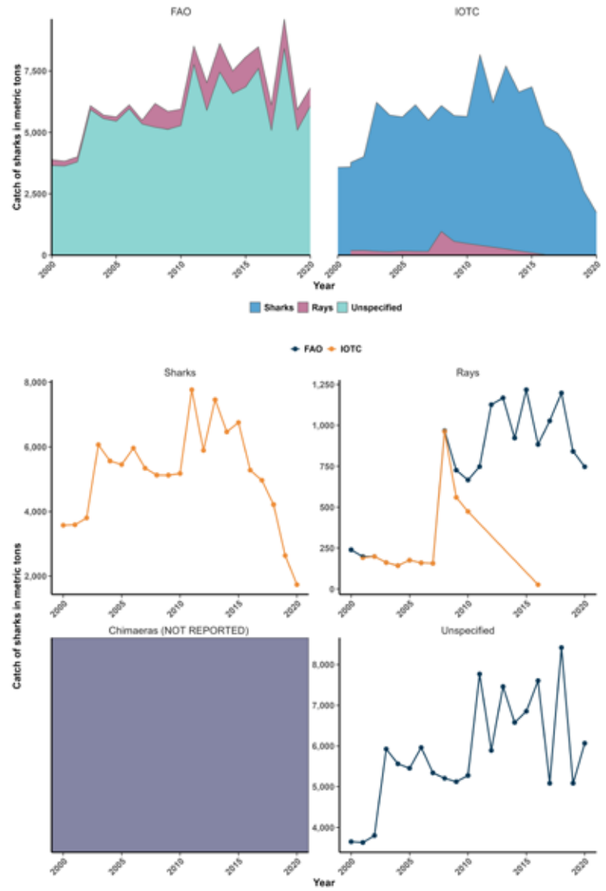
FISHERIES

Fleets

Oman's fisheries can be divided into an artisanal and industrial sector. Artisanal fisheries dominate the volume of catches, accounting for over 94% of all marine catches at 254,767 metric tonnes (mt) of the 257,172 mt in 2020 (NCSI, 2021). In 2020, 51,600 fishing licenses were issued and 24,349 boats were registered in the total fleet (NCSI, 2021).

Artisanal fishers use several types of vessels, including skiffs (fibreglass or aluminium boats, 5–9 m in length) which are the dominant artisanal vessel type (93% in 2010) used across Oman's territorial waters; wooden *dhows* (traditional canoes, 10–15 m) used mainly in the Alshaqiah governorate; wooden *houris* (3–10 m); and *shashas* (3–4 m) made from the fronds of palm trees and mainly found in the Albatinah governorate (Khalfallah et al., 2015). Of these, motorised fibreglass skiffs and wooden *dhows* with ice boxes are used to target sharks and rays (Henderson et al., 2007; FAO, 2024b; Looker, personal observation, 2024).

Oman's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



Until 2011, industrial fisheries primarily targeted demersal fish and cuttlefish using demersal trawlers, which operated at least 16 km away from the coast, at depths of at least 50 m. This gear was banned due to overfishing. To target large pelagic species (e.g., tuna) longlines (*manshalla*) are used on vessels operating beyond 20 nm (Morgan, 2006; Henderson et al., 2009; Khalfallah et al., 2015; FAO, 2024b).

While there exists subsistence and recreational fisheries, there are no data available on their catches.

Gear

Fisheries in Oman are multi-gear and multi species. The traditional *dhows* used seines (*yaroof*) and drift nets (*al-hayali*), as well as mono-filament gillnets (*al-liekh*) prior to them being banned under the Royal Decree 20/2019 promulgating the Law on Living Aquatic Wealth (FAO, 2024b). However, gillnets can still be bought locally and are used by skiff fishers as well (Looker, personal observation, 2024). Based on a bycatch study conducted in 2013 for the Environment Society of Oman (ESO) interviewing most fishers on Masirah, depending on the season and which species are targeted, the nets will either be top-, mid- or bottom-set, often with a soak time of over 24 hours (Looker, personal observation, 2024). Other gears used include handlines and pole lines, longlines, troll lines, barriers, fences, and weirs (Henderson et al., 2009). Prior to the ban in monofilament nets, various types of gillnets were used to target sharks such as drift nets for pelagic species (e.g., Blacktip Shark) and fixed (set) gillnets for semi-pelagic or demersal sharks (e.g., Milk Shark; Henderson et al., 2004). At less than 100 m depth, 70x6 m gillnets were used, in deepwater the net would be set 3–4 m below the surface (Henderson et al., 2004). However, targeted shark fisheries primarily use handlines, pelagic and demersal longlines, and driftnets, as well as illegal gillnets (Henderson et al., 2007, 2009; Almojil, 2021; Looker, personal observation, 2024). Ropes extending as far as 3 km, fitted with tuna heads tied 28 m apart from each other as bait are also used to target sharks (Al Mukrashi, 2016). Based on fishery and landing surveys from 2009–2011, it was estimated that the catch per unit effort (CPUE) for longlines and drumlines was 0.014 and 0.009 sharks and rays per hook per hour, respectively, and 6.4 sharks and rays per hour for trawls (Henderson & Reeve, 2014). Rays, especially guitarfishes, are targeted, but limited information is available on the gears used.

PRODUCTION

Overall landings

While it was operational, the demersal trawl fishery was responsible for the majority of catches in the industrial fishery. In 2002, 10,682 mt (86.1% of total catches), with a value of USD 16.7 million, was reported to the Food and Agriculture Organization of the United Nations (FAO; Morgan, 2006). In the same year, catches from the pelagic longline fleet reached 1,720 mt (13.9%) with a value of USD 7.6 million (Morgan,

Small scale fishing boats, tarads, in Muscat, Oman | Rima W. Jabado

2006). However, since 2010, small pelagic fish have made up the majority of total catches, including sardines, Indian Mackerel (*Rastrelliger kanagurta*; 12%), and small jacks (FAO, 2024b). In 2012, the most landed species were small pelagics, followed by large pelagic species, demersal catch (i.e., ribbonfish, emperor, croaker, and catfish), and sharks and rays (FAO, 2024). There are limited data regarding discards, given that it is illegal, but it has been suggested that 1% of total catches during the early 2000s were discarded (Kelleher, 2004).

The artisanal fishery reports the largest volume of catches, totalling 114,180 mt in 2002 (Morgan, 2006). This is dominated (99.6%) by coastal fisheries with 113,750 mt (USD 102.3 million), and the remaining catches were reported from the lobster (0.3%) and abalone fisheries (0.1%; Morgan, 2006).

Shark and ray landings have fluctuated between 3,830–9,614 mt (averaged 6,464 mt annually) between 2000–2022, but generally have shown an increasing trend, as the artisanal fishery grew, based on reports to the FAO (FAO, 2024a). These landings were reported under generic labels, i.e., 'Rays, stingrays, mantas nei [not elsewhere included]' and 'Sharks, rays, skates, etc. nei', the latter category was more prominent, with an average of 5,756 mt annually compared to 708 mt annually for the former (FAO, 2024a). Similarly, estimates from the Sea Around Us indicate that from 2000–2019, shark and ray landings ranged between 3,697–9,354 mt (average 6,508 mt annually), valued from USD 3.4–24.7 million (Khalfallah et al., 2015, 2020). No data are available for chimaeras.

Under national statistics, Oman recorded 7,073 mt of sharks (6,314 mt) and rays (759 mt) landed by artisanal fisheries in 2020 (NCSI, 2021). Of these, 6,068 mt of sharks and 747 mt of rays were landed by artisanal fishers from Dhofar (1,831 mt), Ash Sharqiyah South (1,322 mt), Al Wusta (1,232 mt), Al Batinah (1,198 mt), Musandam (830 mt), and Muscat governorates (401 mt; NCSI, 2021). Additionally, 245 mt of sharks were landed by the coastal fishery in the same year (NCSI, 2021).

Species-specific

Landed shark and ray species have been primarily observed in Masirah, including thresher sharks (family Alopiidae), hammerheads (family Sphyrnidae), mako sharks (*Isurus* spp.), Bramble Shark (*Echinorhinus brucus*), Silky Shark, Milk Shark, cownose rays (*Rhinoptera* spp.), and eagle rays (Aetobatidae family; Henderson et al., 2007; Peschak, 2012; Looker, personal observation, 2024). In Kumzar, shark fishers mainly catch Blacktip Shark, Whitetip Reef Shark (*Triaenodon obesus*), hammerheads, and rarely Whale Shark (Castelier, 2020). Whale Shark is usually not targeted, and if a live specimen is caught incidentally, they are released as they are not commercially valuable (Times News Service, 2018). While sharks and rays are usually landed, they have occasionally been found discarded after unloading, while rays are de-winged and the rest of the body is usually discarded (E. Looker, personal observation, 2024).

There are limited species-specific catch or landings data available, with no reports at this level to FAO; most shark and ray catches (99.9%) from 2000–2019 were labelled as 'Elasmobranchii' (Khalfallah et al., 2015, 2020).

Little research has been undertaken in Oman on shark and ray fisheries since 2015. Based on landings surveys undertaken prior to 2010, there are at least 44 shark (n=29) and ray (n=15, of which six are guitarfish) species that are commercially landed, of which eight species dominate: Milk Shark, followed by Bigeye Houndshark, Spottail Shark, Sliteye Shark (*Loxodon macrorhinus*), Hardnose Shark (*C. macloti*), Blacktip Shark, Scalloped Hammerhead (*Sphyrna lewini*), and Silky Shark (*Carcharhinus falciformis*; Henderson et al., 2004, 2007, 2009). Compared to the other sharks, there was a significantly greater proportion of female Bigeye Houndshark than males (4.5:1) landed (Henderson et al., 2004, 2009). It is important to note that there were landing biases towards 'smaller' (<100 cm total length, TL) animals observed here, i.e., mature specimens of smaller species (e.g., Milk Shark, Hardnose Shark, and Sliteye Shark) and juveniles of larger species (e.g., Spottail Shark), possibly due to the gear used (Henderson et al., 2009).

Few rays have been observed at landing sites, with some specimens of Longtail Butterfly Ray, as well as Halavi Guitarfish, Bengal Whipray, and Whitespotted Whipray (*Maculabatis gerrardi* formerly known as *Himantura gerrardi*) occasionally seen (Henderson & Reeve, 2014).

TRADE

Processing

Shark catches from artisanal fisheries are landed whole and sold fresh in Oman, primarily at the Masirah landing site, with a portion of this being refrigerated and sold to the KSA, UAE, and Yemen (Morgan, 2006; Khalfallah et al., 2015; Castelier, 2020; FAO, 2023, 2024b; Looker, personal observation, 2024), or dried/salted at processing facilities in southern Oman for consumption (Henderson et al., 2004; Khalfallah et al., 2015). Industrial catches tend to be frozen onboard and then exported to Asia, Europe, and Africa (Khalfallah et al., 2015).

Traditionally, sharks were sought after for their meat but in the late 1990s, this shifted to targeting these species for their valuable fins (Henderson et al., 2004, 2009). Shark meat is often dried and can be found headless and butterfly sliced in markets (Peschak, 2012; Looker, personal observation, 2024). Fins are attached to the shark until landed, where they are removed and usually dried to be exported (Looker, personal observation, 2024). In a month, a shark fisher may earn as much as OMR 1,500 (~USD 3,900) by selling ~15 large sharks, especially their fins, to UAE or other Asian markets (Dent & Clarke, 2015; Al Mukrashi, 2016). However, interviews with traders in the early 2000s noted that the number of sharks being processed were decreasing, with a noted reason being due to lack of supply. For example, a processing plant in Sur which had previously processed over 500 sharks annually had closed (Henderson et al., 2004).

Liver oil was traditionally extracted from sharks to produce eyeliner locally known as *kohl* (see 'Cultural Significance' section) and to waterproof wooden *dhows* (Henderson et al., 2004; Al Mukrashi, 2016). Other parts of the shark are used, such as skin for their leather, liver, jaws and cartilage, but as exports to Asian countries mainly (Henderson et al., 2004).

Anecdotal information suggests that rays are targeted for their wings (Looker, personal observation, 2024). However, little information is available on the ray species being processed and how they are utilised if retained.

Domestic

At or near landing sites, large sharks (>1.5 m TL) are sold for consumption, similarly small and/or juvenile sharks are sold in local supermarkets (Looker, personal observation, 2024), with a 200 g bag of dried shark pieces selling around OMR 1,950 (~USD 5.07, see https://www.luluhypermarket.com/en-om/al-maradem-dry-shark-fish-200-g/p/326553). Sharks are usually dried to be cooked in traditional dishes, such as *rabees* (see 'Cultural Significance' section), or used fresh in soup (Looker, personal observation, 2024).

Export

The main shark product exported from Oman are the highly valuable shark fins, the selling price of which varies depending on the species and the type and size of fin, though generally the size is proportional to its value (Henderson et al., 2004). Scalloped Hammerhead can fetch the highest price in the fin trade (Henderson et al., 2004). Sharks, wedgefishes (Rhinidae), and guitarfishes (Glaucostegidae and Rhinobatidae) are also frequently transported to the UAE in trucks where they are auctioned and processed for their fins and their meat (Jabado et al., 2015; Jabado, 2018).

According to FAO reports, in 2019–2021, between 132–421 mt (valued between USD 145–296 thousand) of shark and ray products were exported, of which 6–73 mt (USD 820–29,730) were re-exported (FAO, 2023). Most fish products are exported fresh or chilled to the KSA and UAE via freezer trucks (Morgan, 2006; Peschak, 2012; Khalfallah et al., 2015; Jabado et al., 2015). In 2020 and 2021, fresh or chilled sharks as well as dried or salted sharks dominated exports (both >37% or >140 mt each year; FAO, 2023). A small portion (1.3 mt or 0.3% in 2021) of fresh or chilled rays were reported (FAO, 2023). Dried shark and ray products are also frequently exported, primarily exported to Hong Kong Special Administrative Region (SAR), as well as China, Viet Nam, Sri Lanka, Italy, and Qatar in lower quantities (<20 mt; FAO, 2023). In 2019, the products most exported (by weight) were 94.5 mt of dried or salted shark fillets (71.6%), then 20.84 mt of dried shark fins (15.8%), with the remainder being fresh or frozen sharks (FAO, 2023).

However, reports to FAO are suspected to be an underestimate of total exports, especially considering the low number of fins reported. In the Arabian Peninsula, Oman is amongst the top exporter of fins (Almojil, 2021; Looker, personal observation, 2024) and was amongst the top five fin exporters to Hong Kong SAR in 2012 (Peschak, 2012). In 2019–2021, Oman reported exporting nearly 590 mt of sharks and rays to United Nations (UN) Comtrade (UN Comtrade, 2024). Fresh or chilled sharks were still the primary exports in volume, with an average of 180 mt annually, followed by shark fins (53 mt), and fresh or chilled rays (20 mt; UN Comtrade, 2024).

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed species are included amongst the shark and ray products exported from Oman for commercial and occasionally educational purposes (CITES Secretariat & UNEP-WCMC, n.d.). These products are from wild specimens and include primarily fins and other smaller quantities of meat and skins exported for commercial purposes (CITES Secretariat & UNEP-WCMC, n.d.). In 2012–2022, Oman reported the top shark exports by species, being 81.6 mt of Silky Shark, 24.9 mt of Shortfin Mako (*Isurus oxyrinchus*), 19.0 mt of Great Hammerhead (*Sphyrna mokarran*), and 13.6 mt of Oceanic Whitetip Shark (*Carcharhinus longimanus*) in the entire time period (CITES Secretariat & UNEP-WCMC, n.d.). The

Shark fins set aside for processing at fish factory in Seeb, Oman | Rima W. Jabado

Sharks piled on truck for intercity transport in Oman | Rima W. Jabado

Longtail Butterfly Ray *Gymnura poecilura* and cownose rays *Rhinoptera* landed in Al Duqum, Oman | Rima W. Jabado

Spotted Eagle Ray *Aetobatus ocellatus* caught in a beach seine | heliastes21 | iNaturalist.org (CC BY-NC)

top ray exported was Whitespotted Wedgefish (*Rhynchobatus djiddensis*) with ~2 mt, other guitarfishes, wedgefishes, and Spinetail Devil Ray (*Mobula mobular*) contributed less than 1 mt each (CITES Secretariat & UNEP-WCMC, n.d.).

Import

In recent years (2019–2021), between 431–506 mt of shark products (worth USD 188 thousand to 1.38 million) were reportedly imported, of which over 99% originated from Yemen (FAO, 2023). The majority (>70% by weight) of these products were fresh or chilled sharks, followed by dried or salted shark fillets (<14%), and around 1% were dried/salted/smoked shark fins and fresh or chilled ray meat each (except in 2019 where 16%, 77.8 mt, were reported; FAO, 2023).

Shark and ray imports reported to the UN Comtrade from 2019–2021 totalled over 1,250 mt valued at USD 1.7 million (FAO, 2023). Similar to FAO records, during this period, fresh/chilled sharks comprised the majority of this catch, averaging 383 mt annually (FAO, 2023). Rays (fresh or chilled) had the second highest imports on average with 28 mt annually, followed by shark fins with 5 mt (FAO, 2023).

Records provided to both the FAO and UN Comtrade indicate that shark and ray meat is the most desirable import. However, according to Hong Kong SAR's Census and Statistics Department, there are larger quantities of dried fins being imported, with over 65 mt recorded since 2012, peaking at 1,049 mt in 2018, and currently reaching 760 mt in 2023 (Hong Kong Census and Statistics Department, 2023). It is important to note that fin imports also include the CITES-listed Oceanic Whitetip Shark, Great Hammerhead, and Scalloped Hammerhead that were either from wild specimens to be used for educational purposes or confiscated/seized specimens for law enforcement (CITES Secretariat & UNEP-WCMC, n.d.). Whether these fins were utilised or re-exported elsewhere is not clear. Additionally, live, captive-bred, Ocellate River Stingray (*Potamotrygon motoro*) are also commercially imported in various quantities (CITES Secretariat & UNEP-WCMC, n.d.).

CULTURAL SIGNIFICANCE

Liver oil from sharks is used to make *kohl*, a traditional eyeliner prepared by Omani women. *Kohl* is traditionally used to deflect the sun, much like sunglasses do. Landed sharks are stored for two days, unexposed to sunlight and dust, to brew their liver (Al Ghalaini, 2021). Oil is extracted from the liver, filtered, then dipped into with cotton, burned, and covered with an *Al-Jahlah* (type of clay pot) to create a soot. The soot is collected and soaked with water before either being dried into powder form or being burned, dried, and grinded with local plants, then soaked in water again to create *kohl* (Al Ghalaini, 2021; Al Oraimi, 2024).

Shark meat is valued in traditional dishes such as *rabees*, where it is cut into small pieces, boiled, shredded, then seasoned and stir fried (Looker, personal observation, 2024).

Dhow vessel with fishing nets on Masirah Island, Oman | Rima W. Jabado

RESEARCH

There have been limited research efforts, in part due to lack of funding, focusing on sharks, rays, and chimaeras in Oman. Few studies have been conducted evaluating this species group's biology and the impacts of fisheries (e.g., Henderson et al., 2004, 2007, 2009). In 2024, the Indian Council of Agricultural Research - Central Marine Fisheries Research Institute (ICAR-CMFRI) initiated a collaborative project between India and Oman to improve research and capacity building for shark and ray conservation (Shukla, 2024).

MANAGEMENT

Governance framework

Fisheries management is overseen by the Ministry of Agriculture, Fisheries and Water Resources (MAFWR). One of the outcomes of the MAFWR is to renew a five-Year National Development Plan to develop and modernise the fishing industry.

Policy

Under Decree 4 of 1994, fishers are prohibited from discarding any shark part or shark waste at sea or inshore. The handling, marketing, or exporting of any shark part is also prohibited unless a licence is obtained from the competent authority. Captured sharks must be landed, transported, and sold whole, with finning prohibited without a special permit by the appropriate authority. No regulations are in place for rays or chimaeras.

Other non-shark specific legislations which may indirectly benefit sharks and rays include (Morgan, 2006; Khalfallah et al., 2020; FAO, 2024b):

- Bottom trawlers are banned;
- The use of mono-filament nets is banned;
- The use of spearguns to fish is also banned, under police regulation (Royal Decree 20/2019 Promulgating The Aquatic Living Resources Law, Article 13);
- There are restrictions on the number of registered and licenced vessels;
- Catch quotas were established for the industrial, demersal and pelagic fisheries, set at a total of 103,500 mt (28,000 and 75,500 mt, respectively) as of 2006;
- Industrial fishing vessels are prohibited from fishing in and near areas reserved for artisanal fishers (i.e., within 20 nm);
- No vessel is allowed to continue fishing operations in one section for more than five consecutive days. The maximum duration of any fishing trip is restricted to 60 days for longline vessels;
- Distance between adjacent vessels during fishing operation should be at least 5 nm;
- Fish discarding is mostly prohibited, although in practice, a limited amount of discarding is permitted;
- At least one surveillance officer must be onboard each fishing vessel for monitoring and surveillance purposes; and
- Fishers are required to obtain a licence to fish.

Enforcement and monitoring

Oman has been a Party to the United Nations Convention on the Law of the Sea (UNCLOS) since 1989, the Convention on Biological Diversity (CBD) since 1995, and CITES since 2008. There have been some efforts by the MAFWR to spread awareness about CITES-listed species to reduce catches of these species (E. Looker, personal observation, 2024); however, the effectiveness of this has yet to be proven.

There are hotlines provided by the MAFWR where callers can report wildlife violations and stranded turtles/cetaceans, but this number is also used to report oil spills as spills are frequently reported the staff. For example, in 2020 a caller had reported a live guitarfish captured and tethered by a rope to an anchor. The fisher was fined and had to release the specimen alive (Looker, personal observation, 2024).

Community involvement

There have been limited educational and awareness campaigns on the importance of sharks and rays in Oman. Considering the traditional value of these species there is a negative reception towards their conservation and sustainable fishing (Looker, personal observation, 2024).

Gaps

Despite the fisheries sector being well monitored, especially in terms of fishing licences, vessel registration, and targeted species catch, there is limited conservation management for sharks, rays, and chimaeras (Almojil, 2021).

Oman is Party to CITES, yet listed species are still caught and traded in large quantities without an assessment of the impact of the trade on the species. Due to lack of awareness and training on species identification, this provides difficulties in enforcement, despite there being identification guides available (e.g., Reeve et al., 2011a, b). For example, in 2021 a Whale Shark was incidentally caught in a net, and although there is no legislation against shark fishing, the fisher was still fined due to the specimen being misidentified as a whale, which is illegal to hunt (Muscat Daily, 2021).

There is a lack of transparency in the trade routes of shark and ray products to and from Oman, with reports to different entities displaying varying information. There is limited monitoring in place at the border for fish products and limited compliance with the need for CITES permits, providing difficulties in tracing the origin of imported or exported shark and ray products (Looker, personal observation, 2024).

While there are existing MPAs, enforcement and their effectiveness in conservation management are unknown. Furthermore, at the time of their creation, sharks, rays, and chimaeras were not considered. For example, at the Daymaniyat Islands Nature Reserve, there is a popular dive and snorkelling site called Blacktip Alley due to the abundance of Blacktip Shark, yet fishing here is not completely banned within the MPA; Omani fishers are still able to acquire a fishing license to operate within the reserve, and have been observed setting lines (Looker, personal observation, 2024).

RECOMMENDATIONS

Policy

- Due to the high catch quotas permitted in industrial fisheries, and the resulting high levels of shark and ray bycatch, it would be beneficial to these species as well as commercial species' populations if these quotas were to be lowered.
- Considering the relatively frequent occurrence of large female sharks and juveniles in landings, it would be beneficial to set size restrictions for commonly landed species (Henderson et al., 2009).

Science/knowledge/research

- Although several workshops on shark and ray identification have been organized in Oman since 2010 by the International Fund for Animal Welfare (IFAW), continuous species identification training to fisheries officers would improve the taxonomic resolution in existing data; it could support future stock assessments; and ensure compliance with CITES listings.
- Providing educational and awareness campaigns on the importance of sharks and rays in Omani waters would be beneficial for these species' conservation and management.

Management/governance/conservation

- While observers are required to be onboard industrial vessels to monitor activities, there is limited capacity for this due to lack of staff. Thus, building capacity should be a priority to improve monitoring efforts and enforce existing laws (Morgan, 2006). It would also provide more jobs for locals and increase 'Omanisation' (a nationalization programme), especially with marine biology graduates from local universities such as Sultan Qaboos University (SQU).
- There is a need to improve traceability of shark and ray products by providing accurate information on the quantities of sharks and rays traded.
- Current and future MPAs should consider full protection for sharks, rays, and chimaeras.
- Increasing the number of trained fisheries officers at landing sites, as well as at borders would increase

traceability of shark and ray products being traded, as well as encouraging compliance with CITES listings.
- The existing hotlines to report illegal discards would benefit from continued further training.
- There is a need for improving public awareness and outreach to educate fishers (and consumers) on banned fishing gears and protected species, such as clear signage at fish landing sites, fish souqs and marinas/ports or notifications on social media outlets.

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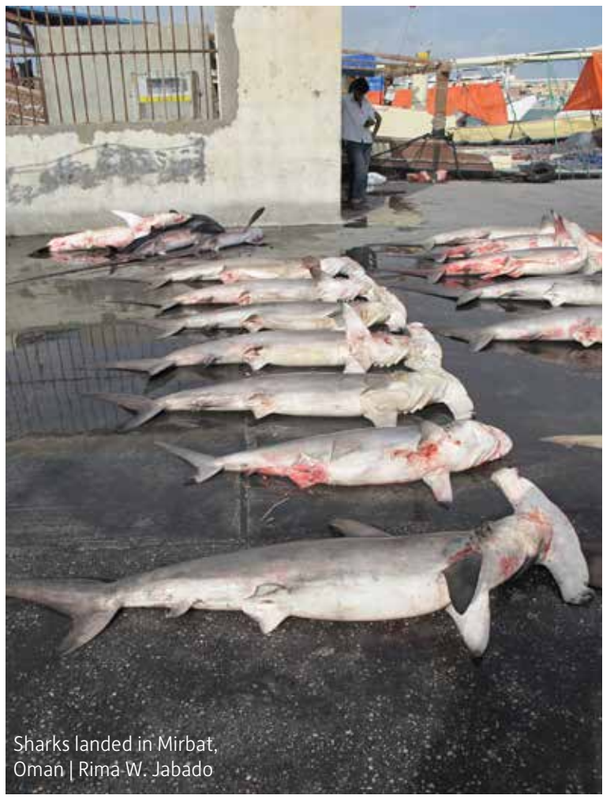
Moore A.B.M., Almojil D., Harris M., Jabado R.W., & White

Sharks being offloaded from dhow boats in Mirbat, Oman | Rima W. Jabado



Sharks landed in Mirbat, Oman | Rima W. Jabado

Shark meat being dried in Al Duqum, Oman | Rima W. Jabado

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Indo-Pacific Leopard Shark *Stegostoma tigrinum*, Daymaniyat Islands, Oman | David Robinson

PAKISTAN

Geowinter | Pexels

PAKISTAN

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INTRODUCTION

The Arabian Sea is the northwestern extension and contiguous sea of the Indian Ocean. This sea is connected to two high-salinity and high-temperature water bodies, i.e., the Persian Gulf, through the Gulf of Oman and the Strait of Hormuz; and in the southwest, the Gulf of Aden connects it with the Red Sea. Pakistan forms a major part of the northern border to the Western Indian Ocean; it has a coastline of about 1,000 km which extends between the Indian border in the east and the Islamic Republic of Iran's border in the west. Pakistan's Exclusive Economic Zone (EEZ) is 240,000 km².

The River Indus, which is the 19th longest river in the world, discharges on the east coast of Pakistan forming a large delta which covers approximately 6,000 km². This river is comprised of 17 major creeks, numerous minor creeks, extensive mudflat areas, and 1,290 km² of mangrove forests. The dense forests are mostly located in pockets created by the creeks.

Oceanographic conditions along the coast of Pakistan are driven primarily by the Indian Ocean monsoons. The southwest (summer) monsoon season is from mid-May to mid-September, and the northeast (winter) monsoon season is from December to February. The months of mid-September to November and March to mid-May are transition months, known as the post-southwest monsoon calm period and the pre-southwest monsoon calm period, respectively. The presence of a permanent oxygen minimum zone between 150–1,000 m depth is one of the significant features of the Arabian Sea which affects the distribution and abundance of fish and shellfish fauna, including sharks and rays in coastal and offshore waters of Pakistan. The seasonal reversal of winds leads to upwelling of nutrient-rich water along the continental shelf during the summer monsoon season. The presence of upwelled low-oxygen water on the continental shelf affects the distribution of demersal fishes and shrimps. The movement of demersal fishes including sharks, rays and shrimps, to avoid the low oxygen water, restricts distribution, concentrates biomass, and, consequently, increases availability to fisheries. The distribution and abundance of sharks and rays in coastal and offshore waters, therefore, is highly dependent on oceanographic conditions, mainly on the movement of the oxygen minimum zone.

FISHERIES

Fleets

Pakistan has a large fleet consisting of about 28,000 fishing boats ranging from small fishing boats (<10 m) operating in shallow coastal waters to large trawlers and gillnetters (>25 m) operating in offshore waters in the EEZ. Fleet size and total fishing effort have grown from 800 small wind-driven gillnet fishing boats in 1947 to 2,800 fishing vessels in the early 2020s, some of which are more than 30 m long. A detailed description of fishing boats is provided in Khan (2022).

Gear

Gillnets are the most important fishing gear used in Pakistan. Types include small-mesh (2 cm) bottom-set gillnets called *Thukri* and large-mesh (15 cm) driftnets used by the tuna gillnetters targeting large pelagic species in offshore waters. Bycatch of these gillnets is known to include several shark species.

There is a targeted stingray fishery (Dasyatidae) based mainly in the Jiwani and offshore Sonmiani area. In this fishery, stingrays are caught in specially designed fixed bottom-set gillnets (Moazzam & Osmany, 2021a). This method of stingray fishing is called *Arrassi* or *Lay*. Fishers are believed to have traditional knowledge about the migration routes of stingrays and place the large-meshed, bottom-set fixed nets in these routes accordingly. Migratory routes may change with seasons, in which case the placement of the nets is shifted as needed (Moazzam & Osmany, 2021a).

Shrimp trawling was introduced to Pakistan in the 1950s, and as of 2023, the shrimp fleet consisted of about 3,000 mechanised fishing trawlers, with the capacity to fish in deeper waters (Khan, 2022). Trawlers operate from shallow coastal waters out to a depth of about 200 m in the offshore waters. Previously, these vessels conducted only shrimp trawling, but since 2002 almost all trawlers have operated both a shrimp trawl net (especially in August–September) and a high-opening bottom trawl for fish. The operation of such a large trawling fleet has resulted in the depletion of shrimp stocks and several ecological impacts that may seriously affect the biological diversity and productivity of the fishing grounds. One major problem is the use of fine-mesh nets that incidentally catch juveniles of commercially important and unimportant food species in massive quantities. Trawling is a significant contributor to landings of small sharks (e.g., *Rhizoprionodon* spp.), rhino rays (e.g., *Glaucostegus* spp.), and rays (e.g., *Maculabatis* spp.).

Seine gear, locally known as *Katra* is used to catch small pelagics including sardines (*Sardinella* spp.), anchovies (family Engraulidae), and scads (family Carangidae). It is estimated that there are more than 600 such boats, of which 500 are based in Sindh and 100 based at Damb (Balochistan).

The estuarine set bag net (ESBN), locally known as *Bhulla* has been used in the creek areas of Sindh since the late 1970s. This gear is placed in the creeks of the Indus Delta to catch fish and shellfish that migrate with incoming and outgoing tides. Because it is often set across the entire width of smaller channels and uses a small mesh size, it catches large numbers of juveniles and even larvae of commercially important species. Although their use has been banned for many years, it is estimated that about 8,000 ESBNs are still operating in almost all large and small creeks of the Indus Delta system. Often small stingrays and juvenile Bull Shark (*Carcharhinus leucas*) are caught in ESBNs installed in the lower reaches of the Indus Delta.

Longlines and handlines are also important fishing gear types used for catching large demersal species, including croakers (family Sciaenidae), eels (order Anguilliformes), groupers (Epinephelidae), seabreams (Sparidae), sharks, and rays in coastal and offshore waters. In addition to these, cast nets and beach seines are important gear types being used in coastal, creek, and intertidal waters. Under national legislation, there is a ban on the use of trawl nets, ESBNs, and seine nets in the creek area of the Indus Delta and the entire extent of Balochistan waters; however, extensive poaching occurs throughout these areas. Handlines using live baits (mainly Saddle Grunt, *Pomadasys maculatus*) are used to catch large sharks in the Indus canyon, off Ormara and Jiwani along the Pakistan coast.

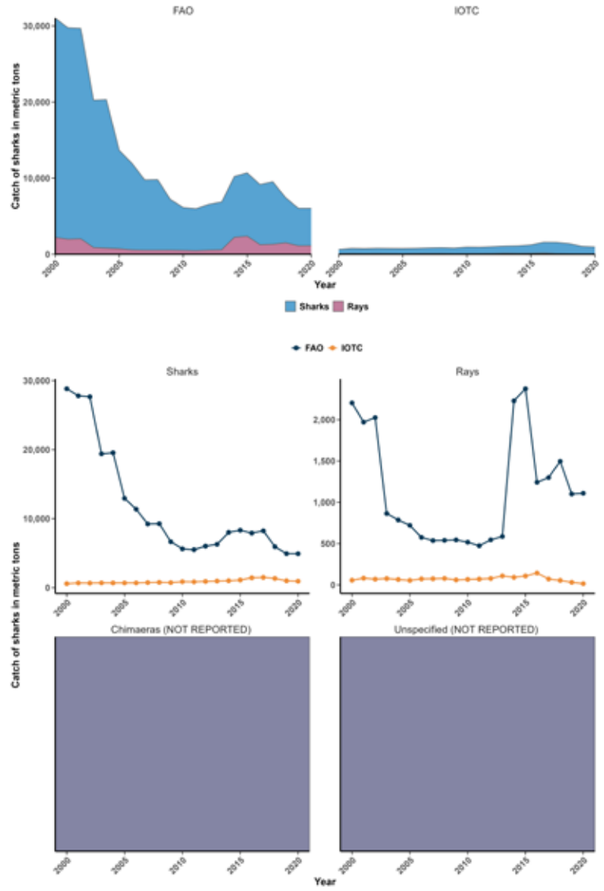
Tuna longlining started in 1991 with the fleet increasing to 50 vessels in 1993. Offshore longlining continued until May 2009 with nine vessels operating. These longliners have been observed to catch Shortfin Mako (*Isurus oxyrinchus*) as bycatch.

PRODUCTION

Overall landings

Average annual landings of sharks and rays in Pakistan are reported to be 12,139 metric tonnes (mt) including 3,217 mt of sharks, 1,089 mt of rhino rays, and 7,984 mt of (other) rays (Anonymous, 2023). Shark landings fluctuated between 1950–2022, reaching a peak in 1979 when about 74,691 mt of sharks were landed (Figure 1). Landings of sharks have decreased steadily since 1999 when targeted shark fishing was prohibited in Pakistan under a blanket ban (see 'Policy' section).

Pakistan's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization (FAO) and Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tons (mt) | Source: FAO (2022) and IOTC (2022)



Species-specific

Species-specific data on shark and ray landings are not recorded or available. However, studies about landings of sharks, rays and rhino rays collected from Karachi Fish Harbour, which is the largest landing centre of Pakistan, estimated that about 70% of commercial landings are routed through this harbour (Moazzam & Osmany, 2014, 2020, 2021a-d, 2022a-c; Osmany & Moazzam, 2022). These studies provide information about seasonal changes in the landings of various species, and they indicate that Spadenose Shark (Scoliodon laticaudus) is the most dominant species landed at Karachi Fish Harbour, followed by Silky Shark (*Carcharhinus falciformis*), Milk Shark (*Rhizoprionodon acutus*), Hardnose Shark (*Carcharhinus macloti*), and Shortfin Mako, whereas other species of sharks are less common (Figure 2).

Annual landings of the family Dasyatidae for the period from 1970–2019 are presented indicates that landings totalled 9,221 mt in 1970, and gradually increased to 49,017 mt in 1982 (Figure 3). During this period, rays were caught in large numbers mainly along the Balochistan coast and were subsequently sun-dried and transported to Karachi for fish meal production. The increase in landings during 1973–1982 is attributed to the motorisation of the fishing fleet which helped in increasing turn-around time, fishing duration, and increased overall ray catches. A major decrease in ray catches has been noticed since 1983 when the landings dropped to 10,116 mt. This was due to a move towards transportation and marketing of fresh/chilled fish from Balochistan to the main market in Karachi. This shift in marketing changed fishing operations along the Balochistan coast where most fishing boats shifted their fishing methods from ray fishing to catching of other food fishes. Another decrease in catches of rays was noticed in 2003, which coincided with construction of the Makran Coastal Highway, which further changed fishing patterns and marketing in Sindh and Balochistan. A major part of the fleet that was previously involved in ray fishing shifted to catching of Indian Mackerel (*Rastrelliger kanagurta*), which was transported to Karachi for freezing and export. Present landings of rays are approximately 7,737 mt annually (2019 figures), which has been mostly stable for the since the early 2000s.

Pakistan has a reasonably large pelagic gillnet fishery which operates in coastal and offshore waters within the EEZ and Areas beyond National Jurisdiction (ABNJ), and also in waters of other countries like Somalia and Yemen. Although this fishery targets tuna and tuna like species, it is known to catch a large number of non-target shark species. Studies have revealed that a large number of pelagic sharks including Whale Shark (*Rhincodon typus*), Silky Shark, Oceanic Whitetip Shark (*Carcharhinus longimanus*), thresher sharks (*Alopias* spp.), hammerhead sharks (*Sphyrna* spp.), and mobulids (*Mobula* spp.) are caught by tuna gillnets (Moazzam & Nawaz, 2014; Moazzam 2017, 2018, 2019b; Moazzam & Khan, 2019). Seasonal distribution of the entanglement reveals that sharks are mainly caught in the winter months with a peak reached in January 2013 (Figure 4). A comparison in incidental catches of sharks in 2013 and 2018 is also presented in Figure 4. There are no data available on chimaera catches and landings.

TRADE

Processing

Traditionally, shark was not consumed in Pakistan and was mainly caught for export to Sri Lanka, usually salted and dried. This is possibly the oldest form of fishing and processing in Pakistan (Buist, 1850). Fish curing yards were established in almost all coastal settlements along the coast. Fishing used to be conducted though multiday trips, in some cases lasting many months, during which fish were eviscerated and salt was applied. Wet salted fish from longer fishing trips and those caught from coastal areas (in fresh form) used to be further processed in curing yards, which involved washing with seawater, applying additional salt, and placing in brine tanks for a few days, after which the fish was dried in the sun. Finally, dried fish was packed in gunny bags. Sharks and rhino rays were the main items that would fetch higher prices and were preferred in the salted dried form.

Salted/dry used to be the main method of processing sharks until the early 1980s when chilled transportation systems in coastal areas improved. At this time, sharks were marketed for local consumption under the disguise of other finfishes. This resulted in a major decrease in salted dried processing in Pakistan and almost all curing yards along the coast of Pakistan were closed. Now, only surplus shark is salted dried, with some still exported to Sri Lanka, whereas a major portion is sold for local consumption.

Rays, including most myliobatids, used to be dried in the sun and used for the production of low-quality fishmeal for the local poultry industry. Rays were caught in commercial quantities as bycatch of shrimp/fish trawling, bottom-set gillnets and longlines being deployed in shallow coastal waters, bays, creeks as well as on the continental shelf areas along the coast of Pakistan. In addition, there is a targeted ray fishery based mainly in Jiwani and other parts of Gwadar District and Bundewari (Lasbela District). In this fishery, rays are caught in specially designed fixed bottom-set gillnets. In Balochistan, the method of ray fishing is called *Arrassi* or *Lay*. The main fishing ground is within Gwater Bay, near the mouth of Dashat River and adjacent waters in Jiwani area; Gunz; Pushukan, Sur, Karwat, Pasni, Ormara along Gwadar District; Sapat and Sonmiani Bay along Lasbela, Balochistan coast; and off creek areas in Sindh coast.

Wings of rays are exported in frozen form to Thailand and Malaysia. At least 15 seafood processing plants located in Karachi, Gwadar, Pasni, Ormara, and Jiwani, and are involved in ray processing. Chilled (treated with ice) or fresh (not treated with ice) rays are landed at major fish harbours and jetties where they are procured by seafood processing plants through a series of intermediaries. Rays are butchered in processing plants and wings are carefully removed, washed, graded, and packed in polyethylene bags before they are frozen in blast tunnels. Frozen wings are packaged and labelled before being stored in freezers until they are exported. It is estimated that about 400–500 mt of wings are exported annually from Pakistan. In 2020, the quantities of export decreased to about 250 mt due to reduced demand in importing countries because of COVID-19. The wings are categorised in three types: white or smooth, brown, and spotted.

Myliobatid rays including mobulids are still sun-dried and destined for fish meal processing plants located along the coast of Pakistan. No gill plates or mobulids are exported. Fins of all sharks and rhino rays are removed after auction, sun-dried and exported mainly to Hong Kong Special Administrative Region (SAR), fetching very high prices.

Fishing boats in Pakistan | Nasha Ila | flickr.com (CC BY-NC-SA 2.0.)

Domestic

All shark and rhino ray species are used for local consumption. After auction, these fishes are taken from landing centres to culling areas where fins are removed and fillets, chunks, and strips of meat are cut and are prepared after removing skin and viscera. These products are sold in the local market under different names. Sharks as such cannot be sold in the local markets because they are considered *haram* (unfit for consumption because of religious reasons); however, fillets, chunks, and meat strips are consumed locally. Offal of sharks, rays and myliobatids are sun-dried and used for the production of low-quality fish meal for the local poultry industry. There is no medicinal or pharmaceutical use of sharks in Pakistan; however, in 1960, shark and ray livers were used for the extraction of vitamins, and a large plant was established for this purpose, but it was closed down in the late 1970s.

Export

Separate data for the export of sharks and rays are not available or recorded in Pakistan. However, it is estimated that shark and ray products valued at about USD 70 million are exported annually, which includes export of shark fins. Sharks and rays are also imported into Pakistan, and small quantities of rays are traded in chilled form by coastal communities living around the Pakistan-Islamic Republic of the Iranian border.

CULTURAL SIGNIFICANCE

Sharks, rays, and chimaeras are not part of any cultural values in Pakistan.

RESEARCH

No major research on sharks, rays, and chimaeras has been carried out in Pakistan historically. Limited information has been provided about shark fishing, including a detailed description of fishing methods along with evidence of harpooning of Whale Shark (Buist, 1850). With the exception of taxonomic work, no other studies were carried out on these species in the subsequent 130 years (see works by Day, Qureshi, and Zugmayer, e.g., Day, 1889; Zugmayer, 1913; Qureshi, 1977). Sharks, rays, and chimaeras of Pakistan are included in various checklists published locally (e.g., Misra, 1969; Jalil & Khalil, 1981; Hoda, 1985, 1988). A handbook of fishes of in Pakistan was recently published which included details of species that occur (Psomadakis et al., 2015).

Since the 2010s, several studies on sharks and rays (including rhino rays) have been undertaken at the regional level (e.g., Jabado & Spaet, 2017; Jabado et al., 2017; Notarbartolo di Sciara et al., 2017; Notarbartolo di Sciara & Jabado 2022). Additionally, several studies on fisheries bycatch have also increased since 2010 and are ongoing (e.g., Moazzam & Nawaz, 2014; Moazzam & Osmany, 2014, 2020, 2021a-d, 2022a-c; Osmany et al., 2015; Moazzam, Khan, et al., 2016; Moazzam, Osmany, et al., 2016; Moazzam, 2017, 2018, 2019a, 2019b; Moazzam & Khan, 2017; Moazzam et al., 2017; Moazzam & Ayub, 2018; Osmany & Moazzam, 2022). Much of this research is undertaken independently of national government organisations (NGOs).

MANAGEMENT

Governance framework

Pakistan has two maritime provinces: Sindh and Balochistan. These two provincial governments are responsible for fisheries governance in their respective provinces. For the implementation of the fisheries management regime, these provinces have separate fisheries departments which have offices at all major fish landing sites. These departments are mandated to manage fisheries in their respective provinces and various legislation have been promulgated for these purposes. Despite having suitable infrastructure and facilities, shark, ray, and chimaera fisheries are not managed by these departments. Fisheries in both provincial waters are open access with no entry restrictions, therefore, there is no control over the size or the type of fishing fleet resulting in over-exploitation of fisheries resources including those of sharks and rays. These provinces also have Wildlife Departments and Environmental Protection Agencies whose mandates may include the conservation of threatened species.

The Federal Government of Pakistan is responsible for fish and fisheries beyond the territorial waters of Pakistan, including the EEZ and ABNJ. Federal legislation and mandate for the management of fisheries are available; however, the management of any fisheries including sharks and rays has not been undertaken by the federal government.

Policy

There is a blanket ban on the catching of all sharks in Sindh as these are included in the Appendix I (Protected Animals) of Sindh Wildlife Protection, Prevention, Conservation and Management Act, 2020. As such, catching of all sharks is technically banned under this legislation; however, Sindh Wildlife Department does not have an established mechanism to enforce this legislation. Under Balochistan Sea Fisheries Ordinance 1970 and Rule No. SO (Coord) Fish/2-I/2013/3148-54, there is a ban on catching, retaining, marketing, and trade of Whale Shark, Silky Shark, Oceanic Whitetip Shark, thresher sharks (Alopiidae), and hammerhead sharks (Sphyrnidae) found in Balochistan. This ban also covers all mobulid rays, sawfishes (Pristidae), guitarfishes (Rhinobatidae), and wedgefishes (Rhinidae). Prior to the Wildlife Protection, Prevention, Conservation and Management Act, sharks and rays were relatively protected under the Sindh Fisheries Ordinance, 1980 and Rule No. 5(3) SO (FISH)/L & A), a ban is imposed on catching, marketing, and selling of the same shark species in Sindh with the exception that for guitarfishes and wedgefishes the Sindh ban refers only to small animals (<30 cm total length, TL).

All pelagic sharks known from Pakistan are included in Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). It is illegal to export any species listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) without valid permission from the CITES Management Authority (i.e., the Ministry of Maritime Affairs, Government of Pakistan). According to the IUCN Red List of Threatened Species, there are 110 sharks and rays occurring in Pakistan, of which 83 (75.5%) are considered threatened (20 Critically Endangered, 34 Endangered, and

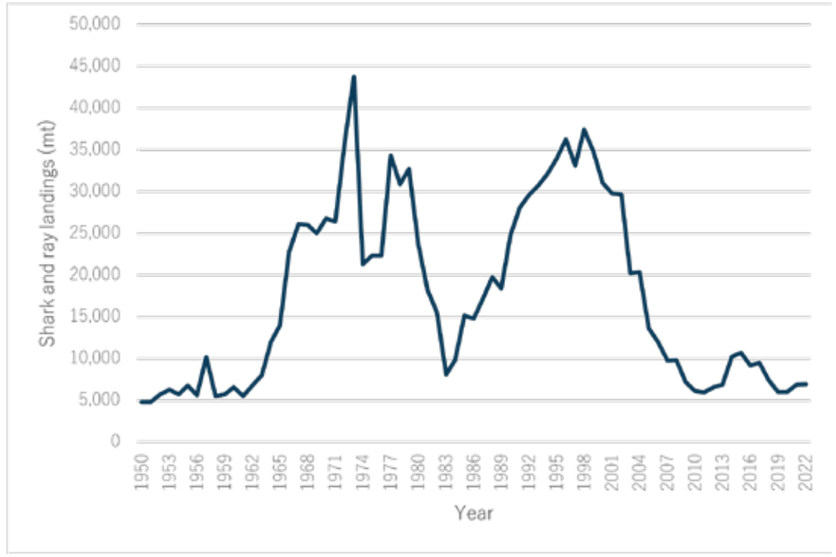


Figure 1: Annual landings of sharks in Pakistan (1950-2022) | Source: FAO (2024)

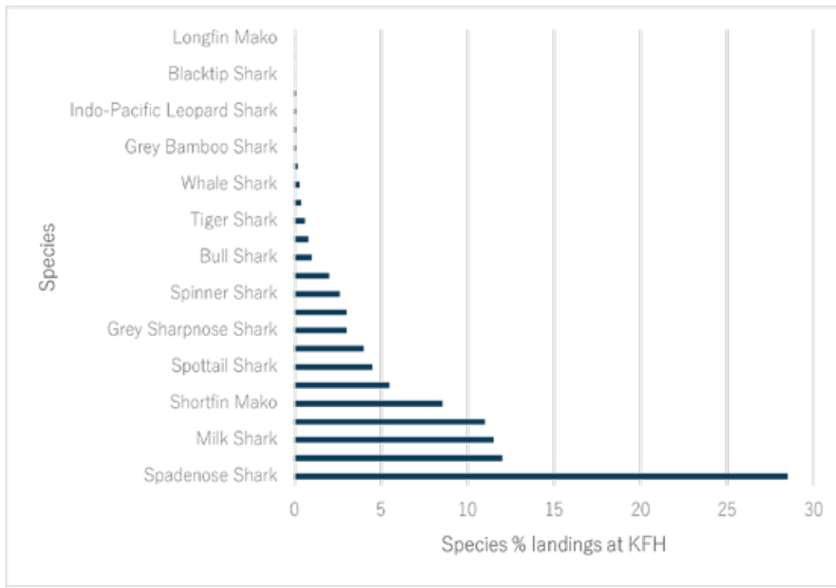


Figure 2: Landings of sharks in Karachi Fish Harbour | Source: Data compiled by author

Sharks being processed at the Karachi fish harbour, Pakistan | Daniel Fernando

29 Vulnerable), as well as 16 Near Threatened, seven Least Concern, and four Data Deficient (Moazzam & Osmany, 2021c; IUCN, 2024). Most pelagic sharks are also considered as highly migratory and listed in Annex I (migratory species) of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). In Pakistan, Tiger Shark (*Galeocerdo cuvier*) is the only large shark that is considered a highly migratory species and is included in Annex I of the 1982 UNCLOS.

Enforcement and monitoring

At the provincial level, monitoring and enforcement of legislation are the responsibility of the fisheries departments. The Fisheries Department of Balochistan has several patrolling boats for enforcement of legislation and taking punitive actions against poachers and violators. Similarly, the Government of Sindh has also recently established monitoring mechanisms and strengthened infrastructure for this purpose., However, in both provinces, there is no control on the management of sharks and rays, although provision exists in the provincial legislation for the management of shark species.

At the federal level, a dedicated force, the Pakistan Maritime Security Agency has been established since 1986 for inter alia management of fisheries in the EEZ. The agency has adequate facilities including airplanes, helicopters, surface crafts (including Corvettes and cutters), as well as large and small patrolling vessels. Pakistan Maritime Security Agency is considered the most powerful Monitoring, Control, and Surveillance (MCS) organisation in the Indian Ocean. It is mandated by the federal government for monitoring fishing operations; however, in the past, this organisation was not involved in the management of sharks and rays in coastal or offshore waters.

Community involvement

Coastal fisher communities, mainly in Balochistan, are traditionally involved in the management of fisheries, including fishing operations, use of specific gears, seasonal control and bag limits. The community is specifically very active in some areas like Miani Hor Lagoon where they decide on the fishing period for catching specific species like jellyfish, razor clam, and other species. They also have declared creek areas as refugia for fish breeding. However, none of the coastal fisher communities, despite having in-depth traditional knowledge about sharks, is engaged in the management of sharks and rays.

Gaps

There are numerous serious gaps regarding the fisheries of sharks in Pakistan. Of foremost concern is the lack of a system of fisheries data collection both at the federal and provincial levels. Fisheries data including those for sharks, rays, and chimaeras are not recorded and the annual reported landings are based on mere estimates. In addition, the exports of shark and ray products, including shark fins and dried products, are not recorded. Shark fins, for example, are recorded as "dried fish" which enables exporters to export fins of even those species whose export should be controlled because of their listing on CITES Appendix II.

While there are several studies available about the biology, stocks, distribution, and abundance of sharks and rays in

Pakistan (e.g., Moazzam & Osmany, 2014, 2020, 2021a-d, 2022a-c; Osmany & Moazzam, 2022) there are still significant knowledge gaps. Specifically, there is a serious dearth of knowledge about chimaeras and even the deep-dwelling sharks, rays, and chimaeras, there are hardly any deepwater species reported.

RECOMMENDATIONS

Policy

There is a need to develop a new fisheries policy and to revise existing fisheries legislation, to include aspects of the management of shark, ray, and chimaera resources keeping in view the stocks, species depletion, and aspects related to highly migratory as well as threatened species and to ensure that other shark species are not over-exploited.

Science/knowledge/research

There is an immediate need for the collection of fisheries data on sharks and rays, including species-level data collection. The Harmonized System (HS code) already exists at the global level and its effective implementation is essentially required in Pakistan to record the exports of shark and ray species and commodities.

There is a need for the fisheries department and academia (universities and research organisations) to start research work on biology, stocks, distribution, and abundance of sharks, rays, and chimaeras, on a priority basis. There is also a need to explore deepwater habitats along offshore waters of Pakistan to determine the species composition and abundance of such species. Research at the fisheries department level is non-existent, therefore, there is a need for strengthening the fisheries department to undertake studies on important fishes including sharks and rays.

Management/governance/conservation

Considering that monitoring and enforcement of legislation have not been conducted effectively at the federal or provincial levels, there is an immediate need for assessments of the gaps in the management of fisheries, and measures may be taken to improve legislation and effectively monitor fishing operations, especially those that target sharks and rays. Strengthening the provincial fisheries departments is essentially required for this purpose.

An effective monitoring, control, and surveillance (MCS) system for shark and ray species must be established at both the federal and provincial levels. At the federal level, the Pakistan Maritime Security Agency may be mandated to monitor shark fisheries for ensuring the management of shark resources in offshore waters. Pakistan has a substantially large gillnet fleet that operates in the offshore waters of Pakistan, and which is marred with high incidental catch of shark and ray species. Monitoring of these fisheries is urgently required to ensure that non-target species are not depleted.

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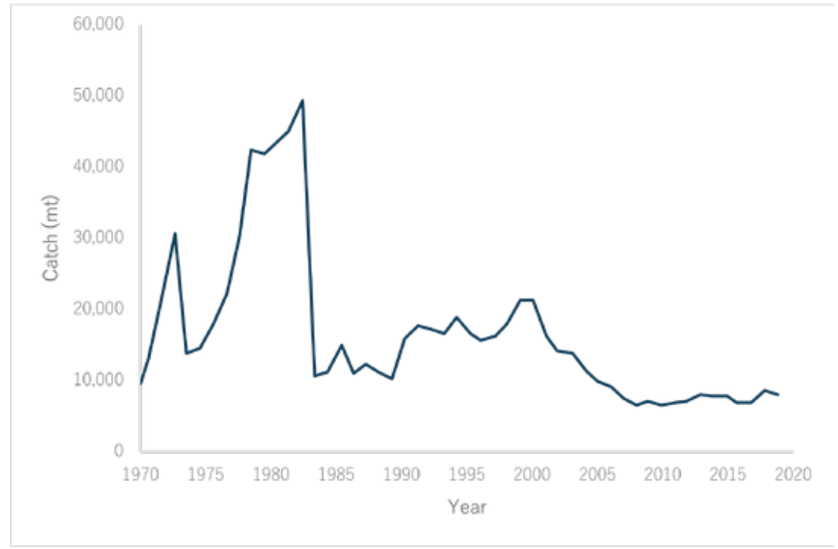

Figure 3: Landings of rays (Dasyatidae) in Pakistan | Source: Moazzam & Osmany (2021b)

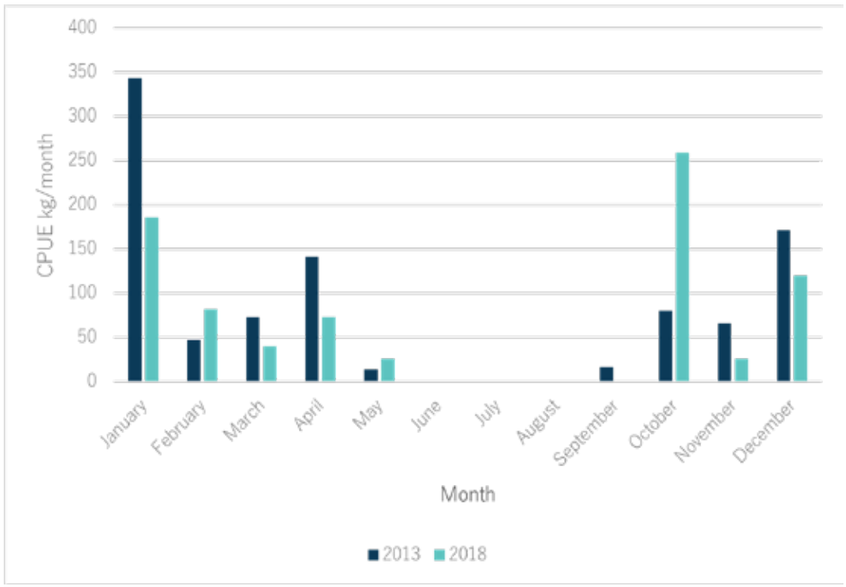

Figure 4: Incidental catch of sharks by tuna gillnet vessels during 2013 and 2018 | Source: Data compiled by author

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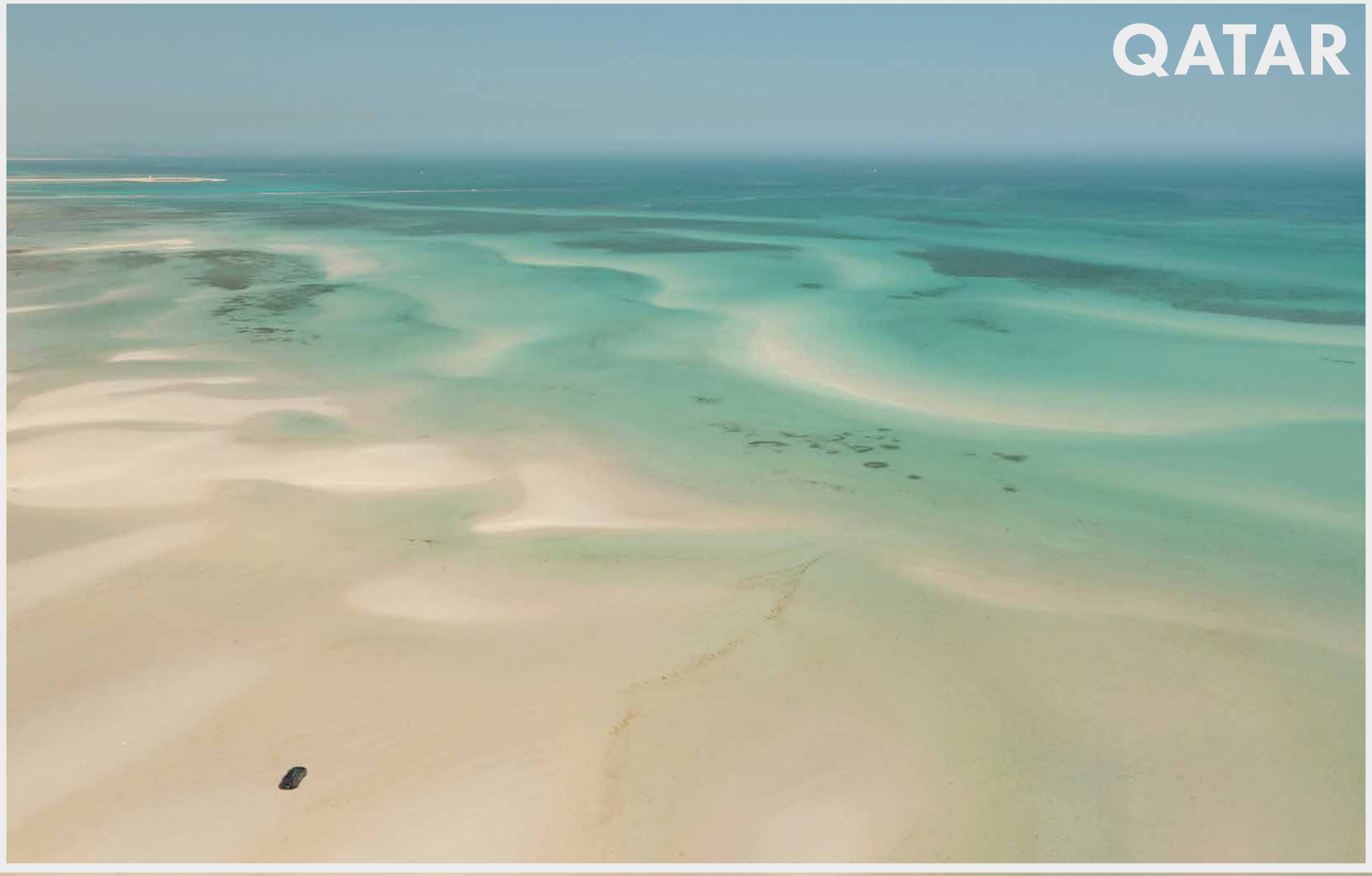
Fishers pulling beach seine in Pakistan | Bilal Shaikh | Pexels.com

Sharponose Guitarfish *Glaucostegus granulatus* being processed at the Karachi fish harbour, Pakistan | Daniel Fernando

Fishing vessels at Karachi fish harbour, Pakistan | Daniel Fernando

QATAR



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QATAR

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INTRODUCTION

Qatar is the only Peninsula that extends from the southern shores of the Arabian Gulf to deeper water almost halfway between Iran and the United Arab Emirates (UAE). It has an Exclusive Economic Zone (EEZ) of around 35,000 km² and almost 600 km of coastline.

There are deeper water migratory species of sharks and rays as well as shallow water reef and benthic sharks and rays, with at least 33 sharks and 25 rays recorded in Qatar (Moore et al., 2012; Jabado & Ebert, 2015). No chimaeras are known to occur in the Arabian Gulf. Sharks and rays are generally not targeted by fisheries, and there are no exports. Occasional incidental catch of small reef sharks is found in markets, but the government is considering banning the sale of sharks. The most famous and largest shark in Qatar is the Whale Shark (*Rhincodon typus*). These plankton feeders aggregate from April–October (peak from May–August) each year approximately 80 km northeast from land to feed mainly on tuna fish eggs (Robinson et al., 2013). Whale Shark ecotourism started in 2022 and has become very popular. Licences are required to operate Whale Shark watching tours to prevent adverse impacts on the sharks and ensure safety for both the animals and tourists. Plans are being discussed to designate the main Whale Shark aggregating area as a Marine Protected Area (MPA), covering roughly 2,200 km² (Wong et al., 2021; Wong, 2022). This designation will also serve as an umbrella protection for other species of sharks including the Bowmouth Guitarfish (*Rhina ancylostomus*) and Scalloped Hammerhead (*Sphyrna lewini*). Local government through the Ministry of Environment and Climate Change (MOECC) acknowledges the importance of the rich marine biodiversity present in Qatari waters and is taking active measures to protect these natural resources, including sharks and rays, by setting up MPAs and minimising threats to sensitive habitats and threatened migratory species. MOECC is working to restore damaged ecosystems, namely mangroves and coral reefs, which will consequently benefit sharks and rays.

Potential important areas for sharks and rays within Qatar include its 22 km² of mangrove strands, 720 km² seagrass beds, coastal and offshore reef MPAs totalling 4,544 km², and 2,629 km² pelagic waters (albeit shallow within the Gulf at <60 m depth). There are four MPAs spanning up to 7,900 km², with coral reefs present in three of them. There are no rivers or estuarine habitats in Qatar.

FISHERIES

Fleets

The Qatar National Fishing Co. (QNFC) was formed in 1966 to start commercial shrimp trawling. By 1979, overfishing caused the collapse of this fishery and then the company started stern trawling for finfish up to 1992 (Al-Ansi & Priede, 1996). In the early 1990s there were 1,250 artisanal fishing vessels with 12,000–14,000 fishers producing 400-500 metric tonnes (mt) each year (Al-Ansi & Priede, 1996). After the discovery of oil in 1939, fishing boats were reduced to 180 vessels with 600–800 fishers. In 1980 there were 171 artisanal fishing boats with a total marine catch of 1,297 mt (Al-Ansi & Priede, 1996). In 1992 the number of fishing boats increased to 422 and caught 7,239 mt (Al-Ansi & Priede, 1996). As the QNFC trawling activities ceased in 1992 due to the artisanal fisheries' landing more valuable catches compared to trawlers, as well as the government banning this fishery in 1993 to declining landings, the remaining fishing boats used fish cages, gillnets, handline, and troll line (Al-Ansi & Priede, 1996; Al-Abdulrazzak, 2013); gillnets in particular are known to incidentally catch sharks and rays (Moore et al., 2012). Catch recovered by the mid-1990s and peaked in 2008 with 17,688 mt due to increase in artisanal fishing boats and fishers. Since 2012 annual reported catch has stabilised to about 15,000 mt. As of 2016, there were 624 fishing boats, of these 374 were *dhows* (traditional canoes used in the region) and 250 were speed boats. These vessels used fish cage, gillnets, and hand and troll lines to target both benthic and pelagic fish, producing a total marine catch of 15,894 mt. In 2022, the fleet comprised of 470 boats operated by 3,207 fishers and producing 14,255 mt of marine catch (PSA, 2022). Whilst recreational fishing is increasing, there is a restriction on fish size, as well as restricted areas where fishing is not allowed, namely MPAs, military areas, oil facilities and assets, and border areas.

Gear

Sharks are caught incidentally in coastal gillnet fisheries, mainly Spottail Shark (*Carcharhinus sorrah*), Blacktip Shark (*Carcharhinus limbatus*), and Arabian Carpetshark (*Chiloscyllium arabicum*). Quantities are not available but fishers using gillnets land sharks and rays (Wong, personal observation, 2024). Other shark and rays are further offshore and thus do not interact with most of the coastal fisheries, such as Whale Shark, hammerheads (*Sphyrna* spp.), Sandbar Shark (*Carcharhinus plumbeus*), guitarfish (Rhinobatidae), and sawfish (*Pristis* spp). There are many rays in sandy coastal waters which are known bycatch of gillnets (e.g., Spotted Eagle Ray, *Aetobatus ocellatus*) but fishers usually discard them and mortality is not known.

PRODUCTION

Overall landings

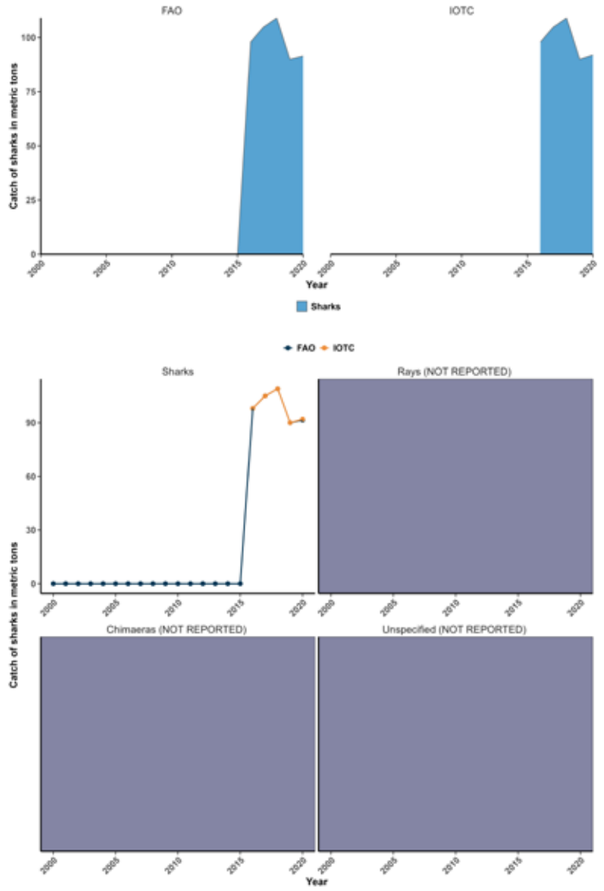
Sharks and rays are generally not targeted, nor is there a shark-processing industry, but they are caught incidentally in gillnets. Sharks are usually retained for local consumption and rays are usually discarded (although sometimes also sold locally). There is no monitoring of landings, and thus no species-specific data. Only one project has focused on gathering landings data on sharks and rays and information was only collated over a two-week period making it difficult to understand trends in species composition in landings (Moore et al., 2012). There are no known targeted fisheries, but bycatch is retained and sold locally. According to reports to the Food and Agriculture Organization of the United Nations (FAO), Qatar has landed between 90.5–108.7 mt of Whitecheek Shark (*Carcharhinus dussumieri*) from 2014–2020, but in recent years this has increased to 188.5 mt in 2021, and even further to 326.6 mt in 2022 (FAO, 2024). There are no ray landings reported to FAO.

TRADE

Processing

There is limited information on shark or ray product traded apart from the occasional sharks and rays landed in local fish markets which are consumed for meat. There is no information on whether these landings contribute to the global fin trade and no indications that oil is produced. However, in 2015 and 2020, 15 mt (worth USD 73,000) of 'Shark fins, smoked, dried, whether or not salted, etc.' and 2.4 mt (worth USD 75,240) of 'Shark fins, prepared or preserved', respectively, were reportedly imported to Qatar (FAO, 2023). Additionally in 2015–2016, 1 mt (USD 19,000) and 3 mt (USD 21,000), respectively of 'Sharks, fillets, dried, salted or in brine' were imported (FAO, 2023).

Qatar's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of ther United Nations (FAO) and Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



There was an increase in 'Rays and skates (Rajidae), frozen' imports, from 1 mt (USD 4,000) in 2015 to 26.04 mt (USD 167,620) in 2019, but no further information has been reported since (FAO, 2023).

Domestic

The general local preference is for fresh shark meat. There is limited consumption of ray meat which is why these animals are usually discarded. However, if retained, rays are also generally consumed fresh. In the past, liver oil was used to waterproof boats. The species consumed for their meat include Blacktip Shark, Great Hammerhead (*Sphyrna mokarran*), and Spotted Eagle Ray.

Export

There are no documented exports of sharks and rays from Qatar.

CULTURAL SIGNIFICANCE

Local traditional divers believe sharks are dangerous due to multiple interactions with them while diving. Pearl divers in particular were afraid of sawfishes (Pristidae) and sharks.

RESEARCH

Whale Shark research started in 2010 by scientists from universities supported by the Qatar Oil industry and MOECC (e.g., Robinson et al., 2013). Studies were carried out on the local population to understand migratory behaviour and feeding ecology, as well as physical oceanography, genetics, and individual shark identification through photo-ID (e.g., Carpenter et al., 1997; Robinson et al., 2013; 2017). In 2022, MOECC in-house scientists started to study and monitor Whale Shark. The government, through MOECC, is responsible for public education, monitoring, management, and conservation of sharks. The Ministry is responsible for designation and management of protected areas critical for the conservation of species and international and regional cooperation. The Arabian Gulf Regional Whale Shark Conservation Centre was established by MOECC and UNESCO. The first Regional Whale Shark Conservation Forum was hosted by MOECC and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) on 22nd May 2023 linking the Gulf Cooperation Council and Arabian Sea coastal nations. This was the beginning of regional cooperation on Whale Shark research and conservation. No other species of sharks or rays had been studied in Qatar.

MANAGEMENT

Governance framework

Whale Shark is listed under international treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS), as well as local legislation, namely the Protection of Wildlife Act. A new MPA has been proposed in 2022 to include the main Whale Shark aggregation areas, one of the largest aggregations globally, covering an area of roughly 2,200 km² (Al-Maslamni, 2015; Wong, 2022). For traceability

Blacktip Shark *Carcharhinus limbatus* in Al Shaheen, Qatar | David Robinson

of catches (amongst other reasons), all boats leaving ports must be registered with the coast guard. Maritime police, coast guard, and Ministry of Environment staff are law enforcement personnel. New rules and regulations are being drafted as of 2023, and expected to be enforced when the MPA becomes effective.

Policy

Besides Whale Shark under the Protection of Wildlife Act, no other species-specific legislation is currently (2023) in place for sharks and rays in Qatar.

Community involvement

Currently, there are no initiatives involving local communities in shark and ray conservation.

Gaps

There is no dedicated shark and ray research in Qatar, with the exception of research on Whale Shark and other shark species (e.g., Scalloped Hammerhead [*Sphyrna lewini*] or Blacktip Shark) associated with oil and gas offshore assets (e.g., Bach et al,. 2014). Further work to understand the diversity, distribution, threats, seasonality, and abundance of sharks and rays is being developed.

RECOMMENDATIONS

Government policies and legislation are important for shark and ray conservation. Effective MPA management and law enforcement are crucial for healthy shark populations in an enclosed sea like the Gulf (Wong et al., 2021). Well-managed MPAs, conservation administrators, and resource managers are needed to ensure healthy shark populations.

Government action is needed to stop shark population decline caused by anthropogenic activities presented by fishing nets and ropes, shipping collision, offshore oil facility cables, buoys and ropes, extractor fans for oil platforms, as well as chemical and plastic pollution. All these threats have to be mitigated. Propeller guards should be installed on all motorised boats in Whale Shark aggregation areas. Strictly regulating the sale of sharks can prevent overexploitation. Well-managed ecotourism can have positive conservation outcomes for target species and socio-economic benefits for communities involved.

Policy

Fishing methods that cause damage to the sea bottom should be banned, including completely banning the use of bottom trawls. This reduces the chance of capturing highly threatened sharks and rays, including guitarfish, sawfish, and hammerhead sharks. Offshore MPAs should be established near oil platforms where there are susceptible species. These have been regarded as important habitats and ecosystems. Sharks and rays are found in podmarks and oil platforms seeking refuge from strong current and feeding opportunities (Al-Maslamni, 2015). Hammerheads, guitarfishes, and cownose rays (*Rhinoptera* spp.) have been reported in these areas.

Coastal mangroves and coral reefs in the Gulf need to be protected and restored to provide habitat for reef dependent marine life including sharks. Develop shark-centred policies to ensure their sustainable future.

Shark landings from small-scale fisheries in Qatar | Rima W. Jabado

Science/knowledge/research

Research to establish baselines on species and populations is the first need for understanding the sharks and rays.

Management/governance/conservation

Fishers should be encouraged to use less destructive fishing methods. While trawling has been mostly banned in Qatari waters since 1992, large amounts of trap fishing (Gagoor) is ongoing and are damaging the seabed.

Recreational fishing has gained popularity since the 2000s, especially spear fishing and troll line fishing. Although sharks are generally not targeted, there are occasional shark fishing competitions, which should not be allowed. Sharks are worth more alive than dead. Ecotourism can be a good non-consumptive use of sharks, with great successes observed in other countries. Blue economy initiatives, such as ecotourism, can replace consumptive activities such as targeted fishing for specific species. Such activities should be properly managed for the protection and benefit of both tourist and target species.

Designation of at least 30% of a nation's EEZ as MPAs will ensure protection of sensitive important habitats crucial for survival of both resident and migratory species Qatar has already identified 30% of its EEZ to be designated as MPAs (Wong et al., 2021). After the initial proposal in 2022, it has been confirmed that the first batch of MPAs will be the Qatar North MPA, covering deeper water ecosystems, the Whale Shark aggregation feeding area, and podmarks relating to sharks and rays.

New environmental laws and regulations specific for individual MPAs and individual migratory species are being prepared to

Dhows (wooden traditional boats) at harbour in Qatar | Rima W. Jabado

Tarads (fiberglass boats) at harbour in Qatar | Rima W. Jabado

strengthen legal actions for the protection of threatened and migratory species as well as important ecosystems.

The government ministries are increasingly supporting public awareness activities to increase public knowledge of the marine environment and conservation. Regular beach and underwater cleanups, mangrove planting involving public and enterprises, banning of shark sales in markets, as well as the establishment of MPAs and restoration of mangroves and coral reefs by academic institutions are supported by government and oil companies. Continued monitoring of the environment and marine life health by in-house government marine scientists to ensure biodiversity conservation is under way. Recruitment of more professional and scientific staff will contribute to more effective administration and management of marine resources allowing Qatar to achieve its Qatar National Vision Goal and United Nations (UN) Ocean Decade 30x30 goal (Wong, et al., 2021).

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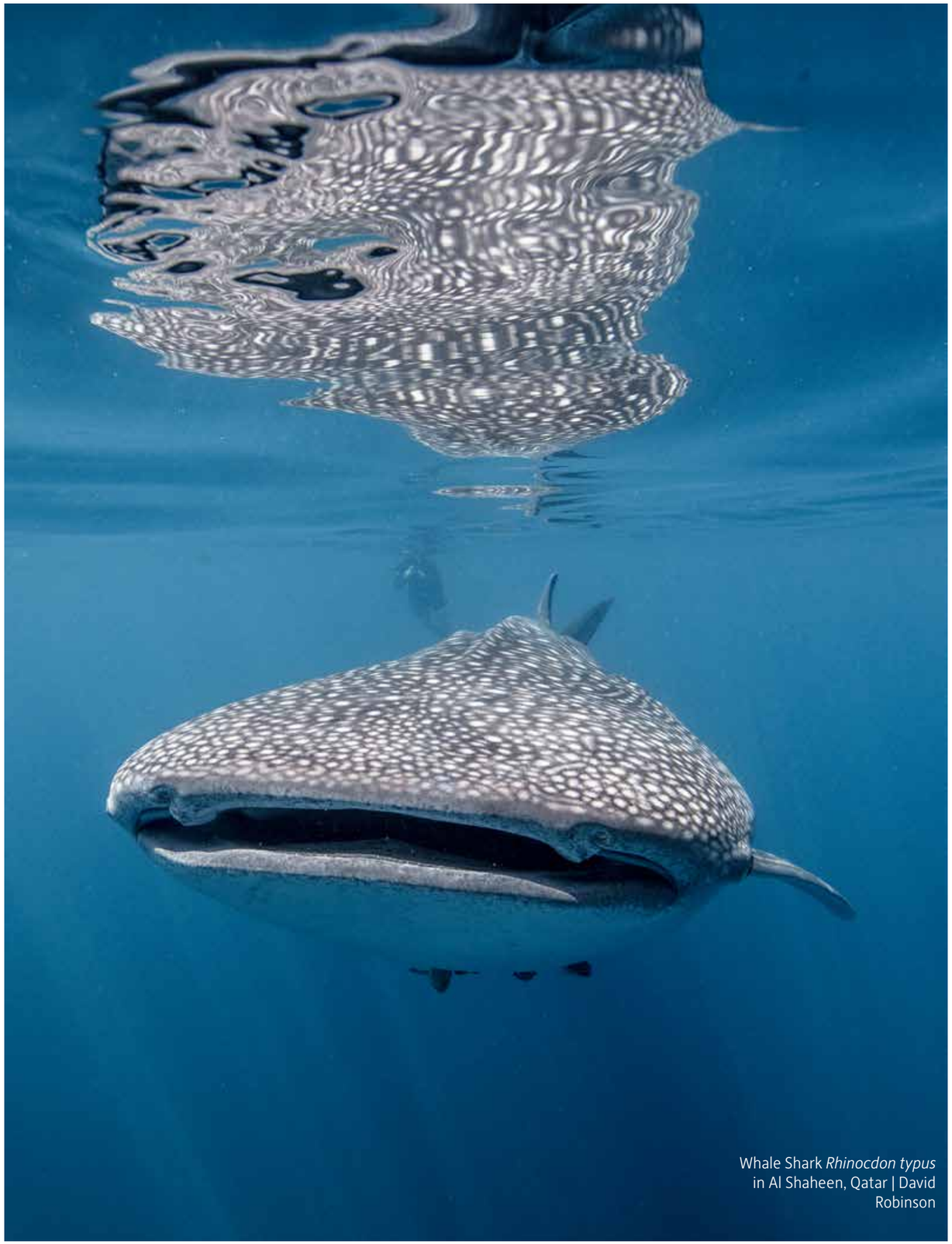
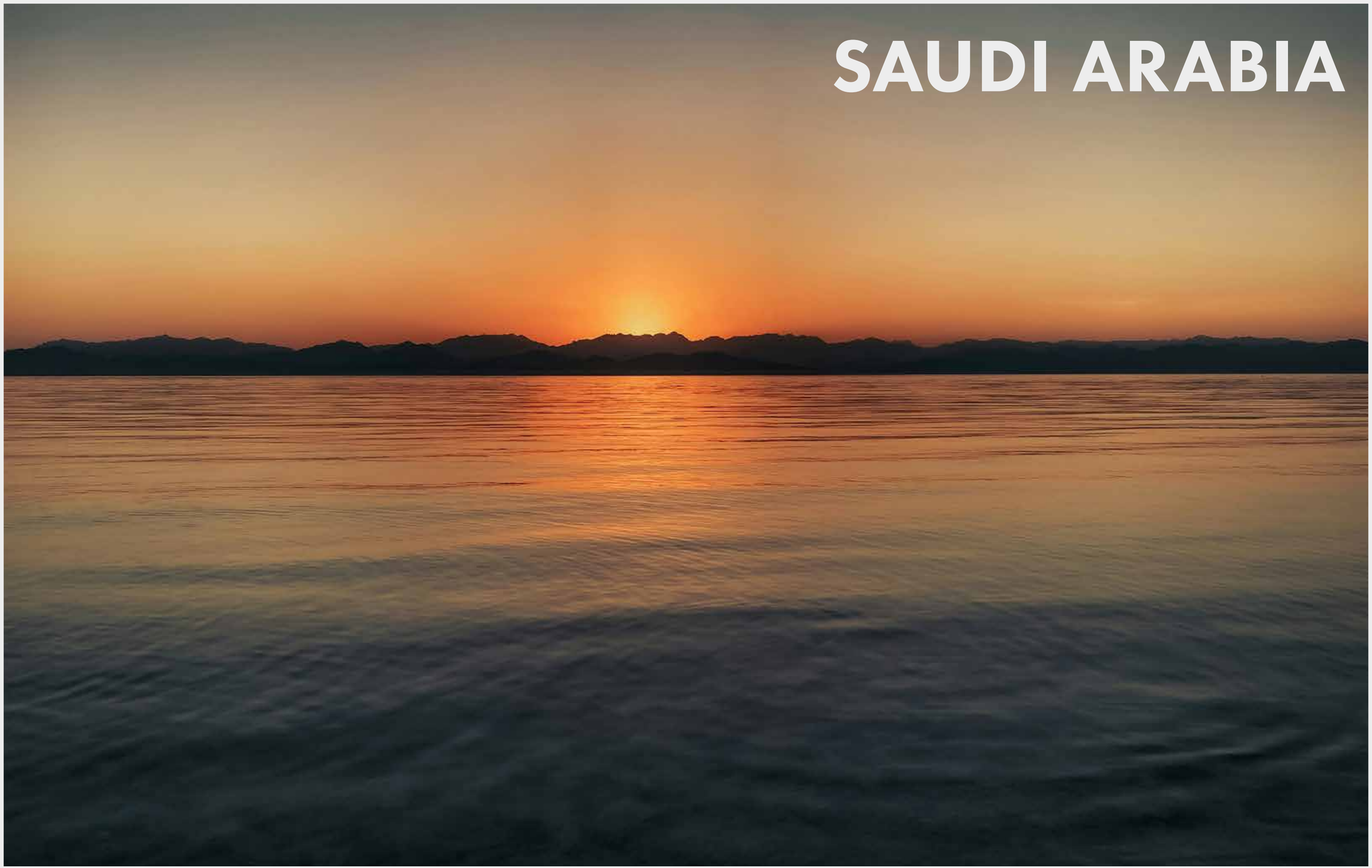
Sharks for sale at Al Khoor fish market in Qatar | J.M.K. Wong



Whale Shark *Rhinocdon typus* in Al Shaheen, Qatar | David Robinson

SAUDI ARABIA



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SAUDI ARABIA

ARABIAN GULF

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INTRODUCTION

The Kingdom of Saudi Arabia (henceforth 'Saudi Arabia') has an Exclusive Economic Zone (EEZ) of 220,184 km², including waters in the Red Sea and Arabian/Persian Gulf (Tesfamichael, & Pauly, 2016; Tesfamichael & Rossing, 2016). In the Arabian Gulf, the territorial area covers an area of 33,792 km² from the border with Kuwait to the Gulf of Salwah (Rabaoui et al., 2015).

The Gulf coastline of Saudi Arabia (Gulf Saudi) is 560 km long, which is the second longest among the Gulf countries (General Authority for Statistics, n.d). The three major habitats along this coast are tidal flats, and intertidal and subtidal habitats (Qurban et al., 2012). Tidal flats (30–40% of embayments) consist of salt marsh and salt flats (sabkha); intertidal habitats include mangroves, open-coast sand beaches, and patchy rock shorelines; and subtidal habitats comprise seagrass beds, coral reefs, and sandy, muddy, and rocky habitats. Several coral islands such as Jana, Jurayd, Karan, Kurayn, Harqus, and Al Arabiyah are located in the Saudi Arabian EEZ (Qurban et al., 2012). The maximum depth of Saudi Arabia's Gulf waters is a little more than 60 m with an average depth around 35 m (Sheppard et al., 2010; Naser, 2014). Wide rapid sea surface temperature changes occur in response to daily and seasonal cycles of heating and cooling, from 16°C in winter to 32°C in summer for offshore areas, and 10–40°C in coastal bays and lagoons (Qurban et al., 2012). In addition, due to restricted water exchange and high evaporation rates, salinities can be as high as 57–63 (average 59.5) in summer, and from 55–62 (average 57.5) in winter. In the Gulf of Salwa, salinity is high, ranging from 55–70 (Qurban et al., 2012). The waters around Jana Island (the second largest coral island after Karan Island) represent a hotspot for sharks and rays based on catch per unit effort (CPUE), in terms of both individuals and biomass based on results from fishery-independent bottom trawl surveys undertaken between 2013–2016. Two other areas, Manifa-Safaniya offshore waters and the southeastern waters, close to the border between Saudi Arabia and Bahrain also show higher CPUE in terms of biomass (Hsu et al., 2022a). These three areas are adjacent to essential habitats of demersal (teleost) fish in the western Arabian Gulf (Lin et al., 2021).

FISHERIES

Fleets

According to 2022 government records, the number of fishing boats operating in Saudi Arabia totalled approximately 10,737, of which 2,132 operate in the Arabian Gulf, with traditional boats comprising 98.5% of the total boats (Marine Fishing Statistics, 2022). Two types of traditional boats are used in artisanal fisheries: 1) *dhow* (traditional canoe), generally 15–20 m in length, vessels that are able to stay at sea for up to five days; and 2) tarad, <10 m in length, which operate for only one day and usually in nearshore areas (Roa-Ureta, 2015; Lin et al., 2019). These traditional boats primarily target Narrow-barred Spanish Mackerel (*Scomberomorus commerson*) and Orangespotted Trevally (*Carangoides bajad*).

Gear

Ten fishing gears are typically used in Gulf Saudi, including trawl (targeting shrimp), drift gillnet (targeting Narrow-barred Spanish Mackerel), trap, small gillnet, longline, troll, handline, surrounding gillnet, fixed gillnet, and set gillnet, in multi-species fisheries. Surrounding gillnets are mainly used to catch, for example, White-spotted Spinefoot (*Siganus canaliculatus*) and Haffara Seabream (*Rhabdosargus haffara*). Fixed gillnets, several hundred metres long, are placed in shallow areas to target schooling fishes including Narrow-barred Spanish Mackerel. Set gillnets are used to catch demersal species in shallow areas. According to landing surveys conducted between 2016–2020 in Gulf Saudi, 87.6% of sharks and rays landed were caught in gillnets, 8.0% in hook-and-line fisheries, 3.7% by trawls, 0.1% in traps, and 0.6% in other gears (Hsu et al., 2022a).

PRODUCTION

Overall landings

According to government records, total landings from marine fisheries were 64,264 metric tonnes (mt) in 2022, of which 62.9% was from the Arabian Gulf (Marine Fishing Statistics, 2022). Annual landings remained stable from 2000–2022, ranging from 63,362–67,944 mt with a mean of 65,279.4 mt. Over 90% of total landings were from traditional fisheries (58,246 mt) and <10% from industrial fisheries (6,017 mt).

In the Arabian Gulf, all landings were from traditional fisheries (40,417 mt; Marine Fishing Statistics, 2022). Shark and ray landings were recorded as 'Requiem sharks' (for all sharks) and 'Stingrays' (for all rays) captured in 'traditional fisheries' in 2021, but in 2022 only sharks were reported (Marine Fishing Statistics, 2021, 2022). During 2000–2020, shark landings ranged from 240 mt (in 2000) to 1,029 mt (in 2003) with a mean of 687.0 mt, and dropped to 599.39 mt in 2021, and further reduced to 40 mt in 2022. Ray landings over this period were 0–0.976 mt per year, with a mean of 0.083 mt, with 0.16 mt reported in 2021 (Marine Fishing Statistics, 2020, 2021, 2022). Most sharks and rays landed were small species or small individuals of large-bodied species and it is rare to find large specimens; 97.2% (1,555/1,600) of measured specimens were <20 kg individuals. The largest shark recorded was a Great Hammerhead (*Sphyrna mokarran*; weighing 65 kg) with another weighing 88 kg reported by a fish buyer (Hsu et al. 2022a; Hsu, personal observation, 2023).

Species-specific

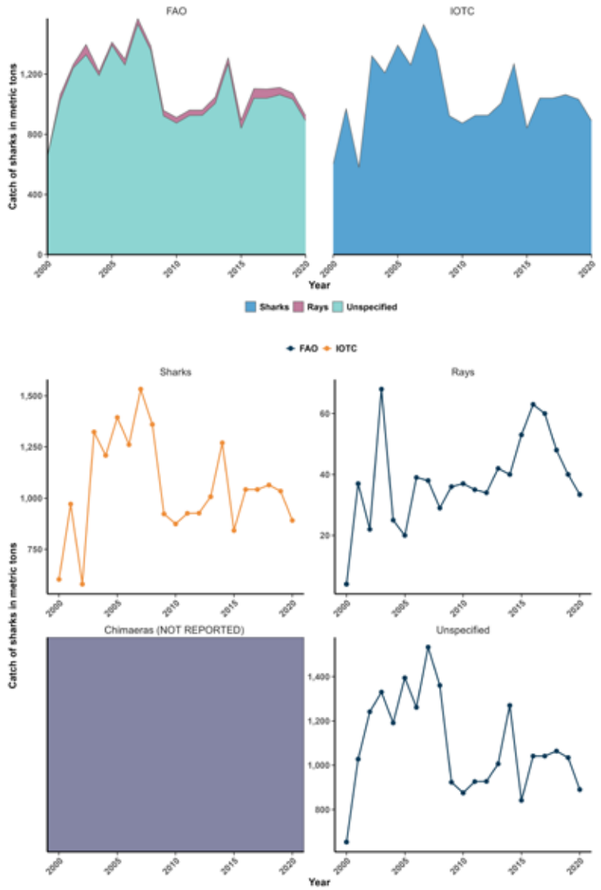
There are no target fisheries for sharks and rays in Gulf Saudi. During 135 landing surveys conducted between March 2016 and February 2020, a total of 1,600 shark and ray individuals with a combined weight of 6,491.51 kg were measured. Landings in terms of numbers were dominated by Human's Whaler Shark (*Carcharhinus humani*; 69.71%), Spottail Shark (*C. sorrah*; 19.56%), and Milk Shark (*Rhizoprionodon acutus*; 10.73%). However, the landings in terms of weight were dominated by Spottail Shark (22.25%), Human's Whaler Shark (14.37%), and Blacktip Shark (*Carcharhinus limbatus*; 10.44%; Hsu et al. 2022a; Hsu, personal observation, 2023). Ray landings, in terms of both number and weight, were dominated by Longtail Butterfly Ray (*Gymnura poecilura*) in fishery-independent surveys, and by Oman Cownose Ray (*Rhinoptera jayakari*) in landing surveys (Hsu et al. 2022a). Chimaeras are not known to occur in the Arabian Gulf.

TRADE

Processing

Shark finning is rarely reported in Gulf Saudi, where sharks are usually landed whole (Jabado & Spaet, 2017). During observations over a five-year period in Jubail, the largest fishery harbour auction fish market, sharks and rays were landed whole and shark finning only happened on three occasions (once with seven individuals finned, and twice with only one shark finned; Hsu et al. 2022a; Hsu, personal observation, 2023). Most sharks and rays were sent to be processed or sold elsewhere in the Kingdom by traders and intermediaries for further processing. Some individuals were sold in retail shops at the Jubail fish market where prices were SAR 10–25 (USD 2.67–6.67) per individual. If sold in small batches with several individuals, the converted prices were lower and sold by weight (Hsu, personal observation, 2023). These were mostly for domestic consumption.

Saudi Arabia's total catch of shark, ray, chimaera, and unspecified species reported to the Food and Agriculture Organization of the United Nations (FAO) and Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



Domestic

Meat of small sharks and rays is consumed locally in fresh form, mostly by foreign workers, particularly those originating from India, Pakistan, Bangladesh, Sri Lanka, and Nepal. Nationals in the Eastern Province of Saudi Arabia rarely eat sharks and rays (Hsu, personal observation, 2023).

Export

Small volumes of shark fins are exported to the Republic of Korea, Indonesia, and Taiwan. Shark meat and other products are also exported to Taiwan. Additional details on the processing and export of shark-related products from the Red Sea or the Arabian Gulf is limited (Jabado & Spaet, 2017; Hsu, personal observation, 2023).

CULTURAL SIGNIFICANCE

Nationals rarely eat sharks and rays and they do not consume Whale Shark (*Rhincodon typus*) because they do not eat fish 'without teeth'. Therefore, Whale Shark incidentally caught in Gulf Saudi waters are not seen at landings and are discarded alive or dead (Hsu et al. 2022a; Hsu, personal observation, 2023.). Although Green Sawfish (*Pristis zijsron*) has not been recorded from Gulf Saudi waters since the early 2000s, they are still caught in Bahraini waters, adjacent to Saudi, every year (Hsu et al., 2022a). Small volumes of sawfish rostra (and shark jaws) enter personal collections or can be found for sale online suggesting that they are potentially still captured but not reported (Hsu, personal observation, 2023; R.W. Jabado, personal communication, 2024).

RESEARCH

The Center for Environment and Marine Studies, Research Institute of the King Fahd University of Petroleum and Minerals, have conducted shark and ray related research in Gulf Saudi, as parts of various projects including 'Sustaining Research Project – Marine Environmental Studies – Phase VI' and 'Establishment of Marine Life Tracking System In Western Arabian Gulf' supported by the Environmental Protection Department, Saudi Aramco. Research included projects to assess shark and ray diversity, understand the biology of selected species such as Great Hammerhead and Scalloped Hammerhead (*Sphyrna lewini*), Whale Shark occurrence and tracking, and contaminant analysis (Hsu et al., 2021, 2022a, b; Yacoubi et al., 2023). The King Abdulaziz City for Science and Technology (KACST) has also funded research projects on Arabian Carpetshark (*Chiloscyllium arabicum*) including fisheries biology and contaminant analysis (Alhajji et al., 2022; A. Alhajji, personal communication, 2023). In 2023, the Marine and Coastal Division, National Center

for Wildlife started a weekly landing survey, which includes the collection of information on species identification, landing quantities, DNA samples, and length-frequency, to understand trends in landings. In addition, time-lapse cameras are planned to be set on 20 vessels to monitor shark and ray bycatch, occurrence, and distribution. A tracking programme (acoustic and satellite) for selected species is also under consideration (N.J. Pilcher, personal communication, 2023).

MANAGEMENT

Governance framework

The Ministry of Agriculture (MoA) is responsible for the management of all fisheries in Saudi Arabia (covering both the Arabian Gulf and Red Sea areas). Saudi Arabia has not developed a framework specifically for shark and ray management (Jabado & Spaet, 2017); however, a 'National Aquaculture Policies and Practices' was published in 2018, and the protections of mangrove ecosystems and marine mammals was included (Ministry of Environment, Water and Agriculture 2018). In a 2018 Environmental Impact Assessment (EIA), benthic animals, fisheries, and effects on natural fauna and native ecosystems were addressed, along with the assurance of the conservation of genetic diversity and biodiversity of the ecosystem. In addition, according to the 'Regulations on Fisheries in Saudi Arabia', there are restrictions on engine horsepower, fishing techniques, areas of net deployment, net mesh sizes and fishing period, for artisanal fishing boats; and on boat length and engine horsepower for modern fishing boats. These restrictions directly or indirectly reduce shark and ray fishing mortality.

Policy

According to the Royal Decree 57543 of 23/08/1439 (year 2008), the fishing of all shark species in any gear is prohibited. Any sharks captured alive must be released back into the wild (Jabado & Spaet, 2017). However, the regulation remains unclear with regards to incidental catches which are still landed. Fishing operations near petroleum, military, and industrial establishments are prohibited, and the Jubail Marine Wildlife Sanctuary (an important site for coral reef habitats and where a diverse community of sharks and rays has been recorded) was established in 1992 (Regulations on Fisheries in Saudi Arabia, 1992; Krupp & Khushaim, 1996). The trawl fishery (for shrimp) is only allowed to operate seasonally between August–January.

Enforcement and monitoring

The enforcement of restrictions on fishing (commercial and recreational) areas, particularly marine facility areas, is strong. Any boat getting close to such areas will be stopped, interrogated, and documents inspected by the coast guard, oil company (Saudi Aramco) security, and the Saudi Navy. Although finning is rare, basic monitoring of sharks and rays at landings such as species identification, number or weight records is scarce.

Community involvement

The involvement of communities in shark and ray related issues is rare, but public awareness to improve knowledge on migratory sharks and rays is increasing (Tatwany, 2018).

Gaps

Field research, capacity building, training and data collection are needed (Tatwany, 2018). Long-term and continuous monitoring of landings and various fishery-independent surveys to reveal the full picture of the status of sharks and rays is necessary (Hsu et al., 2022a). Public and school education on shark and ray ecological importance, threats to sharks and rays, and international conservation policies must be started as soon as possible (Tatwany, 2018). Knowledge of fishery exploitation, habitat destruction, marine pollution, climate change, and animal welfare is also important (e.g., although people do not directly kill Whale Shark, harassment usually occurs when recreational divers encounter a Whale Shark since there is no in-water code of conduct implemented for interacting with this species).

RECOMMENDATIONS

At least 19 species occurring in Saudi Gulf waters have been assessed as Vulnerable, Endangered, or Critically Endangered on the IUCN Red List of Threatened Species at a regional level (Jabado et al., 2017). These species, especially several large species (e.g., the migratory Whale Shark, predatory Great Hammerhead, and benthic Bowmouth Guitarfish [*Rhina ancylostomus*] and wedgefishes *Rhynchobatus* spp.) need to be studied to understand their biology and habitat use, and stock assessments need to be undertaken. In addition, an international collaboration with Bahrain for sawfish (Pristidae) research and management is needed (Hsu et al., 2022a). More than 85% of landings of sharks and rays originated from gillnet fisheries (Hsu et al., 2022a), thus studies on the impact of gillnets (e.g., selectivity, mortality rate, ghost net issue) and further management are critical. Recommendations for management measures including gear modifications and specifications (like mesh sizes), seasonal restrictions (for gillnets), and the creation of marine protected areas (MPAs; covering Jana Island due it being a shark and ray hotspot) have been provided to the government (Hsu et al. 2022a).

Policy

There are some loopholes in the Royal Decree 57543, thus some recommendations are provided as follows:

- The term 'shark' should cover 'shark and ray';
- Implementing a ban on retention and targeting of sharks and rays in high-survival rate fisheries like hook-and-line fisheries and the trap fishery. This should include the release of sharks and rays back to the sea whether live or dead when caught;
- Logbook systems including species-specific identification, gear type and effort (hook numbers, trap numbers, gillnet length and soak time, trawl speed and time), and location for each deployment, should be introduced; and
- Data collection at landing sites should be improved. Records of species (or higher order/family level), numbers, or weight are scarce. Data on boat serial number, fishing gear type, and price information are also often ambiguous.

Science/knowledge/research

There is a need to study the diversity of sharks and rays via:

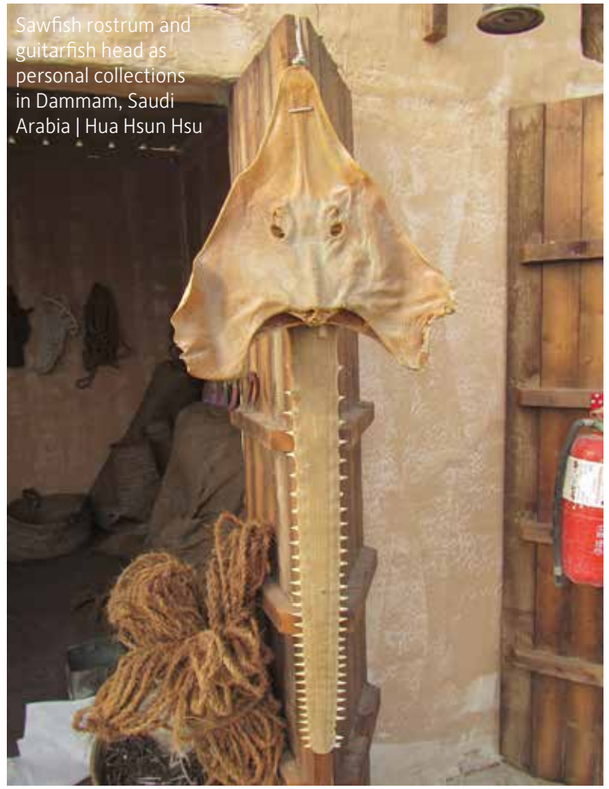
1. Long-term and continuous monitoring at landing sites;
2. Various fishery-independent surveys like trawl, gillnet, and longline; and
3. Baited Remote Underwater Video System (BRUVS) deployment in marine facility areas, island surrounding waters, and MPAs.

This should include information on life history for priority species or groups to understand reproduction, age and growth, and feeding habits (including stable isotope analysis).

Scalloped Hammerhead, Great Hammerhead, wedgefishes, guitarfishes (Rhinobatidae), and Whale Shark should be prioritized as species that are highly threatened, to understand their habitat use (satellite tagging [pop-up and SPOT/SPLASH tags], acoustic tracking; drone surveys; and sighting and reporting for ecotourism) along with undertaking stock assessment or ecological risk assessment (via improved data collection on catch and effort, and life history parameters).

Management/governance/conservation

The development of a national management/conservation strategy and action plan for sharks and rays is important. Fisher and public awareness on sharks and rays and their ecological importance is encouraged. Considering the listings of several species of sharks and rays on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendices, and the fact that Saudi Arabia still exports shark and ray products, issuance of non-detriment findings (NDF) based on scientific investigation is needed.



Sawfish rostrum and guitarfish head as personal collections in Dammam, Saudi Arabia | Hua Hsun Hsu

A tarad and dhows at Darin Harbour, Saudi Arabia | Hua Hsun Hsu

Common Thresher *Alopias vulpinus* | Elke Bojanowski

RED SEA

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INTRODUCTION

Saudi Arabia's Exclusive Economic Zone (EEZ) in the Red Sea spans 186,392 km² (Tesfamichael & Rossing, 2016). Saudi Arabia has the largest spatial extent of shallow marine habitats in the Arabian region, with an estimated 6,660 km² of coral reef habitat in the Red Sea and western shores of the Arabian Gulf. Saudi Arabia's Red Sea coastline extends over 1,840 km, extending from the border with Jordan in the northern Gulf of Aqaba (29°30′ N) to the border with Yemen, south of the Farasan Islands (Oreste Point, 16°22′ N). Much of the coastline is characterised by extensive shallow areas, often fringed by mangrove and seagrass habitats (PERSGA/GEF, 2004; Forestry Economics and Policy Division, 2007). Narrow fringing reefs, typically extend tens of metres from shore before dropping into deepwater; offshore reef habitats, and algal flats. These areas support a wide range of reef morphologies, such as barrier reefs, patch reefs, ridge reefs, atolls, tower reefs, pinnacles, pillars, and spur-and-grove structures, as well as diverse coral communities growing on algal-derived limestone structures (Sheppard et al., 1992).

FISHERIES

Fleets

According to the 2022 census by the General Authority for Statistics,Saudi Arabia's fishing fleet consists of 10,737 vessels, with 8,605 operating in the Red Sea—of which 158 are industrial and 8,447 are artisanal. A total of 30,099 individuals work in Saudi Arabian waters (Red Sea and Arabian Gulf), including 8,746 fishers and 21,353 individuals in related support roles. Of these, 3,780 are Saudi nationals, while 17,573 are non-Saudis (Marine Fisheries Statistics, 2021).

In 2006, the types of vessels reportedly used included fibreglass boats (n=4,804), wooden boats (n=809), and steel boats (n=46; MoA, 2007).

Gear

Fisheries in the Red Sea are predominantly artisanal (Carpenter et al., 1997; De Young, 2006; Tesfamichael & Pitcher, 2006). However, a small-scale industrial sector also targets various demersal and pelagic species, especially shrimp (Marshall, 1996; De Young, 2006). Artisanal fisheries primarily employ five types of gear: dome-shaped wire traps, handlines, gillnets, troll lines, and driftnets. In contrast, industrial operations mainly utilize trawling, gillnetting, and longlining (Jabado & Spaet, 2017). Small vessels in the artisanal sector are typically versatile, adapting their gear choices for multi-species catches based on fishing ground topography and target species (Carpenter et al., 1997; Tesfamichael & Pitcher, 2006). Sharks and rays are often caught incidentally across most of these gear types.

PRODUCTION

Overall landings

In 2022, Saudi Arabia's total Red Sea fishery production was 23,846 metric tonnes (mt), with 6,017 mt coming from industrial fisheries and 17,829 mt from artisanal fisheries (Marine Fishing Statistics, 2022). Within the artisanal sector, production was distributed across various regions: 5,525 mt in Makkah, 8,199 mt in Jazan, 1,229 mt in Asser, 1,346 mt in Tabuk, and 1,530 mt in Medina (Marine Fishing Statistics, 2022). Shark and ray catches in 2021 were estimated at 1,150 mt, comprising 1,140 mt sharks and 10 mt of rays (MEWA, 2021). However, Marine Fishing Statistics reported a lower total catch of 550.75 mt for this species group in the same year, with 507.75 mt of sharks from traditional fisheries and 43 mt (33 mt of sharks and 10 mt of rays) from industrial fisheries (Marine Fishing Statistics, 2021). In 2022, no ray catches were reported, while shark catches totalled 1,078 mt, comprising 36 mt from traditional fisheries and 1,042 mt from industrial operations (Marine Fishing Statistics, 2022).

According to data from the Food and Agriculture Organization of the United Nations (FAO), Saudi Arabia's shark and ray catches (spanning both the Red Sea and the Arabian Gulf) were approximately 890 mt in 2020. Species-specific data were only available for the Whitespotted Whipray (*Himantura gerrardi*, now *Maculabatis gerrardi*) which accounted for about 33 mt (FAO, 2022).

Species-specific

Species-specific data on landings are limited. Observed landings at Jeddah, the largest landing site, recorded between 2011–2013, included 880 Spottail Shark (*Carcharhinus sorrah*), representing 32.52% of all shark and ray individuals caught (Spaet & Berumen, 2015). Other frequently landed species include Grey Reef Shark (*C. amblyrhynchos*; n=287, 10.61%), Silky Shark (*C. falciformis*; n=272, 10.05%), Blacktip Shark (*C. limbatus*; n=276, 9.13%), and Milk Shark (*Rhizoprionodon acutus*; n=262, 10.01%), among others.

TRADE

Processing

Shark and ray meat is generally sold fresh and whole to consumers at local fish markets.

Domestic

Fresh shark and ray meat are consumed domestically, predominantly by low- and middle-income families. Generally, sharks and rays are of low value (Spaet & Berumen, 2015).

Export

Official data on shark and ray exports and imports are unavailable, and informal trade networks make tracking difficult (see trade flow map in Figure 4, Jabado & Spaet, 2017). Some shark meat is believed to enter and exit Saudi Arabia via Yemen and Oman, although details on quantities, processing methods (fresh or salted dried), and trade routes remain unclear.

CULTURAL SIGNIFICANCE

There is a common belief that the consumption of young-of-the-year sharks offers health benefits for lactating and pregnant women, especially from species such as the Milk Shark.

RESEARCH

Since its opening in 2009, the Red Sea Research Center at King Abdullah University of Science and Technology (KAUST) has undertaken a wide variety of shark and ray research to enhance our understanding of their ecology in the Red Sea. Some examples of past and ongoing research include the world's largest Whale Shark (*Rhincodon typus*) tagging programme (e.g., Berumen et al., 2014; Cochran et al., 2016; 2019), fish market surveys (Spaet & Berumen, 2015), Baited Remote Underwater Video (BRUV) and drone surveys (Spaet et al., 2017;McIvor et al., 2022), longline surveys, shark tagging and tracking (e.g., Braun et al., 2015; Spaet et al., 2017), and shark population genetics (Spaet et al., 2015).

MANAGEMENT

Governance framework

The Ministry of Agriculture (MoA) is entrusted with the management of all fisheries in Saudi Arabia.

Policy

In 2008, a royal decree prohibiting all shark-fishing activities was enacted by the Ministry of Agriculture to protect shark and ray resources. Details on penalties for violations of the law are not specified, however, and enforcement strategies appear to be virtually non-existent.

Enforcement and monitoring

Management, monitoring and large-scale outreach/awareness campaigns are non-existent (Bonfil, 2003).

Community involvement

Community involvement in shark and ray conservation is non-existent.

Gaps

A comprehensive list of gaps and issues in shark and ray research, policy, and management was published in 2003 (Bonfil, 2003). Most of the points made then are still relevant in 2024. Overall, one of the biggest issues is the lack of reliable data: 1) catch data are patchy and often unavailable (e.g., regional and species-specific data); 2) there is a critical lack of information on fleet size and fishing effort (e.g., number and power of vessels and number of fishing hours/days); and 3) there is a lack of stock assessments and information about shark and ray biology (e.g., abundance of the species and fisheries biology of the principal species). For instance, published records make no mention of shark nursery areas in Saudi Arabian waters within the Red Sea.

Shark landings at the Jeddah fish market | J.L.Y Spaet

Yet, the nature of the coastline (extensive shallow areas, largely fringed by mangrove and seagrass habitats; Khalil, 2004; FAO, 2007) and the large quantities of neonate and juvenile sharks offered for sale in regional fish markets (Spaet & Berumen, 2015) strongly suggest the existence of local nursery areas. Close examination of potential nursery sites, following the criteria of Heupel et al. (2007) would be beneficial. Furthermore, no quantitative data exist on shark and ray life history variables.

The root of these data issues is not a shortage of resources or personnel, but lack of prioritisation of sharks and rays within fishery agencies, as well as a lack of environmental and socioeconomic training among managers and the fisheries sector itself.

RECOMMENDATIONS

Research priorities should include routine systematic fishery surveys in combination with species-level monitoring and reporting of landings. This would provide key information on diversity, patterns of abundance, sex ratios, and maturity composition for those species taken directly or indirectly in marine-capture fisheries. There is also a pressing need to identify spatial and temporal sensitivities, such as nursery areas or seasons of high incidental catch rates. Further work should aim to identify species, areas of origin, and Saudi Arabia's involvement in the Red Sea fin trade.

Policy

There is a need to implement 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 the CMS Sharks Memorandum of Understanding (Sharks MoU) through new regulations. The development and implementation of recovery plans for sharks and rays, including interim measures such as non-retention measures for a species until a stock assessment is available, should be prioritized.

Science/knowledge/research

The collection of reliable catch and effort data for shark and ray fisheries is key to generating time-series catch-per-unit-effort and fishery-dependent abundance data. Development of stock assessment, age and growth and reproductive studies of sharks and rays should be prioritized including the identification and characterisation of nursery areas and other sensitive habitats along the coast.

Mandatory species-specific reporting at import and export should be implemented to monitor trade.

Management/governance/conservation

In many countries, overfishing is driven by extreme poverty and lack of alternatives (Pauly et al., 1989). However, in the case of Saudi Arabia's Red Sea, overfishing, appears to be unrelated to sustenance or economic need. The effectiveness of existing conservation management for fisheries operating in Saudi Arabia's Red Sea waters should be further strengthened (Berumen et al., 2013) but changing this situation may prove extremely difficult. In some countries, sharks and rays are considered to have greater value alive in terms of attracting ecotourists (i.e., scuba divers) than in fisheries (e.g., Dicken & Hosking, 2009; Catlin & Jones, 2010; Vianna et al., 2010). While Saudi Arabia has long been characterised by a very limited tourism industry (apart from religious pilgrims), increasing efforts are underway to expand marine-based tourism. Yet still, an apparent lack of political will, in combination with a general dearth of public awareness, seem to be preventing the implementation of effective fisheries management plans for shark and ray resources.

Unlike most other countries bordering the Red Sea, financial and human resources for adequate fisheries management are not a limiting factor. Current border control regulations require each boat to report to one of the numerous coast guard stations along the coast every time they leave or return to port. An investigation of each boat's landings by coast guard authorities could therefore be implemented without incurring major additional infrastructure or costs. Even without intensive training of personnel, such monitoring of landings would be a first step towards effective conservation of Red Sea sharks and rays, particularly if this included effective penalties for violations to the royal decree forbidding shark fishing.

Some steps have been taken in the right direction. Saudi Arabia is investing in education and research and building capacity and awareness on environmental issues among its population. Yet, without immediate action to regulate fisheries activities along its coast, Red Sea shark and ray populations may face serious collapses in the coming years.

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Shark and ray landings at the Jeddah fish market | J.L.Y Spaet.

Shark landings in Jubail fish market | Hua Hsun Hsu

SRI LANKA

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INTRODUCTION

The Democratic Socialist Republic of Sri Lanka (henceforth 'Sri Lanka') is an island country situated within the Bay of Bengal with a coastline of over 1,340 km and an Exclusive Economic Zone (EEZ) of 532,619 km², within the Food and Agriculture Organization of the United Nations (FAO) Fishing Areas 51 and 57. The surrounding, relatively narrow continental shelf contains multiple shark and ray habitats across coastal ecosystems such as estuaries, lagoons, mangroves, seagrass beds, and coral reefs (sandstone and limestone). The shelf edge drops to several hundred, and at times several thousand metres, often within 10 km from the coast. This enables pelagic species to be found relatively close to shore, especially on the northwest, south, and east coasts. Additionally, on the east coast a deepwater canyon extends into the Trincomalee Harbour where depths can exceed 700 m, providing crucial habitats for deepwater sharks within 1–2 km of the coastline. Pigeon Island, situated on the east coast with its fringing coral reefs, is the only known location where a healthy resident shark (Blacktip Reef Shark, *Carcharhinus melanopterus*) population exists. There are upwellings on the southern coast, however the limited fisheries effort and location data make it challenging to correlate the area with the higher records of species diversity and proportions of immature to mature individuals in the area.

FISHERIES

Fleets

The 2019 annual Department of Fisheries and Aquatic Resources (DFAR) statistics report a total licensed fishing fleet of 48,976 vessels (open-access fishery; DFAR, 2020). There are 4,885 (10%) multi-day vessels (10.5–28.5 m), which comprise 23 vessels that are >24 m in length and 1,449 vessels that are authorised (1,182 were 'active') to fish in the high seas (beyond the EEZ), where the use of vessel monitoring systems (VMS) is mandatory (DFAR, 2020). The rest comprises 948 (2%) single-day vessels (8.5–9.8 m); 23,404 (48%) out-board engine fibreglass reinforced plastic boats (OFRP) boats (5.5–5.7 m); 2,140 (4%) motorised traditional boats (4–11 m); 16,312 (33%) non-motorised traditional boats (4–9 m); and 1,287 (3%) beach seine crafts (4–9 m; DFAR, 2020). Vessels fishing in pelagic waters target tuna and billfish, while coastal fisheries also target other species (e.g., crustaceans and reef fishes). Only a few fisheries target sharks and rays, with the majority of catch and landings of this group comprising secondary catch (incidental catch of non-target species). Marine fisheries together employ around 224,610 active fishers (DFAR, 2020).

Gear

Gear types include gillnets, longlines, trolling lines, handlines, ring net, beach seines, hand nets, and various types of traps. Sharks and rays are predominantly captured incidentally by longlines and gillnets. There are specific target fisheries for deepwater sharks (for their liver oil, squalene) utilising handlines, while localised and seasonal ray fisheries exist in the north and north-western regions using bottom set gillnets. Until 2012, a targeted thresher shark (*Alopias* spp.) fishery existed in the southern coastal waters that used shark longlines. Shark and ray bycatch is from gillnets, longlines, trolling, beach seine nets, and ring nets. Gillnets include surface, midwater, or bottom set nets, however, catch or landing breakdowns are not available for that resolution of gear type. Over 36% of vessels utilise more than one gear type, depending on season or target species.

PRODUCTION

Overall landings

Annual landing statistics (referred to as 'production') from 2019 by the DFAR shows that sharks and rays comprise 3% (14,280 mt) of marine fish production. Total marine fish production in the same year was 415,490 mt (DFAR, 2020). No information is available on chimaera catches or landings.

Catch data provided to the FAO between 2000–2009 listed Sri Lanka as the 14th largest shark and ray fishing country globally, contributing 2.4% (19,988 mt) of global catches of this species group (Lack & Sant, 2011). Catch tonnage reported to the FAO in 2018 was 2,745 mt, down from 7,501 mt in 2017 (FAO, 2020).

Species-specific

National data suggest that the most prominent shark species from landings data include Silky Shark (*Carcharhinus falciformis*; ~32.9% of total shark and ray catch) and Blue Shark (*Prionace glauca*; ~12.7% of total shark and ray catch), while mako sharks (*Isurus* spp), hammerhead sharks (*Sphyrna* spp), Oceanic Whitetip Shark (*Carcharhinus longimanus*), along with several other species make up the remainder. In the Indian Ocean, Sri Lanka is presently the largest Silky Shark catcher and the second-largest mobulid ray (Mobulidae) catcher (Okes & Sant, 2019). Mobulid rays are incidentally captured in nets deployed for tuna and the numbers landed in Sri Lanka are estimated to exceed the total bycatch of mobulids from all global purse seine fisheries combined; potentially making Sri Lanka one of the largest mobulid fisheries (Fernando & Stewart, 2021). Data collected from smaller landing sites (Blue Resources Trust, unpublished data, 2023) shows that of over 1,000 survey days between 2017–2023, Indian Ocean Bluespotted Maskray (*Neotrygon indica*) comprised 41% of catch (11,130 specimens of this species), followed by Scaly Whipray *Brevitrygon imbricata* (7%), Silky Shark (7%), Spinetail Devil Ray (*Mobula mobular*; 5%), Grey Sharpnose Shark (*Rhizoprionodon oligolinx*; 4%), Blue Shark (3%), Sharpnose Guitarfish (*Glaucostegus granulatus*; 3%), Coach Whipray (*Himantura uarnak*; 3%), Whitespotted Whipray (*Maculabatis gerrardi*; 2%), Stripenose Guitarfish (*Acroteriobatus variegatus*; 2%), Broad Cowtail Ray (*Pastinachus ater*; 2%), *Chiloscyllium* sp. (2%), and Sicklefin Devil Ray (*Mobula tarapacana*; 2%), followed by several other ray and shark species, and one record of Sicklefin Chimaera (*Neoharriotta pinnata*).

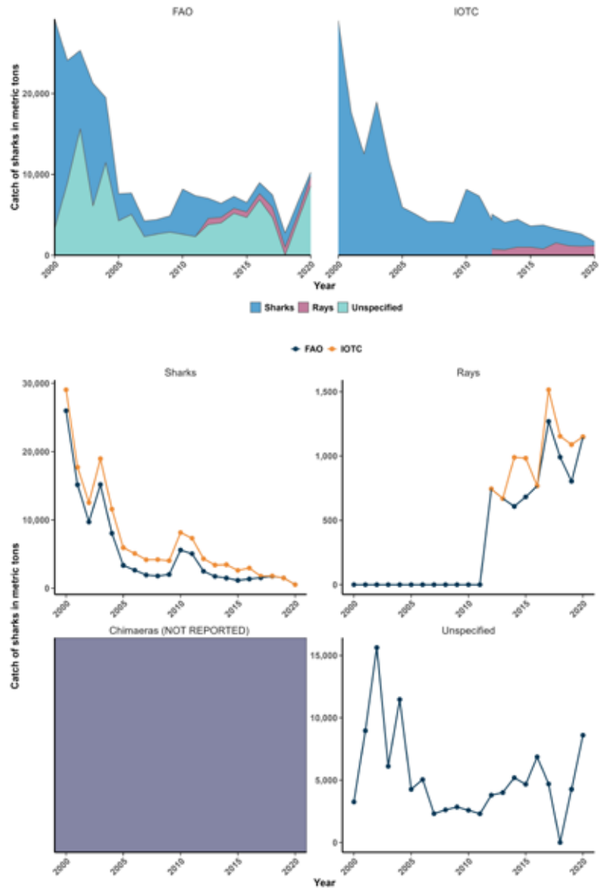
Some species of reef sharks such as the Indo-Pacific Zebra Shark (*Stegostoma tigrinum*), Tawny Nurse Shark (*Nebrius ferrugineus*), and Whitetip Reef Shark (*Triaenodon obesus*) have practically disappeared (de Silva, 2006); while Tanna et al. (2021) shows that sawfishes (Pristidae) are now functionally extinct.

TRADE

Processing

Sharks and small rays are landed whole, while larger rays are generally cut into two or more pieces to fit into the boat hold. They are usually 'assembled' at the landing site prior to being sold. Both shark and ray meat are either sold fresh, or salted and dried. Shark and ray fins and mobulid gill plates are removed after landing, sun dried, and exported. Skins (particularly of rays) are dried and exported. The teeth and jaws are cleaned, dried, and either sold nationally or exported for the curio trade. Deepwater shark livers are placed on metal drying racks for oil extraction in preparation for export (no further purification or processing takes place nationally).

Sri Lanka's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tons (mt) | Source: FAO (2022) and IOTC (2022)



Domestic

Shark and ray meat is largely consumed domestically, predominantly by low- and middle-income families. It is available in fresh and dried (salted and then dried) forms. Milk Shark (*Rhizoprionodon acutus*) are highly valued in certain communities due to beliefs that it benefits lactating mothers. Silky Shark, mako sharks, and Blacktip Shark are highly valued in fresh form, while thresher sharks, Blue Shark, and Tiger Shark (*Galeocerdo cuvier*) are generally dried before consumption. Preferences vary across regions. It is suspected that some meat is ending up in livestock feed, however, there are no data presently available to support this assumption. Some shark and ray meat is also imported for consumption (e.g., from the United Arab Emirates [UAE]; Jabado et al. 2015).

Export

Derivatives, including shark and ray fins and skins, jaws, teeth, and mobulid gill plates (all in dried form), in addition to shark liver oil are predominantly exported, in addition to some meat. The small number of exporters purchase their products from middlemen across the country. Destination countries include Hong Kong Special Administrative Region (SAR), Singapore, Japan, and Taiwan, while skins, jaws and teeth are also exported to neighbouring countries. As of 2023, no further value addition is being conducted within Sri Lanka.

There are only two shark and ray commodity codes that appear in trade databases for Sri Lanka: 'Fish; frozen, dogfish and other sharks, excluding fillets, fish meat of 0304, and edible fish offal of subheadings 0303.91 to 0303.99' (Harmonised System [HS] code 30381) and 'Fish; edible offal, shark fins' (HS code 30571). Hong Kong SAR is by far the largest destination for shark fin products from Sri Lanka (90%), which is then followed by Singapore (8%) and then Viet Nam and Malaysia, although not as regularly over the years for the last two countries. Data from Customs show that in 2021, a total of 101,745 kg of shark and ray fins worth LKR 690,503,500.00 (USD 2,065,899.47 as of 19th March 2023) were exported to Hong Kong SAR (84,981 kg), followed by Singapore (10,348 kg), UAE (3,046 kg), United Kingdom (UK; 2,550 kg), and several other nations (each less than 630 kg). Some Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) trade data are also available; however, concerns exist as there are instances of the export and import data mismatching. This is expected if a lower import is recorded since exporters often request a higher export volume than actually shipped but it does not explain how an import can be higher than the export. Additionally, illegal trade is occurring, which is confirmed by seizures in Hong Kong SAR and Sri Lanka. Some illegal trade is also occurring from India to Sri Lanka, due to the fin export ban in India (since 2015).

It should be noted that DFAR (2020) mentions that 95,637 mt of fish was imported and 28,771 mt of fish was exported in 2019, of which a proportion may include sharks and rays. Since the 1950s, local fish production has been supplemented with cheap imports to meet domestic demand. While export of shark fins is well documented, there is less information on the import of shark meat; trade balance (in USD) for shark products is negative in 2015–2016 but positive in 2017, when the exported income becomes more than double that of imported expenditure.

Small scale fishing boats in Sri Lanka | Blue Resources Trust

Multi-day fishing boats in Sri Lanka | Blue Resources Trust

Whipray with skin being removed for processing in Sri Lanka | Blue Resources Trust

Mobula ray being processed for its meat at Negombo market, Sri Lanka | Blue Resources Trust

Table 1: Registered vessels and vessel types in 2019 | Source: Fernando (2021)

	LENGTH OVERALL		REGISTERED VESSELS
TYPE OF VESSEL	IN METERS	NUMBER	%
Beach seine craft	4–9 m	1,287	3
Non-motorised traditional boats	4–9 m	16,312	33
Motorised traditional boats	4–11 m	2,140	4
OFRP boats	5.5–5.7 m	23,404	48
Single-day boats	8.5–9.8 m	948	2
Multi-day boats	10.5–28.5 m	4,885	10
Total number of vessels		**48,976**	

Table 2: Total non-directed shark catch (tonnes) by gear type, cumulative from 2014–2017 | Source: Fernando (2021)

GEAR TYPE	ALL		SHARKS		RAYS	
Gillnet	5,642.2	51.6%	2,071.4	36.7%	3,570.8	63.3%
Longline	3,989.4	36.5%	3,187.4	79.9%	802.0	20.1%
Trolling	304.8	2.8%	228.0	74.8%	76.8	25.2%
Handline	192.4	1.8%	78.6	40.9%	113.8	59.1%
Ring net	492.1	4.5%	430.2	87.4%	61.9	12.6%
Beach seine	321.6	2.9%	44.9	14.0%	276.7	86.0%
All gears	**10,942.5**		**6,040.5**	**55.2%**	**4,902.0**	**44.8%**

CULTURAL SIGNIFICANCE

Several communities believe that Milk Shark are beneficial when consumed by lactating mothers. The only other established cultural significance of sharks and rays is that their meat has always been consumed in either fresh or dried (salted and dried) form. Sri Lanka depends on marine fisheries as an essential source of protein, with over half of national animal protein consumed originating from seafood.

RESEARCH

The DFAR and the National Aquatic Resources Research and Development Agency (NARA) are the two primary government agencies that conduct shark and ray related research. They conduct some landings surveys, collect logbook data (from high seas vessels), and have conducted several assessments of trade and value chains. The Norwegian research vessel, Dr. Fridtjof Nansen, also conducted a fisheries independent survey in June–July 2018, where they collected some shark data. The Marine Environment Protection Authority (MEPA) has also once undertaken a project to document shark and ray species biodiversity using genetics.

The non-profit organisation, Blue Resources Trust (BRT), conducts long-term fishery landing surveys for all sharks, rays, and chimaeras and holds the largest national checklist with over 104 species in total. BRT also conducts age-growth studies, gut content analysis, socio-economic assessments, and supports national, regional, and global genetic studies (barcoding and population assessments) focusing on sharks, rays, and chimaeras.

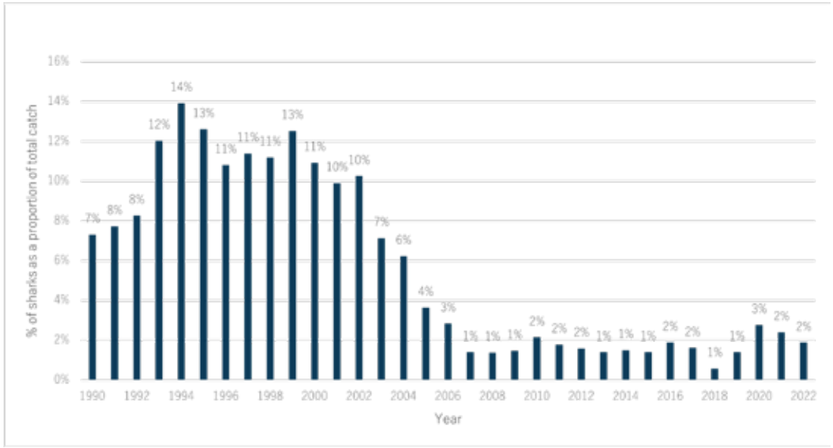
Some universities (mostly student projects) and other non-governmental organisations (e.g., Oceanswell carried out socio-economic studies on illegal shark fisheries) sporadically collect data or conduct assessments for sharks and rays.

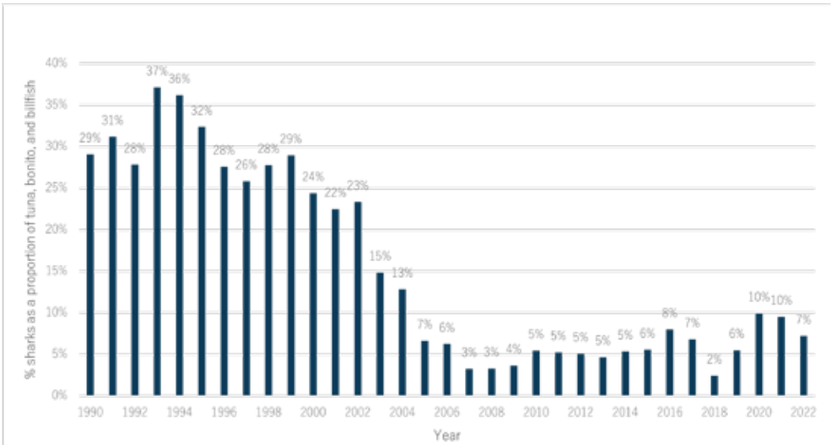
MANAGEMENT

Governance framework

The DFAR is entrusted with the management of all fisheries in Sri Lanka while the Department of Wildlife Conservation (DWC) is mandated with the conservation of fauna and flora (including sharks, rays, and chimaeras). Sri Lanka Coast Guard and Police are responsible for enforcement while Customs enforce regulations at the point of export or import.

Figure 1 | Sharks as a proportion of all other marine catch. Bottom: sharks as a proportion of the 'tunas, bonitos, and billfishes' | Source: Updated by authors from Fernando (2021)





Policy

In 2001, legislation was gazetted to prohibit shark finning and discarding and required that all sharks are landed whole with fins intact (Gazette 1206/20 of 17 October 2001). Following the Indian Ocean Tuna Commission (IOTC) conservation measures, Sri Lanka also prohibited the catching of all species of thresher sharks (Common Thresher [*Alopias vulpinus*], Bigeye Thresher [*A. superciliosus*], and Pelagic Thresher [*A. pelagicus*]) in both commercial and recreational fisheries in 2012 and requires that any thresher sharks caught incidentally be released alive and recorded in logbooks (Gazette 1768/36 of 27 July 2012). In 2015, the previous gazette notices were rescinded and brought together under one single management measure entitled: the Shark Fisheries Management Regulations, 2015 (Gazette No. 1938/2 of 26 October 2015) and the Shark Fisheries Management (High Seas) Regulations, 2015 (Appendix 7.2 and Appendix 7.3). In addition to fins naturally attached and the thresher shark prohibition, this requires the owner or skipper of the vessel to release live sharks, especially juveniles or pregnant sharks and includes prohibitions on the fishing and landing of Oceanic Whitetip Shark and Whale Shark (*Rhincodon typus*). In total, five species of shark belonging to three families are protected in Sri Lanka. There are no size or catch restrictions in place.

While since the 2000s there has been a shift to establishing Marine Protected Areas (MPAs), they tend to cover a very small area and are mostly focused on coral reef ecosystems and sea turtles. Currently 28 MPAs, including Fisheries Management Areas (FMAs), have been established. Only one of these, the Pigeon Island MPA, includes a resident population of Blacktip Reef Sharks along with the occasional Lemon Shark (*Negaprion brevirostris*). None of the FMAs explicitly encompass sharks or rays.

Enforcement and monitoring

The geographical spread of fishing grounds and landing sites presents a major challenge to the surveillance and monitoring of both small-scale coastal fisheries and offshore fisheries. Some fishing regulations (such as the prohibition on bottom trawling or dynamite fishing) are not actively or sufficiently enforced. Compliance of the protected shark and ray species is relatively high, but by no means perfect - there are still regular records of illegal finning or the landing of protected species. However, in relation to the implementation of other fisheries regulations, these are well complied with. There has also been renewed effort in strengthening enforcement of offshore fishing regulations and licensing of multi-day fishing vessels operating outside the EEZ (including the introduction and expansion of VMS).

The BRT, the FAO, and the IOTC have conducted capacity strengthening workshops focusing on the identification of (national and CITES-listed) species for DFAR, NARA, Coast Guard, Navy, and Customs. Fisher outreach and awareness on protected shark and ray species is extremely low, however, DFAR has recently expressed their intention in expanding education and awareness programmes and initiated work to improve and encourage safe release of protected species at sea. Monitoring at sea is conducted primarily by the Coast Guard, while landing sites are monitored by DFAR and NARA, in addition to independent organisations such as BRT. Domestic trade is not actively monitored but through occasional government or independent investigations. Export trade is monitored by Customs.

Community involvement

Community involvement in shark and ray conservation is minimal to non-existent. There are few instances where communities or individuals have reported infractions involving protected species. Some of the deepwater shark fisheries reported halting their fisheries when they encountered large numbers of pregnant individuals to protect populations; however, many of these deepwater fisheries have since completely ceased due to limited catches (likely due to overexploitation). It is hoped that community involvement will improve as DFAR and other organisations conduct their outreach and awareness programmes.

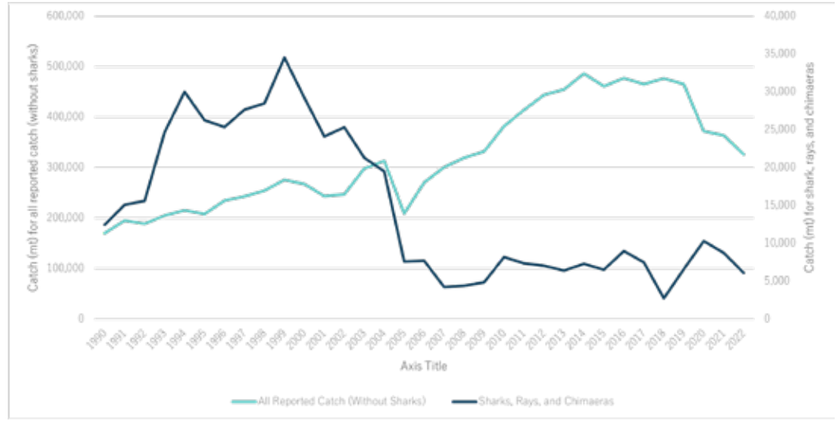
Gaps

There is insufficient species-specific data available on the shark and ray fishery and trade, and no stock status, catch per unit effort (CPUE), or data from discards/releases. There are also significant gaps in import and export statistics with relation to the products and derivatives of sharks and rays in trade. For example, Sri Lanka only declared shark fin trade data to the United Nations (UN) Comtrade until 2017, but there are data from Hong Kong SAR declaring shark fin imports from Sri Lanka until 2020. There are also discrepancies between the data declared by the two countries; for example, in 2017 Hong Kong SAR declared ~25% more shark fin imports in terms of quantity than what was declared as exported to Hong Kong SAR by Sri Lanka. Insufficient awareness of regulations at the ground level coupled with challenges of enforcement are impacting existing measures and any future introduced management.

Some gaps exist with the implementation of the CITES convention (particularly for exotic species). Sri Lanka is yet to implement the Convention on the Conservation of Migratory Species of Wild Animals (CMS) or take actions on recommendations from the CMS Sharks Memorandum of Understanding (MoU). The IOTC Conservation and Management Measures (CMM) on mobulid rays (Res. 19/03) is yet to be implemented in Sri Lanka. Many MPAs remain as paper parks with limited enforcement. To date, there has not been any direct shark protection through the DWC-Fauna and Flora Protection Ordinance (FFPO).

Silky Shark *Carcharhinus falciformis* landed in Beruwela, Sri Lanka | Blue Resources Trust

Figure 2 | A comparison of all marine species without sharks (top) tunas and bonitos, and billfish (bottom) with shark catches between 1990–2022, as reported to the FAO. Both highlight increasing or ongoing effort and catch, while shark catches decline | Source: Updated by authors from Fernando (2021)



The current structure (or lack thereof) for the large spatial fisheries makes monitoring and enforcement challenging (e.g., no mandated ports of landing).

RECOMMENDATIONS

Priorities include the implementation of CMS and the current IOTC CMM on mobulid rays. Introducing protections for sawfish (in the hope that some individuals may still be found), the rapidly declining rhino rays (such as the Stripenose Guitarfish, found only in India and Sri Lanka), and interim measures for other species to halt or prevent declines are critical. Introducing traceability of sharks and rays (from capture to consumption/export). Research to conduct stock assessments and identify critical habitats. All of this has to be complemented with improved outreach and awareness. Further, adding species to protected lists is insufficient if there are no recovery plans in place.

Policy

- Implement CITES, CMS, and IOTC CMM through new regulations.;
- Mandate species-specific reporting by exporters/importers (ensuring that enforcement authorities only need to validate shipments);
- Ensure that exporters cannot retrospectively obtain a permit if they are intercepted without one;
- Revise and update the national species protection lists following IUCN Red List of Threatened Species assessments and national stock assessments. This should be followed by signing and ratifying the Cape Town Agreement, the Biodiversity Beyond National Jurisdiction treaty (BBNJ), increasing wildlife fines, removing fishery subsidies, mandating specific landing sites to improve monitoring and enforcement, and limiting the number of registered fishing vessels (effort);
- Implement a recovery plan for species, including interim measures such as non-retention measures until a stock assessment is available for a species. Other measures such as controls or limits on gillnets, bycatch mitigation, seasonal closures, etc, should be investigated; and
- Improve awareness of national regulations and legislations among judiciary, to ensure that marine species violations are treated as serious crime.

Manta and devil ray *Mobula* spp. gill plates drying the sun in Negombo, Sri Lanka | Blue Resources Trust

Common Thresher *Alopias vulpinus* landed in Beruwela before the non-retention measure was enacted in Sri Lanka | Blue Resources Trust

Bramble Sharks *Echinorhinus brucus* captured in deepwater fisheries | Blue Resources Trust

Science/knowledge/research

- Conduct research on species critical habitats and support the development of stock assessments;
- Ensure data are accessible and shared across national agencies, independent bodies, and management conventions; and
- Increase awareness of protected species, shark and ray biology and life history, and sustainable alternatives.

Management/governance/conservation

- Encourage a transition into (or maintaining of existing) sustainable fishing techniques such as pole and line;
- Implement the Shark-NPOA, CITES, shark non-detriment findings (NDF), and CMS Sharks MoU recommendations;
- Move away from reactionary management to proactive management, particularly at a national level (Sri Lanka has an established record of proactive management via international conventions which must now be translated to a domestic level);
- Strengthen national capacity (conducting stock assessments, monitoring fisheries, species identification, genetic tools, and to ensure more active participation at regional forums such as the IOTC); and
- Explore alternative methods of data collection for small scale vessels (e.g., electronic monitoring systems [EMS] or crew-based monitoring).

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SUDAN

SUDAN

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INTRODUCTION

Sudan is located in northeast Africa at the southern edge of the Sahara. It has an Exclusive Economic Zone of about 82,561 km^2. The Sudanese Red Sea coast is about 750 km long, including bays and inlets, from its northern border with Egypt and Eritrea in the south. Most of the Sudanese Red Sea is pristine and has high-quality coral reefs and marine life that attracts international tourism through scuba diving.

The warm waters of the Red Sea are ideal for coral growth, temperatures are high enough, salinity is right, there are not too many storms to break the growing coral and little sediment deposited from land (Berry, 1964). The Red Sea contains unique coastal and marine environments. Its physical conditions range from near-shore shallows to depths of over 2,000 m in the central rift that have created an extraordinary range of ecosystems and biological diversity. The Red Sea harbors one of the highest levels of endemism for marine organisms (DiBattista et al., 2016). The reefs of the Red Sea region are composed of approximately 200 species of stony corals, representing the highest diversity in any section of the Indian Ocean (PERSGA, 2010). Other Red Sea ecosystems include mangroves stands, seagrass beds, algal reefs, and intertidal habitats.

Sudan hosts an extensive and complex network of coral reefs, seagrass beds, mangroves, and other shallow marine habitats that support a diversity of marine fauna and flora. Sudan's varied coastal and marine ecosystems support biological diversity and endemism. This includes fringing coral reefs which line the entire coast, lagoons or *marsas*, islands, seagrass beds (there are eight species including *Halophila ovalis, H. stipulacea, Halodule uninervis*, and *Thalassia hemprichii* that are frequent or common along the coast particularly in Dungonab Bay), and small mangrove stands particularly in the south (FAO, 2008). The total Sudanese mangrove area has ranged between 329–721 ha in the last few decades. The literature showed an increase in mangroves from 1984–1990, while it decreased sharply from 1995 to 2000. A massive change happened between 2000–2010, when an increase in mangrove cover was observed (Osman & Elbashier, 2019). Waters around the islands and along most of the coastline provide feeding, nursery and/or nesting sites for marine wildlife, including for what may be the most important remaining Dugong (*Dugong dugon*) population on the coast of Africa (PERSGA, 2006). Nesting sites of Green Turtle (*Chelonia mydas*) and Hawksbill Turtle (*Eretmochelys imbricata*); as well as for seabirds, including Osprey (*Pandion haliaetus*), Sooty Falcon (*Falco concolor*), Sooty Gull (*Larus hemprichii*), White-eyed Gull (*Larus leucophthalmus*), Bridled Tern (*Onychoprion anaethetus*), White-cheeked Tern (*Sterna repressa*), Crab–plover (*Dromas ardeola*), and other charismatic species are also present here. Both Green Turtle and Hawksbill Turtle are commonly reported foraging in Dongunab and Mukkawar Island National Park and Khor Alnasrani north of Port Sudan (PERSGA/GEF, 2004a; El Hassan et al., unpublished data). The eastern shore of Mukawwar Island is a turtle nesting site of regional and possibly international significance (PERSGA/GEF, 2004a). The offshore islands on the southern coast are known to support a significant number of nesting sites for these species. Anecdotal observations suggest that Humpback Whale (*Megaptera novaeangliae*) and Common Bottlenose Dolphin (*Tursiops truncatus*) occur around the small Sanganeb Atoll (PERSGA/GEF, 2004a).

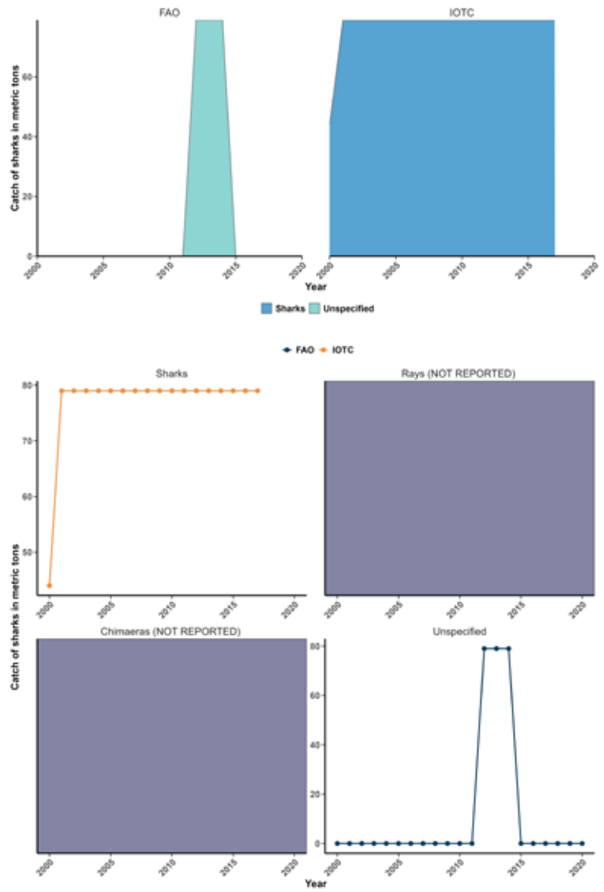
About 65 species of bony fishes are considered to be of economic importance, in addition to sharks, rays, shrimps, lobsters, crabs, molluscs, and sea cucumbers. There are 280 species of bony fishes reported from the Sudan Red Sea; with 60–70% of fish landings being groupers (*Epinephelus* spp.), and Two-spot Red Snapper (*Lutjanus bohar*). There are also 26 shark species, three guitarfish species, Green Sawfish (*Pristis zijsron*) and 11 ray species that have been genetically identified from the Sudanese Red Sea coast (Elhassan, 2002, 2017). A total of 251 bony fish species, including Green Humphead Parrotfish (*Bolbometopon muricatum*), Humphead Wrasse (*Cheilinus undulatus*), Leopard Coral Grouper (*Plectropomus leopardus*), and eight other species of groupers, were reported from the Sanganeb Atoll alone, with estimations of the actual number of species above 300 (Krupp et al., 1994 in PERSGA/GEF, 2004a). Large bony fishes, including tuna (Scombridae), barracuda (Sphyraenidae), and sailfish (Istiophoridae), are also reported (PERSGA/GEF, 2004a). Populations of several commercially important invertebrates are present in the Sanganeb Atoll, the most important being the Toothed Top Shell (*Tectus dentatus*, formerly *Trochus dentatus*).

The southern Sudanese Red Sea coast is the most productive area for fishes, particularly for sharks. It provides feeding and breeding grounds for many coastal shark and ray species as indicated by the high number of neonates and juveniles of Blacktip Shark (*Carcharhinus limbatus*), Spottail Shark (*C. sorrah*), Scalloped Hammerhead (*Sphyrna lewini*), Milk Shark (*Rhizoprionodon acutus*), and Spinner Shark (*C. brevipinna*) caught in the trawl fishery operating in these waters and from sharks landed in the Port Sudan fish market before the shark fishing ban (Elhassan, 2002, 2017). The *marsas*, islands, and mangroves on the southern coast serve as pupping and nursery grounds for at least 20 shark species, two guitarfishes and ten rays, including Great Hammerhead (*Sphyrna mokarran*), Scalloped Hammerhead, Grey Reef Shark (*Carcharhinus amblyrhynchos*), Silky Shark (*C. falciformis*), Silvertip Shark (*C. albimarginatus*), Blacktip Shark, Spinner Shark, and Green Sawfish (Elhassan, unpublished data, 2002, 2017). Lagoons of the Sanganeb Atoll are suspected nursery grounds for Scalloped Hammerhead and Great Hammerhead (Elhassan, 2002), with schools forming at the south-western and north-eastern points of the atoll from November to April (Vine & Vine,1980), and pupping for these species being observed in December–March (Elhassan, 2002). Hammerheads usually remain in depths of 70–90 m around the atoll but enter shallower waters (<20 m) in the early mornings and just before sunset. Other large-bodied coastal sharks, including Tiger Shark (*Galeocerdo cuvier*), Silky, Mako (*Isurus* spp.), and Oceanic Whitetip Shark (*Carcharhinus longimanus*), inhabit open water surrounding Sanganeb Atoll (Elhassan, 2002). This open water is also a breeding site for mako sharks and Oceanic Whitetip Shark (Elhassan, 2002). Many coastal areas are also known for aggregations of Reef Manta Ray (*Mobula alfredi*) and Whale Shark (*Rhincodon typus*).

Dungonab Bay, comprising a total area of 284.5 km², contains Mukkawar Island and several other islands within its bounds, which are situated 125 km north of Port Sudan. The diverse habitat types, including coral reefs, mangroves, offshore islands, soft-bottom mud flats, sandy beaches, hard-bottom rocky shores, with adjacent salt marshes, *sabkhas* and *khore* basins (PERSGA/GEF, 2004a), provide for a rich biological diversity. The area provides breeding grounds and areas of refuge for reef fish communities, marine turtles, dolphins, sharks, and rays – including threatened species listed on the IUCN Red List of Threatened species, such as Great Hammerhead, Scalloped Hammerhead, and Green Sawfish (Elhassan, unpublished data, 2002; PERSGA/GEF, 2004a). The Dungonab Bay–Mukawwar Island area is known for seasonal aggregations of Whale Shark and manta rays that are unique in the entire Western Indian Ocean region, and internationally recognised as an Important Bird Area for resident and migratory birds (PERSGA/GEF, 2004b). In addition to oyster farming and tourism activities, artisanal fishing is allowed in Dungonab Bay, with the prohibition on shark fishing. However, sharks and rays are caught as bycatch in the artisanal fisheries. No monitoring or enforcement mechanisms are in place.

The small Sanganeb Atoll close to the centre of the Red Sea provides optimal conditions for coral growth and reef development, supporting marine biodiversity. It is designated and managed as a no-take zone. Sanganeb's physical features, which include shallow reef flats, ribbon reefs, lagoons, shallow pools (<20 m deep), vertical drop-off reef slopes with terraces to the seabed, and surrounding open waters up to 800 m deep, host a spectacular diversity of coral and fish species. The atoll supports numerous herbivorous fish, particularly Sohal Surgeonfish (*Acanthurus sohal*) and parrotfish (*Scarus* spp. and Green Humphead Parrotfish), and is a fish nursery and spawning ground, including for sailfish. Limited research has been conducted on the deeper outer slopes that fringe the atoll (PERSGA/GEF, 2004b). Schools of Great Hammerhead and Scalloped Hammerhead are reported in the winter in Sanganeb National Park. No study on sharks and rays has been conducted to investigate the species or their status in Sanganeb National Park.

Sudan's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



FISHERIES

Fleets

According to official statistics, between 1,000–1,200 registered fishing boats operate along the Sudanese coast (M. Iragi, Marine Fisheries Administration, personal communication). Wooden and fibreglass boats are used along the Sudanese coast. The number of wooden boats operating ranged between 200–300 vessels of 10–12 m in length, most of which operate in the southern coast. Specifically, the wooden boats 6–12 m long are fitted with a sail and inboard engine are used for fishing trips lasting between seven to ten days, depending on the boat size, with a crew of four to five people. Fibreglass boats are fitted with an outboard engine. About 4,000 registered full-time fishers engage in Sudan's artisanal, multispecies coastal fisheries, and around 2,000 recreational fishers are known (M. Iragi, Marine Fisheries Administration, personal communication, 2023).

Before introducing fibreglass boats to fishing communities, Sudan's Red Sea artisanal fleet comprised entirely of locally made wooden boats. Boat building continues to be an important activity along the coast, especially near Suakin. Non-mechanised dug-out canoes, mechanised *houris* and *sambuqs* using onboard motors and inboard diesel engines, respectively are also used. In 2010, navigation devices like global positioning systems (GPS) and fishfinders were introduced to aid in the exploitation of new fishing grounds for better management of the fisheries (M. Iragi, Marine Fisheries Administration, personal communication, 2023).

The coastal waters are divided into three fishing grounds: the northern area from Port Sudan to Osief near the border with Egypt, the central area around Port Sudan, and the southern area from Port Sudan to the Gulf of 'Agig Bay. Artisanal fisheries in Sudanese waters operate from October–May, with some fishers collecting sea cucumber (*beche de mer*) and Toothed Top Shell during the other four months. Besides finfish, there is a significant kokian fishery (Giant Spider Conch or *Trochus dentatus*). Exploitation of sea cucumbers along the Sudanese coast was initiated in the late 1970s. The production has been based on two species groups (*Holothuria* spp. and *Actinopyga* spp.). Pearl oyster (*Pinctada margaritifera*), and ornamental seashells (mainly *Strombus* and *Lambia* species) are also collected.

Whitetip Reef Shark
Triaenodon obesus | Sylvain Le Bris | iNaturalist.org (CC BY-NC)

Gear

Marine fisheries are artisanal in nature. Fishing activity is carried out using traditional gears, crafts, and fishing techniques. Fishing with handlines is the most common fishing method, particularly in the central and northern coastal areas. On the Sudanese coast, fishers use gillnets with different mesh sizes and total lengths that are deployed at different depths, each suited to catching certain species. Based on the target catch, fishers are generally active in:

- Bays, inlets, and *marsas*, consisting of single and multiple channel water bodies more or less perpendicular to the coastline and extending inland for 1–5 km with water depth reaching depths up to 180 m. This zone is famous for sardine and *Siganus* spp.;
- Coastal boat channels extending for some half a nautical mile (nm) from shore with a depth of approximately 5.5 m and harbouring mullet, Milkfish (*Chanos chanos*) and *Lethrinus* spp.;
- Fringing reefs parallel to the coast at distances of 1–2 nautical miles (nm), with important fishes such as *Caranx* spp., *Lethrinus* spp., and *Plectropomus* spp.;
- Deep boat channels with depths of 73–366 m which are known for *Aprion* spp. and sharks;
- Outer barrier reefs within a continental edge where Two-spot Red Snapper, Humpback Red Snapper (*Lutjanus gibbus*), and Yellow-edged Lyretail (*Variola louti*) are found; and
- Pelagic zone of over 550 m with *Agus* sp., *Caranx* spp., mackerel, tuna and other species (Sudan country report 2008).

Fishing activities are generally directed at finfish, shrimp and wild molluscs. Handlines of hook size 6/0–9/0 and length of 70–120 m target coral reef finfish and particularly high-priced groupers, which are caught on the near- and offshore reef systems and in the archipelagos. Gillnets are mostly used in the southern coast and are used in lagoons and on reef flats for capturing roving herbivores such as parrotfish, surgeonfish and mullet. Two types of gillnets with different mesh sizes are deployed in different depths. For example, monofilament gillnets with mesh sizes of 2–3.5 inches (5–8.9 cm), lengths of 100–1,000 m and height of 1.5 m are deployed at depths of 1.5–2 m for catching mullets (M. Iragi, Marine Fisheries Administration, personal communication, 2023). The commercial fishery consists of trawlers and purse seiners. Both trawling and purse seining are seasonal activities from October–May. Twenty-five to 18 licensed Egyptian trawlers operate from October–May in an area of 71,000 ha in the Southern coast Dalta Tokar, Gulf of 'Agig, Mersa Mogadam, and Tala Tala Kabir and Tala Sagir at depths of 37–73 m targeting shrimp, lizard fish, and goat fish. These vessels usually discard other species incidentally caught. Purse seines target sardines and mullets (M. Iragi, Marine Fisheries Administration, personal communication, 2023).

PRODUCTION

Overall landings

Until the early 2000s, shark catches from the artisanal fisheries were landed in four main landing sites before they were brought to Port Sudan central fish market and were officially recorded by the Sudanese Marine Fisheries Administration as total weight on five days per month. Since the shark trade ban was enacted in 2016, shark landings are no longer recorded by the Marine Fisheries Administration.

Catches from the Egyptian trawl fishery in Sudan's EEZ are not landed in Sudan. Since 1979, Sudanese observers, from the Marine Fisheries Administration and the Marine Research Centre, on board of the Egyptian trawl fishing vessels operating along the southern coast of Sudan record catches of bony fishes and shrimp. Shark bycatch in trawling is only sometimes recorded as weight (most of them are juvenile; Elhassan, 2002).

Yemeni boats have intensively poached sharks from Sudanese waters since early times, with a small shark fishing operation that started in the 1990s. Some Sudanese companies licensed for shark fishing employed Yemeni fishers between 1992–1997 (Marine Fisheries Administration records).

Overall, there are no official data available on the quantities of sharks or rays caught by national fisheries in Sudanese waters, apart from catch data and effort obtained through research conducted by the author of this chapter. However, before the shark fishing ban in 2016, shark bycatch from trawling operations ranged from 2–5 metric tonnes (mt) per trip, with fishing expeditions lasting up to 21 days at sea. These sharks were typically landed in Egypt. Following the ban, trawl vessel crews are required to return all shark bycatch to the sea, regardless of the species (M. Iragi, Marine Fisheries Administration, personal communication, 2023). The survival rate of returned sharks is unknown. Additionally, The Marine Fisheries Administration maintains catch records (by weight) of illegal shark fishing activities by foreign poaching vessels.

Species-specific

Non-target catches or incidental catches of sharks and rays in gillnets are not well documented in MAF records. In a study on shark bycatch in trawl fisheries along the Sudanese Red Sea coast (Elhassan, 2002, personal observation, 2010), large numbers of requiem (*Carcharhinus* spp.) and Hammerhead (*Sphyrna* spp.) sharks were recorded, with small specimens consumed by the crew. Before the enforcement of the shark fishery and trade ban in 2016, Grey Reef Shark, Silky Shark, Blacktip Reef Shark, Blacktip Shark, Spinner Shark, Spottail Shark, Milk Shark, Scalloped Hammerhead, Great Hammerhead, Tiger Shark, Tawny Nurse Shark (*Nebrius ferrugineus*), and Whitetip Reef Shark (*Triaenodon obesus*) were landed with occasional landings of Sandbar Shark (Carcharhinus plumbeus), Pigeye Shark (*C. amboinensis*), and Sharptooth Lemon Shark (*Negaprion acutidens*).

TRADE

Processing

Sharks are dressed (headed, finned, and gutted) and chilled on the fishing boat at sea before being landed at the fish market in Port Sudan. All fish caught from the southern, central, and northern coasts are brought to the Port Sudan fish market. Pre-ban on shark trading (in 2016), fresh shark fillets were sold to popular small restaurants that also served shark and ray meat processed into fish balls to consumers largely unaware of what meat they were consuming. The few fishers that still target sharks land the trunks and sell shark fillets in other areas of the city, particularly to residents from neighbouring African countries. In recent years, bycaught rays have also been landed whole, quickly processed outside the fish market and sold as fillet in the same neighbourhoods. Egyptian trawl fishers reportedly freeze whole sharks and land them in Egypt (M. Iragi, Marine Fisheries Administration, personal communication, 2023).

Domestic

The meat of most sharks is favoured by shark meat traders, except that of Tiger Shark which is considered tough and sticky. The meat of the Whitetip Reef Shark is also of low preference. Small- and medium-sized individual Blacktip Reef Shark are in high demand. Pups and juveniles of most species are preferred as they contain less urea than mature specimens and can be cooked easily. People in Sudan usually do not directly buy shark meat. Before the enforcement of the shark fishing law, owners of small restaurants bought shark meat, cooked it, and sold it in fish dishes, for example, fish and chips. Consumers were not aware it was shark meat. Shark meat is sold in Port Sudan town only.

In the past, fish processors did not sell crude shark liver oil but instead used it for treating wooden boats to make them watertight. Shark liver oil is occasionally used for medicinal purposes, for instance to cure chest diseases. A small shop in Port Sudan sells shark liver oil as a treatment for back pains and rheumatism.

Export

Fins are by far the most valuable shark and ray product. Those of Whitespotted Wedgefish (*Rhynchobatus djiddensis*) are the most desirable, whilst those of Tiger Shark are considered of lesser value in the local market. After the prohibition of shark fishing by local order in 1989, no official records on the fin trade are available. Anecdotal information indicates that fins are illegally exported to Dubai, United Arab Emirates (UAE) or sold to Chinese nationals working in Sudan.

CULTURAL SIGNIFICANCE

Before the enforcement of the ban on shark fisheries in 2016, the jaws of Tiger Shark and Shortfin Mako (*Isurus oxyrinchus*), and sometimes Green Sawfish rostra, were sold as curios to tourists in Port Sudan. Given the prevailing prejudice that all sharks are 'man-eaters', locals do not generally keep shark or ray parts in their houses. Some fishers have kept a large jaw or rostrum as a memory of encountering the species or as decoration (such as rostra of Green Sawfish).

RESEARCH

Academic and non-governmental institutions in Sudan do not currently conduct studies or research on sharks or rays, studies by the author of this section being the exception. The ban on fishing and selling of sharks and rays and legal action taken against illegal markets made it increasingly difficult to study sharks and rays in the Sudanese Red Sea. Scarce funding and technical support for conducting scientific research handicaps evidence-based shark and ray conservation management.

MANAGEMENT

Governance framework

Conservation management for sharks and rays is the responsibility of Sudan's Marine Fisheries Administration. The Marine Fisheries Administration is responsible for legally regulating shark and ray fisheries and trade, and the enforcement of the law. The Coast Guard is responsible for surveillance of coastal waters for illegal fisheries but lacks sufficient resources to fulfil this role. Tourism agencies also have a role to play in the conservation management of sharks, particularly for Grey Reef Shark, hammerhead sharks, Whale Shark, and manta rays as these substantially contribute to tourism revenue earnings.

Policy

Shark fishing was prohibited in Sudan by a local order in 1989. In 2008, upon pressure from the Tourism Department, fishing for sharks was banned by law. Despite the prohibition, fishing for sharks was still practiced and large quantities, particularly of juvenile sharks, were landed in the fish market of Port Sudan. In 2016, the law was amended to ban all trade in sharks and any of their parts. These regulations are now being enforced. However, sharks are sometimes are caught as bycatch or illegally harvested and their fins are often sold in clandestine markets.

The Sanganeb Atoll Marine National Park and Dungonab Bay - Mukkawar Island Marine National Park, established in 1990 and 2005, respectively, are recognised as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site with no-take and buffer zones since July 2016. Sanganeb Atoll Marine National Park is a no-take area while traditional fishing is allowed in Dungunab Bay National Park for fishermen in Dungunab village.

New Marine Protected Areas (MPA) have been proposed; the Suakin Archipelago, a group of islets in the southern coast, has been proposed for IUCN category 11 National Park status, and another has been proposed at Shaab Rumi about 40 km northeast of Port Sudan. The Sawakin Archipelago offers important habitat for resident and migratory birds, sea turtles, and functions as a nursery ground for sharks and rays, including globally threatened species (Scalloped Hammerhead, Great Hammerhead, Oceanic Whitetip Shark, and Green Sawfish), that currently lack spatial protection in this archipelago (Elhassan, 2002, 2017). Shaab Rumi, with remnants of Jacques Cousteau's underwater study base from 1963, is a popular tourist destination and diving site. Tourism agencies, who bank on sightings of Great Hammerhead, Scalloped Hammerhead, Grey Reef Shark, and manta rays contribute to the conservation management in Shaab Rumi through reporting the incidence of shark fishing to the police and Marine Fisheries Administration.

Community involvement

Coastal communities are currently not involved in the management of shark and ray fisheries. Awareness campaigns by the author for shark and ray conservation targeting fishers since 2002 have been positively received, resulting in one fisher quitting shark fishing and one of the two main shark and ray traders in Port Sudan shifting to bony fish trade. Additionally, some fishers in Dungonab Bay work seasonally with tourist agencies as guides at diving sites. In 2019, the sawfish team (officers from the Marine Fisheries Administration and the author), received a small grant from the Shark Conservation Fund (SCF) to survey sawfish pupping grounds and conduct awareness campaigns among fishers, along the coast. The sawfish team carried out a successful awareness campaign along the coast on the status of Green Sawfish and the need to conserve the remaining population along this coast. The result of these campaigns was the collection of photos and videos

of pups released by the fishers and the identification of two important nursery areas for Green Sawfish in the southern Sudanese coast.

Gaps

The population status of sharks and rays in Sudan is poorly known, since national research and international collaborations focus primarily on bony fishes. This knowledge gap, along with the absence of government monitoring for catches, landings, and trade, limits the ability of fisheries managers to detect changes over time (whether natural or anthropogenic), develop appropriate management strategies, and assess the success of management. The law banning shark fisheries and trade does not offer protection for rays, with the exception of Green Sawfish.

The general lack of awareness about sharks and rays among the Sudanese public and the absence of educational outreach also nurtures public misconceptions and a lack of support for their protection.

RECOMMENDATIONS

With the local ban of shark fisheries in Sudan's EEZ in 1989, and an amendment to the Marine Fisheries Law in 2016 prohibiting trade in sharks and any of their parts, the trade in fins, meat, and oil has shifted to the black market and catches or landings are not monitored.

Tourism is becoming an increasingly important source of employment and revenue for Sudan, with sightings of Great Hammerhead, Scalloped Hammerhead, Grey Reef Shark, and manta rays being key attractions. Marine protected areas provide some protection to key shark and ray habitats, but incidental catch of sharks and rays from artisanal fisheries in Dungonab National Park would impact their populations.

Policy

The Marine Fisheries law needs to be revised to address the issue of non-target/bycatch more effectively and include rays, whilst the Marine Fisheries Administration is under pressure from fishers to amend the shark fishery and trade ban to exclude sharks caught as bycatch. To maximise compliance among fishers, targeted awareness campaigns on the regulations pertaining to sharks and rays and their importance for the diverse and productive ecosystems must be conducted along with law enforcement.

Sanganeb Marine National Park and Dungonab Bay - Mukkawar Island National Park management system is guided by the 2017–2021 Integrated Management Plan (IMP). However, this does not include a shark and ray management. Therefore, a management plan and monitoring programme for shark and ray conservation should be incorporated into the integrated management plan. Both parks have monitoring programmes, but limited enforcement due to a lack of resources. The creation of an integrated coastal zone management plan would benefit the overall seascape, including priority shark and ray habitats not currently under management. The participation of all stakeholders, particularly fishers, in developing management plans for fisheries in general, and sharks and rays in particular, is essential to ensure equity in shared responsibilities and benefits.

Replanting and recovery programmes are needed for mangrove stands that provide shelter and food for birds, shrimp, and fish (including rays and some sharks), which have been degraded by camel grazing and felling or cutting of limbs, along with behaviour changes among the nomads.

Science/knowledge/research

There is paucity in research on sharks and rays in the Sudanese Red Sea because such studies are considered costly and the landing of only trunks, an illegal and obscure process, restricts access to relevant biological and morphological information. International assistance could enhance local research capacity. Training on the identification of sharks and rays as a prerequisite for systematic data collection should be prioritised. Surveys are needed on the bycatch of sharks and rays in trawl fisheries and of shark and ray nursery areas in the Sudanese Red Sea for improving their protection during breeding seasons, along with collaborative research on stocks and movements of migratory shark and ray species with neighbouring countries. Studies of socioeconomic aspects of shark and ray fisheries and trade are necessary to formulate recommendations on conservation management approaches that benefit local fishers and their communities and incentivize their compliance.

Management/governance/conservation

The Arab League Educational, Cultural and Scientific Organization (ALECSO) initiated a Programme for the Environment of the Red Sea and Gulf of Aden (PERSGA) in 1974. One of its most significant achievements was the development of The Jeddah Convention, signed in 1982 by the plenipotentiaries of the governments in the region. Article XVI called for the creation of 'The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden', an intergovernmental organisation dedicated to the conservation of the coastal and marine environments in the region. This body was officially established in 1995 at the first Council Meeting in Cairo. It has inherited the acronym PERSGA from ALECSO's original programme. PERSGA's Member States include Djibouti, Egypt, Jordan, Saudi Arabia, Somalia, Sudan, and Yemen. The headquarters of the organisation are located in Jeddah, Saudi Arabia. PERSGA offers a platform for regional and international collaborations to advance marine science and shark and ray conservation management in littoral states of the Red Sea, including Sudan.

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Small scale fishing boats, sambuks, in Sudan | Jillian Amatt Artistic Voyages | Unsplash

UNITED ARAB EMIRATES

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INTRODUCTION

The United Arab Emirates (UAE) is located on the southern side of the Arabian/Persian Gulf (hereafter referred to as 'the Gulf'). It has two coastlines: a stretch of about 650 km west facing the Gulf and about 70 km east facing the Sea of Oman (Spalding et al., 2001). Of the seven emirates, the shoreline of the Emirate of Abu Dhabi is the longest and represents almost 70% of the whole UAE's coast. Overall, it has an Exclusive Economic Zone (EEZ) of 58,292 km² (Flanders Marine Institute, 2019).

Its waters are home to a diversity of fish, marine organisms, and productive habitats, including salt marshes, mangrove forests, seagrass beds, coral reefs, and algal beds, most of which intergrade with each other in many places. These biologically diverse marine ecosystems play an important ecological, recreational and cultural role in the UAE by providing food and shelter for numerous fish and marine species, protecting coastal areas from storm surges, preventing coastal erosion, as well as supporting commercial fishing and a diversity of recreational activities. The subtidal habitats include coral reefs, seagrass beds, and oyster beds, while the intertidal zone consists of mangroves, saltmarshes, mudflats and algal mats (Mateos-Molina et al., 2020, 2021). Some of these habitats create complex seascapes in coastal lagoons that are considered priority areas for the conservation and management of marine biodiversity, as they provide food, shelter, nursery, and breeding grounds for many marine species (Mateos-Molina et al., 2023). Coral reefs and coastal lagoons have been highlighted as the most important ecosystems for sharks and rays in the UAE (Jabado et al., 2021; Mateos-Molina et al., 2023).

Reports indicate that 70% of the UAE coastline has been reclaimed since the 1990s. Specifically, coastal development, exemplified by the increased size of the city of Dubai between 1970–1985 (from 18 km² to 100 km²), and the urbanisation of the 60 km shoreline from Jebel Ali to Sharjah are likely to have greatly impacted fisheries resources. This has led to the destruction of wildlife breeding and feeding habitats (coral reefs, seagrass beds, lagoons, mangroves, and beaches) which has had direct impacts on the diversity and abundance of species and caused a decline in fisheries resources. Threats to fisheries resources in the Arabian Gulf and Sea of Oman mirror those which occur on a global scale. However, they are exacerbated by the extreme environmental characteristics in the region and by the lack of environmental impact assessments and studies that has permitted the large scale and widespread loss of important habitats and resources. For instance, reef fish populations have suffered as a result of natural die-offs of corals in the Arabian Gulf due to rising sea water, temperature and salinity levels in the summer. In fact, in 1995, a heat-induced die off affected 90% of all corals in the southern Arabian Gulf. These seasonal changes place the whole system under stress as temperatures often exceed those that are tolerable by corals. Overall, threats to these ecosystems are ongoing and confounded with population growth, increased oil exploration, and shipping traffic, overexploited fisheries, and climate change (Sheppard et al., 2010).

FISHERIES

Fleets

The fishery is characterised by highly diverse catches and is comparable to multi-species tropical fisheries (Grandcourt, 2012; Jabado et al., 2015a). It is often described as 'artisanal' because of the traditional fishing gears and methods used, however, it operates on a scale that is commercial in nature (Grandcourt, 2012). Two types of boats are allowed to operate in UAE waters, namely the traditional *dhow*, or *lansh*, and the fiberglass dories, or *tarad* (Carpenter et al., 1997; Jabado et al., 2015a).

Lanshes are traditionally built wooden *dhows* (constructed with fiberglass reinforced plastic hull, while retaining their traditional form) and powered by inboard engines (Al-Ansi & Priede, 1996). They are usually between 12–22 m in length (Grandcourt, 2012). These boats tend to cover long distances and can stay at sea for several days and up to several weeks. Typically, gears used on these boats consists of fishing traps, but driftnets, gillnets, hook and line as well as trolling lines can also be used (Carpenter et al., 1997). Large hooks and longlines (*manshalla*) enable the targeting of pelagic species, including sharks. Fish is stored whole on ice in insulated cool boxes and is landed at permitted landing sites.

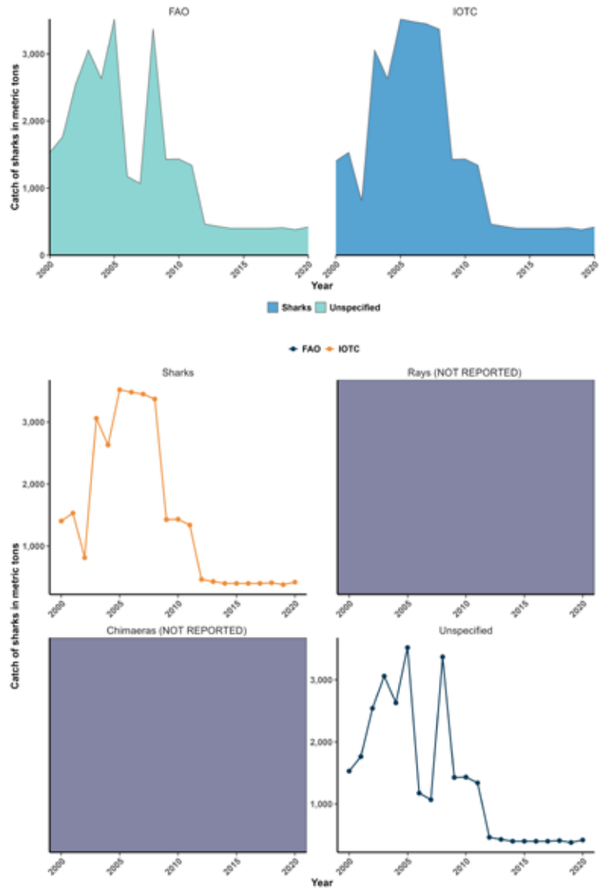
Tarads are usually 8–10 m in length and are powered by one or two outboard engines. Because of the small size of the boats, fishing trips are usually a day in duration, but can last several days. Some tarads are equipped with two 250 horse power (hp) engines, and can therefore travel long distances in a short amount of time. They generally utilise a variety of gear including traps, hand lines, trolling, and various types of gillnets. Catches are sold at fish markets and landing sites, and buyers are generally local traders or hotel and supermarket purchasers (Al Mousa et al., 2008). These operations are usually organised by fisheries cooperative societies that have been established in each emirate. These cooperatives have been set up by the government to also deal with fisher needs, ensure their training, and increase awareness among both the fishers and the general community of newly implemented laws and subsequent ministerial decrees (Al Janahi, 2008). Most landing sites, particularly ones in major cities, have facilities for landing, storing, auctioning, wholesaling and retailing the catch.

Individuals engaged in fishing as full-time or part-time fishers increased from 3,955 in 1976 to 24,925 in 2012 (MOCCAE, 2024). These numbers reflect a combination of both local and expatriate fishers (mostly from the Indian sub-continent); of total fishers, 7,241 are UAE citizens and the remaining 17,684 are expatriate fishers. This is mainly because many Emiratis are not solely dependent on income from fisheries and are increasingly involved in other industries.

In 2013, the number of fishing vessels registered in the UAE totalled 6,304 including 620 *dhows* and 6,304 *tarads*. Since the 1990s, the number of tarads has increased while the number of dhows has slowly decreased. This has been attributed to the higher cost of operating these vessels with fishers choosing to move to the smaller, more efficient, tarads.

Recreational fisheries are a rapidly growing sector and while it has been suggested that total productivity and harvest pressure from this fishery is minimal compared to the commercial fisheries (Grandcourt, 2012), data are not readily available to determine their impact. Fishing is mainly carried out from small motorboats from the shore using hook and line, wires (gargoors), and fly-fishing. Licensing of recreational fishers was introduced between 2001–2003 and can be in the form of annual or weekly licenses available to both locals and expatriates over the age of 18. In the Abu Dhabi Emirate alone, there are usually over 5,000 annual license holders. With this many licences in use, it is likely that interactions between fishers and sharks and rays occur, potentially having some impact on the species. In fact, citizen science reports to the Elasmo Project indicate that sharks and rays are frequently landed after capture in these fisheries (Jabado, unpublished data, 2024).

United Arab Emirates' total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



Gear

Generally, the most common gear used is circular dome shaped fish traps made from galvanised wire called *gargoors*. However, a large variety of gears exist including gillnets (*Mansab*), drift nets (*Asharee*), barrier traps (*Hadrah*), handlines (*Hadaq*), and longlines (*Manshala*). These are used based on the type of fishing vessel and target species (Carpenter et al. 1997), and are usually used alone or in combination with other traditional gear (Table 1). In-depth information and descriptions of the various fishing gears, methods used, and target species for each have been published by Carpenter et al. (1997), Beech (2004), and Grandcourt (2012).

PRODUCTION

Overall landings

Catches in the UAE are diverse, with characteristics of a multi-species tropical fishery. Over 100 species are landed at approximately 42 landing sites along the coast, where they are auctioned fresh. Target species are usually representative of the Carangidae (jacks), Lethrinidae (emperors), Haemulidae (grunts), Serranidae (groupers), Scombridae (kingfish), Siganidae (rabbitfish), and Sparidae (sea breams) families. Demersal species are more common than pelagic ones in landings. Pelagic catches are mostly dominated by Spanish mackerel (*Scomberomorus* spp.) and other large pelagics, while small pelagic species such as *Sardinella* spp. and anchovies (Engraulidae) are captured in inshore waters (by beach seines and set nets) in the northern emirates of Umm Al Quwain and Ras Al Khaimah and on the east coast in the emirate of Fujairah.

Species-specific catch information is limited in the UAE with only the Environment Agency - Abu Dhabi (EAD) having collected detailed long-term data from Abu Dhabi waters on commercially important fish species. The Ministry of Climate Change and Environment (MOCCAE) has also been collecting information on species and catch effort but little analysis relating to stock assessments has been published. Information from these fisheries statistics programmes indicate that between 2006 and 2013, fish landings totalled between 100,403 mt and 73,203 mt, respectively. Catches started declining in 2007 reaching 96,453 mt but the lowest catches were recorded in 2012 at 72,728 mt. These numbers increased again slightly in 2013 and reached 73,203 mt, with the largest quantities of fish having been recorded from the emirate of Sharjah and Ras Al Khaimah at 17,420 mt and 16,920 mt, respectively and representing 47% of the total catches of the UAE (MOCCAE, 2024). There are no data collated or available on the overall production of sharks and rays in the UAE.

Reports to the Food and Agriculture Organization of the United Nations (FAO) indicate that shark and ray landings fluctuated between 430–3,520 mt, and averaged at 1,551 mt, between 1986– 2022 (FAO, 2024). Generally, landings are declining, except for peaks between 2002–2008 when catches averaged 2,481 mt annually (FAO, 2024).

Species-specific

Species-specific information on sharks and rays is only available from a survey undertaken between October 2010–September 2012 in Abu Dhabi, Dubai, Sharjah, and Ras Al Khaimah (Jabado et al., 2015a; 2016). Data were recorded from 12,482 individual sharks representing 30 species occurring

Table 1: Main fishing gear utilized in the UAE | Source: Carpenter et al. (1997), Beech (2004), Grandcourt (2012), Jabado et al., 2015a

GEAR	DESCRIPTION
TRAPS	
Gargour	Wire traps in the shape of a dome (can be over 1.5 m in diameter) with a funnel like entrance and a steel reinforced base (with escape panel in Abu Dhabi). Bait used includes dead fish, bread, dried fish and green algae. Mainly used to target demersal and semi-pelagic species including groupers (Serranidae), seabreams (Sparidae), emperors (Lethrinidae), snappers (Lutjanidae), sweetlips and grunts (Haemulidae), jacks (Carangidae), and parrotfishes (Scaridae).
Al Hadhra	Fixed semi-permanent intertidal barrier trap connected to the shore via a long fence of steel poles and nylon netting. Fish are harvested at low tide and include species such as mullets (Mugilidae), rabbitfishes (Siganidae), jacks (Carangidae), barracudas (Sphyraenidae), needlefishes (Belonidae), snappers (Lutjanidae), and seabreams.
LINES	
Hadaq	Monofilament hand line with one or more baited hooks to capture species such as groupers (Serranidae), emperors, seabreams, sweetlips, jacks, Spanish mackerels (Scombridae), and cobias (Rachycentridae).
Manshalah	Longline designed with about 50 to 100 large sized hooks. The number of hooks and the length of the mainline depends on the target species. This gear is banned but is still used to catch large species such as groupers, sharks (Carcharhinidae), and cobias (Rachycentridae).
NETS	Central Government
Ghazal	Encircling gillnets up to 500 m in length and 10 m deep set at the surface and used to target large pelagic species, such sweetlips and grunts and jacks.
Al Defara	Encircling gillnets up to 500 m in length and 4 m high set in shallow coastal waters targeting demersal and pelagic species.
Al Sakkar	Barrier nets up to 1500 m in length and 4 m high set at high tide and used to shut off a portion of the seabed, trapping small demersal species behind the net as the tide drops.
Dagwa	Purse seine mainly used along the beaches of the northern emirates and Fujeirah. The pulling of the net onto the beach is aided by at least two trucks.
Tadmeer	Small gillnets of 20 m wide set in shallow water near the shore and used to target small demersal species.
Nesaab	Gillnets of 50 m wide and 1–4 m deep set in shallow waters near the shore and used to target small demersal species.

in UAE Gulf waters. The family Carcharhinidae was the most abundant (95.5% of all landed species) and most diverse with 18 species, followed by Hemigaleidae with three species, and Sphyrnidae and Hemiscylliidae with two species each. The six most abundant species included the Spottail Shark (*Carcharhinus sorrah*; 31.8% of shark landings), Milk Shark (*Rhizoprionodon acutus*; 29.9%), Blacktip Shark (*C. limbatus*; 14.3%), Sliteye Shark (*Loxodon macrorhinus*; 8.9%), Whitecheek Shark (*C. dussumieri;* 4.5%), and Arabian Smoothhound (*Mustelus mosis*; 1.6%). The remaining 24 species recorded comprised between 0.01–1.4% of the total shark landings (Jabado et al., 2015a; 2016).

During these surveys, data on rays were opportunistically collected. Sixteen species were landed with 1,306 specimens recorded across the country (Jabado, unpublished data, 2024). Four species represented 90.5% of ray landings and included the Oman Cownose Ray (*Rhinoptera jayakari*; 59.4%), Wafic's Eagle Ray (*Aetomylaeus wafickii*; 11.7%), wedgefishes (primarily Whitespotted Wedgefish [*Rhynchobatus djiddensis*] and Smoothnose Wedgefish [*R. laevis*]; 10.5%), and Brown Eagle Ray (*Aetomylaeus milvus*; 8.9%). Wedgefishes and guitarfishes were always retained due to the high value of their fins while other ray species were often discarded by fishers because they are considered unmarketable (Jabado, 2018). The high numbers of cownose and eagle rays recorded here were mostly observed as a result of fishers accidentally setting a net on large aggregations of rays which were subsequently retained. This suggests that these ray records might not be a true reflection of the relative abundance of species of rays within the waters of the UAE (Jabado, unpublished data, 2024).

TRADE

Processing

The trade in shark products consists mainly of fins and meat (Jabado et al., 2015b). Fins are mainly exported to Asia (Hong Kong Special Administrative Region [SAR]) while the meat is dried and exported to Sri Lanka. Shark skins are sometimes also retained and dried for sale to mainland China although additional information on processing once there is not available. Jaws and teeth are sometimes sold to tourists while the market for cartilage is largely non-existent. Liver oil is occasionally traded locally for *dhow* proofing. However, patterns of distribution across the region are complex and dynamic (Jabado & Spaet, 2017) and are likely to have changed since these surveys were undertaken. This is because many species of sharks and rays are now listed on international agreements and the government has taken some action to regulate the trade.

Domestic

Fins are generally removed from sharks, wedgefishes, and guitarfishes for export. Shark meat is sometimes locally consumed. Dried, salted shark meat is the predominant form of processing and is destined for the export market (Jabado et al., 2015b; Jabado & Spaet, 2017). However, small-bodied sharks (<100 cm total length, TL) are preferred by locals for consumption and therefore also sold at local markets. If they are not sold within a few days, the meat is cut into cubes and dried and salted. On the other hand, rays are not often found at markets and if sold, were at low prices as they were deemed to be unmarketable (Jabado, unpublished data, 2024).

Between 2010–2015, small-bodied sharks like the Milk Shark retailed locally between AED 10–20 per kg (USD 2.5–6 per kg). Large-bodied sharks (>100 cm TL) such as Blacktip Shark or Scalloped Hammerhead (*Sphyrna lewini*) in Dubai were valued between AED 8,000 (USD 2,200) and AED 20,000 (USD 5,500) for 20 sharks depending on sizes. Fresh meat was auctioned at AED 6 per kg (about USD 1.7 per kg) but could resell at prices up to AED 40 per kg (USD 11 per kg) after drying and packing.

Export

Since the 1990s, the UAE has been an important transshipment hub and amongst the top global exporters of shark fins, usually destined to Asian markets such as Hong Kong SAR (Jabado et al., 2015b). Dried shark fins recorded in Hong Kong SAR's import statistics from the UAE between 1984¬–1995 peaked at over 500 mt in 1995 (Rose, 1996). Over the years, these numbers have remained relatively stable (Dent & Clarke, 2015; Jabado & Spaet, 2017). Based on Hong Kong SAR statistics in 2011, the UAE exported 479 mt of dried, unprocessed shark fins valued at USD 14.823 million and imported 26 mt valued at USD 1.209 million (Dent & Clarke, 2015). Large quantities of dried shark meat are exported to Sri Lanka, while shark meat from Oman is often transported overland to Saudi Arabia (Jabado et al., 2015b).

After the listing of several shark species on the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), the UAE government protected species listed on CITES in their waters and banned the export of fins originating from them. However, re-exports were still allowed by law and as such the trade with Hong Kong is still ongoing in large quantities. Overall, much of the trade in sharks and their products remains unregulated with little information available regarding species and quantities involved.

CULTURAL SIGNIFICANCE

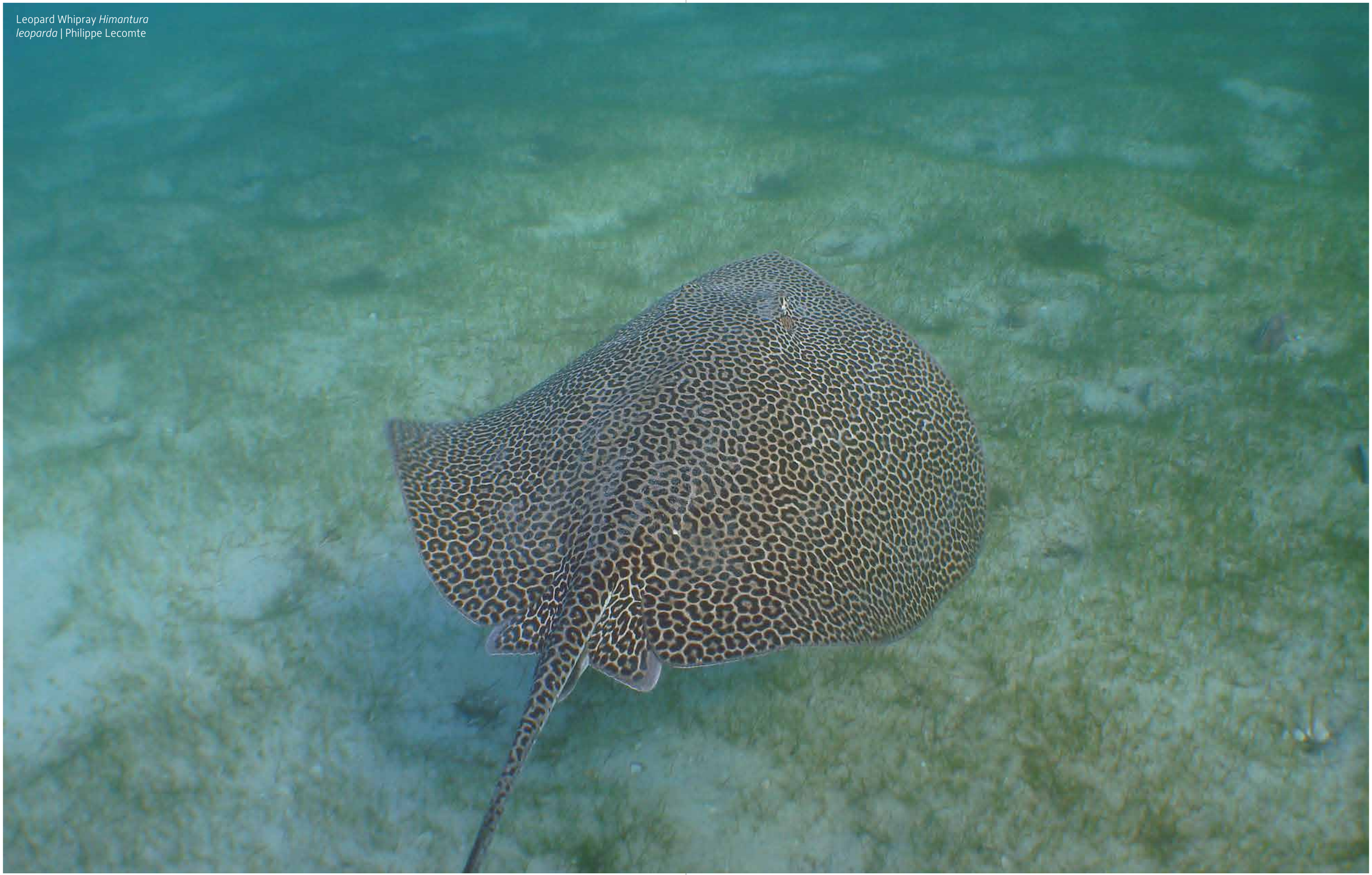
Evidence from archaeological sites in the UAE, dating back over 7,000 years, indicate that there was historically a strong dependence of shark and ray resources (Beech, 2004). Over the centuries, sharks caught were processed and utilised in various ways. Shark vertebrae were used as nose clips by pearl divers operating out of Dubeh (presumably Dubai, UAE; Cousteau, 1963). The oil extracted from livers was used to coat the exposed area (above the water line) of *dhow* hulls to reduce the deterioration of timber and to achieve a shiny appearance. Meat was salted and dried for use during seasons or periods where the weather was unfavourable for fishing (White & Barwani, 1971; Sivasubramaniam & Ibrahim, 1984) while carcasses were used as fertilizers in date plantations. Furthermore, sharks have traditionally been a constituent of the Emirati diet and recipes for shark cooking have been documented for local consumption (Gubanov & Schleib, 1980).

RESEARCH

Research on sharks in the UAE has been spearheaded by very few institutional and non-governmental organisations (NGOs). The United Arab Emirates University (UAEU) stands out as a key academic institution, having conducted consistent research on sharks and rays since the 2000s, contributing significantly to the understanding of these species. Complementing this are non-governmental initiatives as noted below. The International Fund for Animal Welfare (IFAW) also plays a role in advocating for shark welfare and supporting research on a global scale, including efforts within the UAE.

Projects and organisations having been involved in shark and ray research include:

1. The Elasmo Project which was launched at the end of 2009 as part of a PhD research project funded by the UAEU. The main objective was to investigate the diversity, abundance, distribution and trade in shark and ray species from the UAE. Data were collected by undertaking interviews with fishers, leading fishery dependent and independent surveys, analysing biological data and undertaking genetic analysis. Results confirmed 31 shark and over 20 ray species from UAE waters and highlighted that shark stocks were depleted, and that urgent action was needed for their conservation. The project has now expanded to other regions of the world with only short-term work in the UAE (e.g., Jabado et al., 2015b; 2016; Jabado, 2018).
2. Sharkwatch Arabia was launched in 2010 to gather information on the ecology of Whale Shark (*Rhincodon typus*) in the region. As part of a PhD study to better understand these threatened species, the project called on divers to report sightings of Whale Shark in the region and to photograph them in order to allow for the identification of individuals. The work was focused on the UAE and Qatar to collect information on population dynamics, satellite tagging to investigate the movements of the sharks, plankton sampling to determine feeding behaviour, and remote satellite imagery to relate encounters to specific environmental conditions (e.g., Robinson et al., 2017).
3. Emirates Wildlife Society – WWF has been operating in the UAE for several decades and is part of the global World Wildlife Fund for Nature (WWF) network. Their work is focused on a variety of terrestrial and marine conservation challenges across the country. All conservation projects, including shark research and public awareness campaigns, are in collaboration with local and federal environmental authorities. In relation to sharks and rays, projects have been focused on understanding the diversity and distribution of these species in the country,



Leopard Whipray *Himantura leoparda* | Philippe Lecomte

including in critical habitats like coastal lagoons, and coral reefs within marine protected areas, to emphasise the importance of these areas for species conservation. This work has utilized a variety of tools including baited remote underwater camera video systems (BRUVS) and drones (e.g., Jabado et al., 2021; Mateos-Molina et al., 2024).

MANAGEMENT

Governance framework

The governance framework for shark and ray conservation and management in the UAE involves various governmental entities at the federal and local levels. Some of them are:

- The UAE Ministry of Climate Change and Environment (MOCCAE), which is the main authority for developing and implementing policies and regulations for the conservation and management of marine resources;
- The Federal Authority for Land and Marine Transport (FTA), which is responsible for regulating and supervising maritime transport activities;
- The General Authority of Customs (GAC), which is responsible for controlling and facilitating trade activities;
- The local municipalities and environmental authorities in each emirate, which are responsible for enforcing and monitoring local regulations and initiatives related to shark conservation and management.

The fishing industry in the UAE has several stakeholders from Ministries, Emirate rulers, Competent Authorities, Fishermen Cooperatives, and other regulatory entities. It is important to note that these stakeholders have different levels of authority and involvement in the fishing industry from decision making (Ministries and Rulers) to providing scientific support for developing management options (research institutes). They are all extremely important to engage with when any changes to fisheries governance are proposed at various levels of compliance issues, environmental standards, food safety, maritime security, and administration. For instance, entities like the Critical Infrastructure and Coastal Protection Authority (CICPA) need to be able to enforce and implement legislations across UAE waters and the Competent Authorities need to be able to monitor landing sites and fish markets in their respective emirates. Furthermore, Fishermen Cooperatives (around 13 across the country) play an important role in providing a communication platform with many fishers. While not all fishers are part of these cooperatives, and not all are of equal size or provide the same services, these cooperatives serve fishers and also ensure they are made aware of new legislations or changes to fisheries governance.

Policy

The UAE has adopted various policies and regulations to ensure the conservation and management of sharks and rays and their sustainable use. Some of them include:

- The Federal Law No. 23 of 1999 on the Exploitation, Protection and Development of Living Aquatic Resources in the UAE, which regulates fishing activities in the UAE waters and prohibits fishing for threatened species without a permit;
- The Federal Law No. 11 of 2002 on Regulating Flora and Fauna Trade, which regulates trade activities involving wild animals and plants in the UAE and prohibits trade without a permit;
- The Ministerial Resolution No. 500 of 2014 on Regulating Shark Fishing and Trade, which regulates shark fishing activities in the UAE waters and prohibits fishing sharks during the breeding season (March 1–June 30), fishing sharks less than 50 cm in length, and cutting off shark fins on board or at landing sites; and
- The Ministerial Resolution No. 43 of 2018 on Regulating Shark Fishing and Trade, which amends the previous resolution and prohibits the import and re-export of shark meat and fins, except for scientific purposes with a permit from the MOCCAE.

The UAE National Plan of Action (UAE NPOA) for the Conservation and Management of Sharks (2018–2021) outlines the goals, objectives, and actions for enhancing knowledge, policy, legislation, enforcement, capacity building, and awareness of shark conservation and management. The plan highlights the need of the coordination and collaboration among different governmental entities and stakeholders at the national, regional, and international levels on shark and ray conservation and management issues. Within the actions specified, the need to establish marine protected areas that encompass important habitats for the life cycle of shark and ray species is highlighted. There is also urgent need to promote sustainable fishing practices to reduce bycatch and discards of sharks and rays and support alternative livelihoods and incentives for fishers and traders to reduce their dependence on these fisheries and the trade in derivative products (MOCCAE, 2018). This plan of action had not been re-evaluated at the time of writing and has expired.

Enforcement and monitoring

MOCCAE, in collaboration with local governmental entities, conducts regular inspections and patrols at sea, at landing sites, and at markets to ensure compliance with fishing and trade regulations. They also conduct regular data collection and analysis on fisheries catches, landings, trade, and stocks to assess the status and trends of fish populations. Regular awareness campaigns and workshops are conducted to educate fishers, traders, consumers, and the public about the importance of shark and ray conservation and management and inform them of relevant policies and regulations.

Community involvement

There is little community involvement in the conservation of sharks and rays. Several community groups and stakeholders should be involved in the data collection and raising awareness of the status of sharks and rays across the country. The fishers' associations and cooperatives, which represent the interests and views of the fishing community and participate in consultations and dialogues with the governmental entities on shark conservation and management issues, are a key group to engage with.

Tarads and dhows in Abu Dhabi, UAE | Rima W. Jabado


Shark being offloaded from dhow in Sharjah, UAE | Rima W. Jabado

Some NGOs and civil society groups have conducted research, education, and outreach activities on shark conservation and management issues and collaborated with the governmental entities on various projects and initiatives (EWS-WWF, 2015; Jabado et al., 2021). However, these have been short-term projects without continuity.

Generally, only a few academic institutions in the UAE (mostly through the UAEU in Abu Dhabi) conduct scientific studies and assessments on shark and ray ecology, behaviour, distribution, threats and conservation, and provide technical advice and support to the governmental entities and other stakeholders on management issues.

Gaps

Even with the increased attention given to shark conservation, fisheries remain relatively unmonitored. The exception is the Emirate of Abu Dhabi, although even there, data on sharks and rays are scares and not species-specific. Despite the resources available, there is limited human, financial, and technical resources and capacity directed towards fisheries monitoring. This has led to limited enforcement and monitoring of regulations related to shark and ray conservation and management. This is also linked to the lack of effective mechanisms for collaboration among different emirate governmental entities and the need for more transparency for implementation processes.

There is not enough knowledge among stakeholders on why it is important to protect sharks and rays and the existing regulations. Communication methods to share information about shark and ray protection are also insufficient. Moreover, there is a need for greater involvement from various community members and sectors (i.e., commercial and recreational fishers from the fisheries and tourism sectors) in efforts to conserve and manage shark and ray populations and improve the communication channels within and across these sectors.

RECOMMENDATIONS

Policy

The UAE needs to update, effectively implement, and enforce existing policies and regulations on the conservation and management of sharks and rays to ensure their effectiveness, consistency, and compliance with national, regional, and international obligations (Jabado et al., 2018). Stricter and more specific regulations should be implemented to protect shark and ray species or groups that are threatened under the IUCN Red List of Threatened Species. Harmonisation of policies among federal and emirate-level governmental entities is required to enhance transparency and accountability in decision-making and implementation of processes at the federal level.

The UAE is in a good position to explore and apply innovative approaches and technologies for shark and ray management and monitoring such as using artificial intelligence to process large volumes of BRUVS survey data, remote sensing to identify suitable habitats for critical life cycles, citizen science to record the presence or behaviour of animals, etc. However, such initiatives have been limited to a few independent research projects with little government involvement.

Science/knowledge/research

Conservation of shark and ray populations in the UAE requires targeted research to enhance management strategies. This includes standardized data collection to understand trends in shark and ray catches and landings, behaviour, and genetics in the region. A major goal should be to refine methods for evaluating the status and trends of their populations, which will aid in identifying species that urgently need conservation actions due to threats like overfishing (Jabado et al., 2018). The understanding of habitat preferences for sharks and rays is lacking, particularly for vital life-history processes such as reproduction, breeding, and parturition in the UAE's shallow waters (Mateos-Molina et al., 2023). Recognising these critical habitats is essential for the protection of species like the Halavi Guitarfish (*Glaucostegus halavi*) or Whitespotted Wedgefish (*Rhynchobatus djiddensis*) as well as the habitats themselves (Jabado et al., 2021). Innovative, non-destructive monitoring techniques are recommended to sample these habitats more effectively, facilitating comprehensive assessments of shark and ray species richness (Gladstone et al., 2012). Such research should also encompass the socio-economic aspects of shark fisheries to support sustainable practices. In essence, a streamlined research framework integrating biological, ecological, and socioeconomic studies is crucial for devising effective conservation actions for the UAE's shark and ray populations.

Prioritising the conservation of endemic or rare shark and ray species, such as Halavi Guitarfish or Pakistan Whipray (*Maculabatis arabica*), that have a restricted distribution range in the region is needed. Specific research, conservation programmes and monitoring of their ecology, biology, genetics, behaviour, distribution, abundance, and threats are required to protect those unique natural assets.

Management/governance/conservation

It is a critical priority to increase awareness and understanding among fishers, traders, consumers, and the public about the importance of shark and ray conservation and management and the relevant policies and regulations (Jabado et al., 2021). New tools to improve the communication and dissemination of information and messages should be explored to reach different target audiences, as well as the involvement of different community groups (i.e., youth). Incentives and recognition for best practices on sustainable fisheries could also be explored (i.e., ecolabelling).

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Shark landed in Abu Dhabi, UAE | Rima W. Jabado

Shark meat salted and cut into cubes for local consumption in Dubai, UAE | Rima W. Jabado

Wafic's Eagle Ray *Aetomylaeus wafickii* for sale at Sharjah fish market | Rima W. Jabado

Shark fins drying at processing site in Al Dhaid, UAE | RIma W. Jabado

YEMEN

YEMEN

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INTRODUCTION

The Republic of Yemen, or Yemen, is located in the southwestern side of the Arabian Peninsula, bordering Oman and Kingdom of Saudi Arabia (or Saudi Arabia), and facing the horn of Africa, separated by the Red Sea and Gulf of Aden. Yemen's Exclusive Economic Zone (EEZ) is approximately 34,550 km² with a coastline of 2,500 km, shelf area of 41,000 km², and total marine area of 548,014 km² (Shaher, 2007; Tesfamichael et al., 2012a; UNEP-WCMC, 2024). Its EEZ includes the Socotra Archipelago, comprised of the main island Socotra, three smaller islands Darsa, Samha, Abd al-Kuri, and two islets Sabuniya and Kal Farun, located at the junction of the Gulf of Aden and Arabian Sea (Bogorodsky et al. 2021). Biodiversity is high across this region due to seasonal upwellings from the monsoon season (May to September; Shaher, 2007).

Fisheries play a significant role in the socioeconomic status and food security of coastal populations. This sector contributed to around 2–3% of the gross domestic product (GDP) in the 2000s, with around 500,000 people directly or indirectly employed (Morgan, 2006; Shaher, 2007; Tesfamichael et al., 2012a). The fishing industry can be divided into artisanal, industrial, and subsistence; there are no reported recreational fisheries.

According to the IUCN Red List of Threatened Species, there are 97 sharks (n=54), rays (n=41), and chimaeras (n=2) confirmed from Yemeni waters (IUCN, 2024). Of these, 60 (61.8%) are threatened with extinction (12 Critically Endangered, 26 Endangered, and 22 Vulnerable), 15 are Near Threatened, 13 are of Least Concern, and nine are Data Deficient (IUCN, 2024). Seven sharks and rays are considered endemic: Shortbelly Catshark (*Apristurus breviventralis*), Heins' Stingray (*Hemitrygon yemenensis*), Ornate Skate (*Okamejei ornata*), Aden Ring Skate (*Orbiraja philipi*), Dwarf False Catshark (*Planonasus parini*), Aden Torpedo (*Torpedo adenensis*), and Red Sea Torpedo (*T. suessii*; IUCN, 2024).

Whilst dedicated faunistic surveys were conducted from the late 1800s and early to mid-1900s (Bogorodsky et al., 2021), this region still has yet to be explored to its full potential. It is likely that diversity is much higher than is currently known, with many species having only been reported from a few specimens during these aforementioned surveys. For example, the Red Sea Torpedo has only been reported from three animals captured off Mocha in 1897 (Constance, 2024). It has not been seen in 127 years and improved survey effort in the area is needed to determine its status. However, surveys on sharks and rays have been limited due a lack of capacity and decades of political instability.

This limited information was a barrier in the delineation of Important Shark and Ray Areas (ISRA) in Yemeni waters. However, Socotra Islands is considered an Area of Interest (AoI) due the presence of the endemic Dwarf False Catshark and Ornate Skate (Ebert et al., 2017a, b; Jabado et al., 2023). Another AoI that requires further research is Al Mahra (Jabado et al., 2023) where Milk Shark (*Rhizoprionodon acutus*) and Arabian Smoothhound (*Mustelus mosis*) were documented in landings, with their abundance increasing in May due to upwellings (Shaher, 2007).

Yemeni waters appear to be important for the reproduction of various shark species. Pregnant females and neonate sharks (e.g., Blacktip Shark [*Carcharhinus limbatus*] and Milk Shark) have been captured from July to early August (Shaher, 2007). Data collected in Saudi Arabia on the movement of Whale Shark (*Rhincodon typus*) also indicate that the Southern Red Sea waters of Yemen are important for the movement of this species (Cochran et al., 2023).

FISHERIES

Fleets

Yemeni fisheries have grown dramatically since the 1980s. From a total fleet of 3,100 boats in 1988 to 7,713 vessels and 43,100 fishers in the late 1990s. This includes approximately 2,200 vessels and 21,500 fishers, 5,400 vessels and 19,000 fishers, and 1,113 vessels and 2,600 fishers operating in the Red Sea, Gulf of Aden, and Socotra Archipelago, respectively (Bonfil, 2002). In 2012, 20,803 vessels (18,775 multipurpose vessels, 1,040 longliners, 992 purse seiners, and 16 trawlers) and 74,820 fishers were recorded (Julia & Spaet, 2017 and references therein). The artisanal fishery utilises two main vessel types, *Sambouk* and *Houri* (Shaher, 2007). *Sambouks* are 12–20 m long wooden or fibreglass vessels, fitted with an inboard or outboard motor (15–45 horsepower, hp), operated by a four to six-person crew 15–25 miles (~24.1–40.2 km) from the shore (Shaher, 2007; Tesfamichael et al., 2012a). *Houri* are also wooden or fibreglass boats, but these are smaller (3–11 m), powered by an outboard motor (8–15 hp) and/or sails, and operated by four to five individuals (Shaher, 2007; Tesfamichael et al., 2012a). Usually, sharks are targeted using fibreglass boats (7–9 m in length) powered by a 15–45 hp motor (Shaher, 2007). Artisanal fishers activity mainly occurs inshore, but has historically expanded beyond the EEZ and into the wider Indian Ocean (Tesfamichael et al., 2012a).

Subsistence fisheries (locally known as *wasif*) differ from artisanal fisheries in that the latter target species for commercial purposes. This fishery operates around rocky areas and coral reefs using beach seines to target sardines, anchovies, and other small, pelagic species for direct consumption (Tesfamichael et al., 2012a).

Industrial fisheries began in the 1970s and are primarily foreign owned, especially by Egyptians and, to a lesser extent, Lebanese during the 1990s–2010 in the Red Sea and by the Soviet Union (USSR) until the 1990s in the Gulf of Aden (Tesfamichael et al., 2012a, b). On average, industrial vessels are 20–40 m long, with motors of 500–800 hp (Tesfamichael et al., 2012a). More industrial fishing occurs in the Red Sea area compared to the Gulf of Aden due to governments investing in artisanal fisheries in the Gulf of Aden prior to the unification of North and South Yemen (Tesfamichael et al., 2012a). There has been a growing number of industrialised, foreign trawling and long-liner vessels licensed to fish in Yemeni waters, which is mostly unregulated. Sharks and rays are frequently caught incidentally in trawlers, including the endemic Aden Torpedo and Red Sea Torpedo; it is presumed that both populations are in decline due to high trawling efforts (Kyne et al., 2017; Constance 2024).

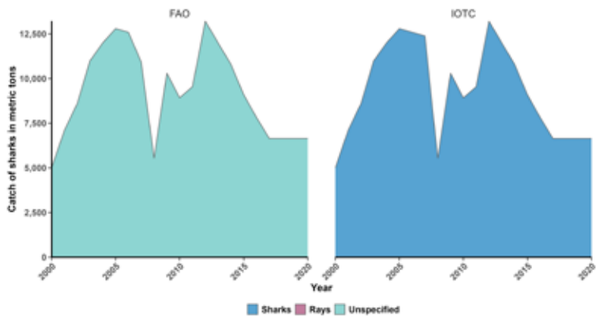
The commercial species targeted by artisanal and industrial fisheries include large pelagic fishes (i.e., tuna and tuna-like species, e.g., Yellowfin Tuna [*Thunnus albacares*], Kawakawa [*Euthynnus affinis*], Skipjack Tuna [*Katsuwonus pelamis*], Stripped bonito [*Sarda orientalis*], Spanish mackerels [Scombridae], marlins [Istiophoridae]), small pelagic fishes (sardines [Clupeidae], anchovies [Engraulidae], Indian Mackerel [*Rastrelliger kanagurta*], Pacific Chub Mackerel [*Scomber japonicus*]), demersal fishes (e.g., emperor fish [Lethrinidae], snappers [Lutjanidae], grouper [Serranidae], breams [Sparidae], barracudas [Sphyraenidae], and jacks [Carangoides]) crustaceans (e.g., spiny lobsters [*Panulirus* spp.] and deepwater shrimps), and molluscs (e.g., cuttle fish and squids; Shaher, 2007; Tesfamichael et al., 2012a, b). Sharks are also targeted commercially for an average of 160 days per year; this includes sharks Blacktip Shark, Scalloped Hammerhead (*Sphyrna lewini*), Milk Shark, and Arabian Smoothhound (Shaher, 2007).

Yemen is amongst the top shark fishers globally based on catches reported (Dent & Clarke, 2015). In the late 1990s to early 2000s, it has been suggested that sharks, Yellowfin Tuna, and other pelagic fish were predominantly targeted east of Al Mukkala (Bonfil, 2002). It is important to note that while fishers operating in the Socotra Archipelago likely catch fewer sharks, these animals are the primarily target here (Bonfil, 2002). Additionally, Qusayar was the most important shark fishing centre in terms of quantities landed (Bonfil, 2002).

Targeted shark catches have been increasing due to greater fishing efforts in the artisanal fishery since the 1990s, and during the early 2000s the average catch per unit effort (CPUE) was estimated at 54–66 kg per boat per day in the Socotra Archipelago (Shaher, 2007). Sharks are also caught as bycatch through Yemen's shrimp trawlers operating at least 6 nautical miles (nm) from the coastline using gillnets. A decreasing trend in commercial shark stocks have been observed since the 1980s due to trawling; illegal, unregulated, and unreported (IUU) fishing; and habitat destruction, including damage to coral reefs, sea grass beds, spawning grounds for cuttlefish (Shaher, 2007, Jabado & Spaet, 2017).

Along the Red Sea coastline there are 31 landing sites, of which most landings are found in the Al Hodeidah governorate (Tesfamichael et al., 2012a).

Yemen's total catch of shark, ray, chimaera, and unspecified species reported to Food and Agriculture Organization of the United Nations (FAO) and the Indian Ocean Tuna Commission (IOTC) from 2000–2020 in metric tonnes (mt) | Source: FAO (2022) and IOTC (2022)



Gear

The artisanal fishery is multi-gear, where both *Sambouks* and *Houri* use troll lines, handlines, purse seines, longlines, and surface gillnets (Shaher, 2007). Women are reported to play an important role in supporting the manufacturing of fishing nets (Jabado & Spaet, 2017). Longlines are used to target tuna, and billfish below 200 m; troll lines are used for pelagic fish, gillnets and driftnets for both pelagic and demersal species are often used within 7–34 m; and purse seines for sardines, Indian Mackerel, tuna, and Spanish mackerels (Shaher, 2007).

Sharks are caught as target and incidental capture using longlines (with 40–70 hooks), gillnets (between two to four nets per boat, 70x15 m, and mesh size between 100–300 mm), and hook and line (Morgan, 2006; Shaher, 2007). No information is available for gears used to catch rays.

PRODUCTION

Overall landings

Landings data are limited, and historically were based on visual estimates rather than being weighed (Bonfil, 2002). Sharks and rays are often lumped together and reported under generic labels to the Food and Agriculture Organisation of the United Nations (FAO). From 2000–2022, shark and ray landings have fluctuated between 5,000– 13,217 metric tonnes (mt; average of ~9,162 mt) of 'sharks, rays, skates, etc. [not elsewhere included] nei', with 9,020 mt catches reported in 2022 (FAO, 2024).

Species-specific

Due to the fact that Yemen's coast is composed primarily of coral reefs, coastal reef species such as Silvertip Shark (*Carcharhinus albimarginatus*), Grey Reef Shark (*C. amblyrhynchos*), Blacktip Reef Shark (*C. melanopterus*), and Whitetip Reef Shark (*Triaenodon obesus*) are targeted by fisheries (Jabado et al., 2015, 2017, 2018). However, Silky Shark (*C. falciformis*) are targeted by Yemeni fisheries on a larger scale (Jabado et al., 2015, 2017, 2018).

Small sharks landed in Yemen | Rod Waddington | Flickr.com (CC BY-SA 2.0.)

Caudal fins being sorted at processing site in Mukalla, Yemen | Rima W. Jabado

Shark carcasses left to dry behind fish stalls at local market in Yemen | Rima W. Jabado

Qalansiya fishing village on Socrotra Island, Yemen | Gerry & Bonni | flickr.com (CC BY 2.0.)

Based on a landing site survey in the Socotra Archipelago from 2003–2005, artisanal fishers were observed to primarily target (in descending order) Blacktip Shark, Silvertip Shark, Scalloped Hammerhead, Blackspot Shark (*C. sealei*), and Spottail Shark (*C. sorrah*; Shaher, 2007). During the early 2000s the average production annually for sharks specifically was estimated to be 7,283 mt (Shaher, 2007). Compared to the Yemeni Red Sea where shark landings were dominated by Milk Shark, followed by Arabian Smoothhound, Sliteye Shark (*Loxodon macrorhinus*), Blacktip Shark, rays and skates, Silvertip Shark, Scalloped Hammerhead, Blackspot Shark, and Spottail Shark (Shaher, 2007). From the Yemeni Gulf of Aden waters, landings were annually dominated by Milk Shark (62.5%), Arabian Smoothhound (22.4%), Sliteye Shark (3.5%), Blacktip Shark (1.0%), and 'Chondrichthyans' (i.e., rays and skates, 7.4%; Shaher, 2007).

TRADE

Processing

Landed sharks are desired commercially for their fins that are cut then dried. Women are traditionally involved in the post-processing of fish (Jabado & Spaet, 2017), likely including sharks and rays. Historically, fins were dried and unsalted according to reports to FAO, from the late 1970s–2014 where it was last recorded 168 mt (FAO, 2023a). In the early 2000s, dried shark fins were being sold at USD 60/kg (Shaher, 2007). Since then, fins were reportedly processed as smoked, dried, whether salted, etc. with 313 mt reported in 2015. However, this has continued to decrease, dropping to 90 mt in 2021, the reason for this is not known (FAO, 2023a). Shark meat is usually dried and sold in local markets, Vitamin A is extracted from liver oil, and jaws and teeth are sold, usually for tourist purposes (Shaher, 2007). Sharks are essentially fully utilised with the skins, cartilage, cornea, and offals being used locally (see Domestic section). There is no information on how rays are being used.

Domestic

Meat of caught sharks is used for direct consumption by drying and salting the filleted meat (Shaher, 2007; Jabado et al., 2015, 2017, 2018). The whole animal is utilised domestically: shark liver oil is used to manufacture cosmetics, pharmaceuticals, and paints (Shaher, 2007); skins are valued for their high-quality leather (Shaher, 2007); and even the corneas of shark eyes have been reportedly used for human transplant and the cartilage is marketed as a cure to all sorts of human ailments (Shaher, 2007). Offal is used as fish meal and animal feed (Shaher, 2007).

Export

Yemeni fisheries cut shark meat into fillets, dried and salted, or remove fins to be exported to other countries such as the United Arab Emirates (UAE) and Hong Kong Special Administrative Region (SAR; Morgan, 2006; Jabado et al., 2015, 2017, 2018). Yemen is one of the top exporters of shark fins to Hong Kong SAR and has recorded some of the highest shark catches globally (Fowler et al., 2005; 2021; Jabado et al., 2015, 2017, 2018).

It is known that the meat of Smoothtooth Blacktip Shark (*Carcharhinus leiodon*) is traded, as their black-tipped fins fetch a high price on international markets (Jabado, et al., 2015). Furthermore, despite being illegal, Spotted Guitarfish (*Rhinobatos punctifer*) fins and meat are known to be traded (Ebert et al., 2017c). Additionally, along with the UAE, Yemen is an important hub for shark transshipment from the Middle East to Asia (Fowler et al., 2005; 2021; Jabado et al., 2015, 2017, 2018).

Based on FAO reports, shark and ray exports ranged from 8–846 mt of shark and ray products between 2000–2021. In 2021, 90.24 mt (worth over USD 3.4 million) of 'Shark fins, smoked, dried, whether or not salted, etc.', 384.08 mt (~USD 148,000) of 'Sharks nei, fresh or chilled', 42 mt (~USD 13,500) of 'Sharks, fillets, dried, salted or in brine', and 2 mt (USD 1,430) of 'Rays and skates (Rajidae), fresh or chilled' were exported (FAO, 2023b).

There are also records of shark fins being imported, with 2.75 mt (worth USD 5,334) and 4.97 mt (USD 19,864) in 2018 and 2019, respectively in reports to the FAO and UN Comtrade (FAO, 2023b; UN Comtrade, 2024).

CULTURAL SIGNIFICANCE

Sharks, rays, and chimaeras are not known to have any cultural significance.

RESEARCH

Marine Science Research and Resource Center (MSRRC) is a government institute active in fisheries and environmental research and works alongside the Ministry of Fish Wealth to collect fisheries data.

MANAGEMENT

Governance framework

The Ministry of Fish Wealth (MFW) is the Marine Science and Biological Research Authority that oversees fishery resource management and controls boat licensing and data collection. The MFW collaborates with the National Corporation for Services and Fish Marketing (NCSFM), the Coastal Fisheries Corporation (CFC), and the Yemen Fisheries Corporation (YFC) to manage fisheries' facilities, marketing, etc. (Morgan, 2006). Fisheries management is also a collaborative front between the MFW and three primary agencies: the Environmental Protection Council (EPC), the Public Corporation for Maritime Affairs, and the Regional Convention for Conservation of the Red Sea and Gulf of Aden (PERSGA). The EPC supports with the coordination of activities related to Marine Protected Areas (MPAs) in territorial waters. The Public Corporation for Maritime Affairs oversees maritime pollution, for example, by developing and enforcing legislations and monitoring oil spills. PERSGA is a regional organisation that supports regional the United Nations Development Programme (UNDP) under the Global Environmental Facility (GEF) and a Strategic Action Plan (SAP) for protection of the region's marine environment (Morgan, 2006).

Policy

Law No.2/ 2006 for Regulation, Conservation, Exploitation of the Marine Organisms aims to tackle unregulated fisheries activities and law violation associated with fisheries activities and environments for sharks and other fish resources to ensure the conservation of the biodiversity and management for their long-term, sustainable use.

In 2007, a law was implemented that required shark fisheries to retain fins to at least 5% of the body weight of the shark (Humane Society International, 2019). There are limited policies or actions taken to support shark conservation, despite their known decline. Currently there is no National Plan of Action (NPOA) for sharks nor is there an NPOA in process.

Yemen is a Contracting Party of the Indian Ocean Tuna Commission (IOTC) as of 2012. Therefore, all Yemeni flagged vessels are prohibited from the retention, transhipment, landing, and storage of whole or products of Mobulid rays, Oceanic Whitetip Shark (*Carcharhinus longimanus*), and thresher sharks (*Alopias* spp); except for subsistence fisheries (IOTC, 2021). Res. 17/05 bans shark finning onboard, the landing of frozen sharks with fins weighing more than 5% of the total shark weight, and purse seiners from setting nets around Whale Sharks (IOTC, 2021). Additionally, as a Contracting Party, Yemen is encouraged to adopt management measures to support sustainable fishing of Blue Sharks (Prionace glauca; IOTC, 2021). However, there is no legislation or other relevant action in place to enforce these conservation measures.

Enforcement and monitoring

Yemen has seven designated MPAs, covering 0.35% of the total marine area (1,932km² of the 548,014km²; UNEP-WCMC, 2024). The Socotra Island MPA (designated in 1996) is the largest and was designated a United Nations Educational, Scientific and Cultural Organization – Man and the Biosphere (UNESCO-MAB) Biosphere Reserve in 2003, and as a World Heritage Site in 2008. The other MPAs include Aden lagoons, Al- Memlah, Khwor Ber Ahmed, Khor-Omaira, Al-Azizi Island and Ras Amran, and North Kamaran Island (UNEP-WCMC, 2024).

To support data collection of sharks and rays, training courses on species identification were provided to fisheries staff in the early 2000s (Bonfil, 2002). Despite this, landings are still recorded at low taxonomic resolution to FAO, and only research conducted on sharks and rays specifically collect species-specific data (e.g., Shaher, 2007).

Community involvement

There is no known community involvement in shark, ray, and chimaera conservation.

Gaps

The biggest challenge to assessing the status of shark and ray populations outlined by Shaher (2007) were:

- Lack of biological data;
- Lack of data on shark fisheries;
- Lack of suitable models for shark and ray populations to assess the impact of fisheries and trade; and
- Lack of validated age estimates, growth rate and estimated age at sexual maturity are essential for stock assessments and demographic models.

RECOMMENDATIONS

Policy

Yemeni fisheries target shark and ray aggregations at breeding and pupping grounds (Jabado, 2015, 2017, 2018). Therefore, policies need to be developed to regulate this fishing, such as avoiding areas important to early life-stages of sharks and rays.

Science/knowledge/research

Implementing a monitoring system would be beneficial in collecting data on shark and ray populations, fishing efforts for these species, etc. This in turn would update the number of species occurring in Yemeni waters, as well as identify which are of commercial importance to fill in knowledge gaps on fisheries management (Bogorodsky et al., 2021).

Management/governance/conservation

Considering the significant fishing effort, especially by artisanal fisheries, regulating the number of boats and fishers registered/licensed would support sustainable fisheries management. Furthermore, this would also allow for evaluation of fishery impacts.

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Coach Whipray *Himantura uarnak* caught by fisher in Yemen | JP | iNaturalist.org (CC BY-NC)

Small scale fishing boats in Mukalla, Yemen | Rima W. Jabado

Dried Scalloped Hammerhead *Sphyrna lewini* and Spottail Shark *Carcharhinus sorrah* for sale at local market in Yemen | Rima W. Jabado