FAO SPECIES IDENTIFICATION GUIDE FOR FISHERY PURPOSES

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FIELD IDENTIFICATION GUIDE TO THE SHARKS AND RAYS OF THE RED SEA AND GULF OF ADEN

PERSGA

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FIELD IDENTIFICATION GUIDE TO THE SHARKS AND RAYS OF THE RED SEA AND GULF OF ADEN

by

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PREPARATION OF THIS DOCUMENT

This document was prepared under the coordination of the Species Identification and Data Programme of the Marine Resources Service, Fishery Resources and Environment Division, Fisheries Department, Food and Agriculture Organization of the United Nations (FAO).

This field guide is largely based on material prepared for training courses on elasmobranch identification delivered in the region by the first author, and promoted by the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA), as an activity of PERSGA's Strategic Action Programme (SAP) towards capacity building and technical assistance in the Red Sea and Gulf of Aden region. Printing was supported by Japanese Government funds.

The increasing recognition of the significance of sharks and batoid fishes as ecosystem health indicators, as well as their particular importance in exploited ecosystems in the Red Sea and the Gulf of Aden, have been key considerations to promote the preparation of this Field Guide. Furthermore, in recent years the reported catches of elasmobranchs in the Red Sea and the Gulf of Aden showed a marked increase.

Concern has been growing around the world about the threats to shark populations from both habitat degradation and fishing. For this reason an International Plan of Action (IPOA) for the Conservation and Management of Sharks is being implemented, aiming among others to (i) facilitate improved species-specific catch and landings data and monitoring of shark catches; and (ii) facilitate the identification and reporting of species-specific biological and trade data.

With this Field Guide the FAO contributes to facilitate the identification of elasmobranch species in such sensitive areas as the Red Sea and Gulf of Aden are.

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Field identification guide to the sharks and rays of the Red Sea and Gulf of Aden.

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ABSTRACT

This volume presents a fully illustrated field guide for the identification of the sharks and rays most relevant to the fisheries of the Red Sea and Gulf of Aden. An extensive literature review and two field surveys in the region were carried out for the preparation of this document. A total of 49 sharks and 45 batoids reliably reported for the region are listed and those common in the fisheries or likely to be found through fishing operations are fully treated (44 sharks and 33 batoids). Included here are the first confirmed reports for the region of *Hemigaleus microstoma*, *Carcharhinus dussumieri*, *Aetomylaeus vespertilio*, *Himantura fai*, *Mobula japanica* and an undescribed *Dasyatis* sp. The guide includes sections on technical terms and measurements for sharks and batoids, and fully illustrated keys to those orders and families that occur in the region. Each species account includes: at least one annotated illustration of the species highlighting its relevant identification characters; basic information on nomenclature, synonyms and possible misidentifications; FAO, common and local names; basic information on size, habitat and biology, importance to fisheries, and distribution. Colour plates for a large number of the species are included.

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A large number of persons provided field assistance during surveys in the region, as well as valuable help with the collection of samples in some cases. Their kindness is gratefully appreciated. The following list is intended to be comprehensive but unavoidably one or two names might be missing, we apologize in such case for the omission: Khaled Hariri, PERSGA; Ahmed Barrania, LMR-WG member, Egypt; Ahmed Ibrahim, National Institute of Oceanography and Fisheries (NIOF); Abd-Alhamied Al-Rashash (Suez) and Galal Abu Al-Wafah (Hurghada), General Authority for Fisheries Resources Development, Egypt. Talal Shusha and Abdul Rahman Fallatah, KSA Fisheries Research Center, Ministry of Agriculture and Water Resources (MAWR); Faisal Showkani, Sulaiman Jhaseb, and Brander Al-Jahdali, KSA Fisheries Department; Salih Al-Shihri, Coast Guard Service, KSA; Osman Farah LMR-WG member and Mahgoub Hassan, NPC/SAP, Sudan; Nasser Djama Abdi, NPC/SAP, Djibouti; Ibrahim Elmi LMR–WG member and Nasser Ali Mahamoud, Ministry of Agiculture, Livestock and Sea (MAEM), Djibouti; Mohamed Mahadi Abubaker, NPC/SAP, Yemen; Hashem Al-Saqqaf LMR-WG member and Murtada Ahmed, Marine Sciences and Resources Research Center (MSRRC), Yemen; Ali Yusr and Omar Mohamed Mazroah, Ministry of Fish Wealth (MFW), Yemen; Fuad Naseeb, Socotra Conservation of Biodiversity Project; Abdul Hakim Said, Fisheries Marketing Services, Mokha; Hassan Bamohaimedan Fisheries Cooperatives, Qusayar. Due acknowledgement is paid to the following authors of the PERSGA reports: K. Hariri, P. Nichols, F. Krupp, S. Mishrigi, A. Barrania, A. Farah Ali, S. M. Kedidi, N. Pilcher, A. Alsuhaibany, and to the PERSGA editor, R. Fleming. Vardis Tsontos (USC) provided help in the preparation of bathymetry and temperature maps.

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INTRODUCTION

The Red Sea and Gulf of Aden (Fig. 1) have formed a traditional trading route for centuries. Since the opening of the Suez Canal in 1869 and the discovery of oil in the mid-1900s, the geopolitical significance of the Region and the importance of these waters for international trade have grown enormously. This route now carries around 7% of total world shipping (Suez Canal Authority statistics 1996), which is equivalent to 14 000 or more vessels each year. Although still relatively understudied, the living marine resources of the Region have attracted increasing interest in recent years, both locally and internationally. Some of the earliest collections, particularly of fish, were made by the renowned Swedish naturalist Peter Forsskål during 1761-1762. The most recent studies in the Region include the work carried out through the Strategic Action Programme, a multi-disciplinary project executed by the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) and funded by the Global Environment Facility, and the Biodiversity Conservation and Sustainable Development Programme for the Socotra Archipelago, implemented through the United Nations Development Programme. An indication of the global importance of the Region is shown by the high degree of biodiversity at genetic, species and ecosystem levels. Endemism is also unusually high; 17% of the fish species are not found outside the Region.

Physical and chemical characteristics of the region

Geology and physical features

The Red Sea is a relatively newly formed ocean located in an arid zone between 12.5°N and 30°N. It consists of a deep, narrow trench 1 932 km in length with an average width of 280 km; the widest point (300 km) is found near Massawa (Eritrea) (ALECSO-PERSGA/UNESCO, 1990). The average depth is about 500 m but its greatest depth exceeds 2 000 m (Fig. 2). At the southern end of the Red Sea are the straits of Bab el Mandeb (literally "Gate of Lamentations"), only 29 km wide and with a maximum depth of 130 m. This structure has profound effects on the movement of waters between the Red Sea and the Gulf of Aden and in the past, during periods of lower sea level, has effectively separated the two water bodies.

Fig. 1 Map of the Red Sea and Gulf of Aden

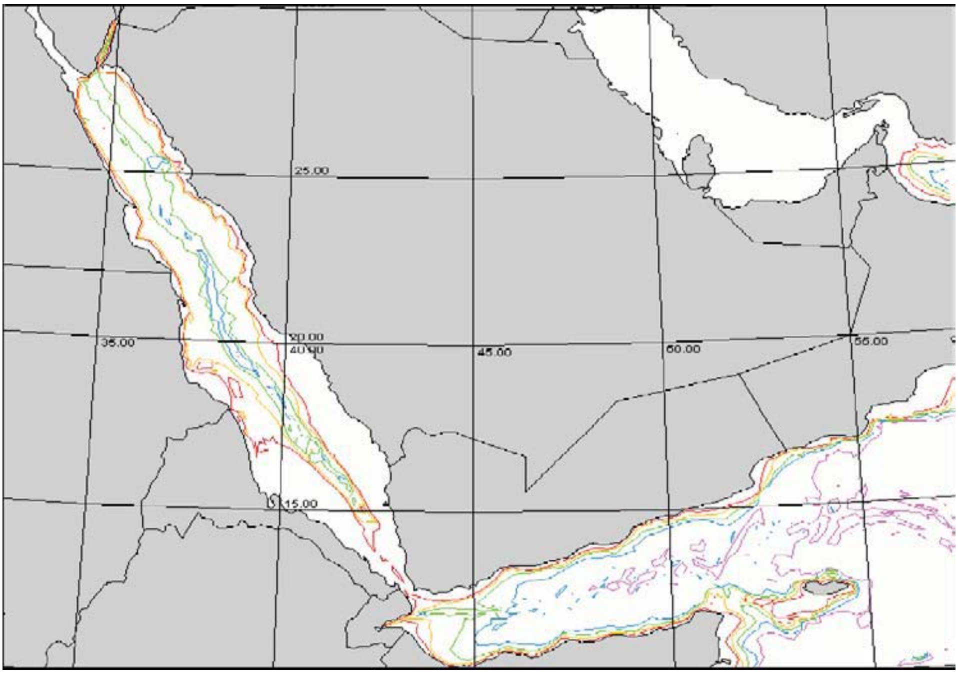


Fig. 2 General bathymetry of the Red Sea and Gulf of Aden
(100 m = Red; 200 m = Orange; 500 m = Green; 1 000 m = Blue; 1 500 m = Dark Blue; 2 500 m = Purple)

The Red Sea developed from the separation of the Arabian plate from the African plate, an event which began about 70 million years ago. The western and southern edges of the plate lie along the rift that runs from the Dead Sea, down the Gulf of Aqaba, the Red Sea, and out through the Gulf of Aden. The Arabian plate is moving northeast away from the African plate and rotating counter-clockwise as the sea floor spreads. Rifting has not taken place as a continuous process, but in episodes. After a recess in the latter part of the Tertiary, rifting recommenced between 2 and 5 million years ago, giving a spreading rate averaging 2 cm per year (Sheppard *et al*., 1992).

The Gulf of Aqaba is a continuation of the Red Sea rift. It is short and narrow (150 km by 16 km) but also deep, up to 1 800 m with steeply shelving sides. A strike-slip faulting pattern has caused the formation of three deep basins. The Gulf meets the Red Sea at the Straits of Tiran where a relatively shallow bar or sill (250-300 m) separates the two water bodies.

The Gulf of Suez, (length 280 km, width 20-40 km), is spreading due to normal faulting. It is shallow with depths mostly less than 50 m, reaching nearly 100 m at the southern end where it meets the Red Sea. In stark contrast to the Gulf of Aqaba, the sea-floor of the Gulf of Suez is generally flat or of low relief.

Wind, temperature, currents and tides

The wind patterns over the northern Red Sea are dominated by the weather systems of the Mediterranean, whereas the southern Red Sea and Gulf of Aden are strongly influenced by Asian weather patterns, and the Indian Ocean monsoons (Fig. 3). In the northern Red Sea (north of latitude 20°N) winds are predominantly from the north northwest, all year round. Only during winter months are there occasional southerly winds. The Bab el Mandeb, the Gulf of Aden and the Red Sea south of 20°N are subject to two monsoonal events each year. During the winter (October to May) the northeast monsoon winds blow into the Gulf of Aden and wind funnels up into the Red Sea from the south southeast. During the summer (June to September) the southwest monsoon winds blow over the Gulf of Aden but the strong winds from the north northwest extend their influence over the southern Red Sea until they are deflected northeast up the southern coast of Arabia. These summer wind patterns cause strong upwelling of deep, cold, nutrient-rich ocean water along the southern Arabian coastline. Coral growth is inhibited, but kelp beds thrive and productivity is high, reflected in the rich coastal fisheries (Sheppard *et al*., 1992).

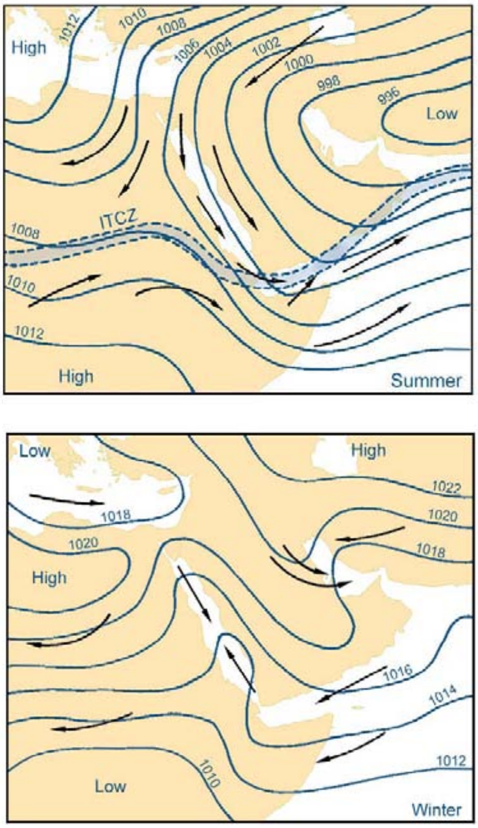
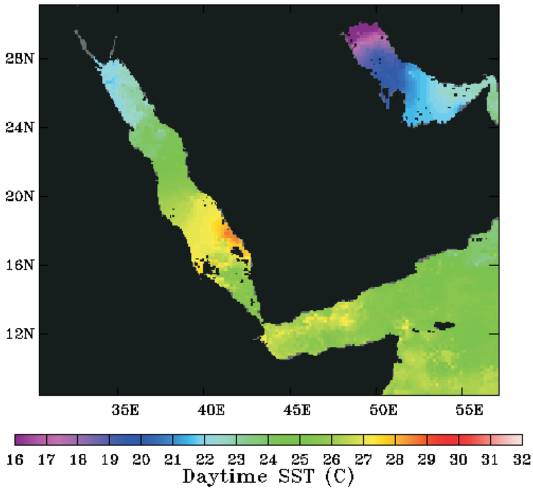


Fig. 3 Major barometric pressure systems and prevailing wind patterns for the Arabian Peninsula and the Intertropical Convergence Zone (ITCZ)
(after Sheppard *et al*., 1992)

Water currents in the Red Sea are driven by density and wind. Evaporation levels of 1-2 m/yr greatly exceed precipitation (10 mm/yr) raising salinity, particularly in the north, to 42 ppt. The loss of water is made up by an inflow of cooler, less saline (39 ppt), surface water from the Gulf of Aden that drifts north. During the winter, in the northern Red Sea and Gulf of Suez, the high salinity surface water cools and its density increases, causing it to sink below the thermocline and flow back towards and into the Gulf of Aden, flowing over the shallow sill at the Bab el Mandeb below the incoming surface water. However, during the summer the wind is blowing from the north northwest out through the Bab el Mandeb. This causes the inflowing 'surface current' to be split vertically into two layers, a top layer flowing out into the Gulf of Aden driven by the wind, a lower layer continuing to flow into the Red Sea to replace the net loss, with the dense saline water continuing to flow out of the Red Sea at a deeper level.

Due to its shape, depth and relative isolation from other major water bodies, the Red Sea is one of the warmest water bodies on earth, reaching surface temperatures of over 32°C during the summer and rarely cooling to less than 20°C during the winter (Fig. 4). The temperature regime of the Red Sea has a strong influence over the Gulf of Aden which has generally similar temperatures to the Red Sea even during summer, when the adjacent waters of the northwest Indian Ocean are several degrees cooler.



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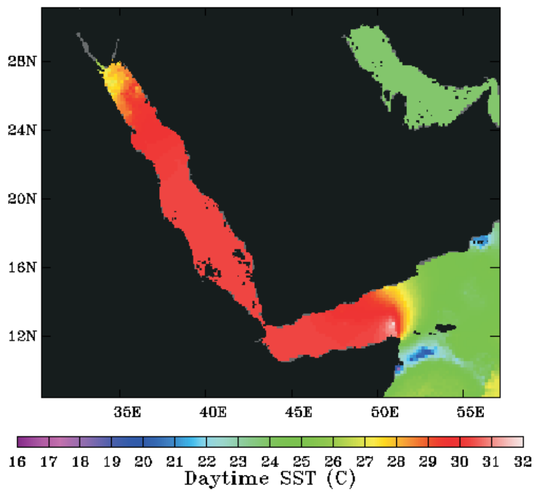

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Fig. 4 Average sea surface temperature maps of the Red Sea and Gulf of Aden calculated with AVHRR data using NASA's Distributed Active Archive Center

The tide system within the Red Sea is generally semi-diurnal with a difference of about six hours in the time of high water between the north and the south. The tidal range is low. The average spring range is 0.5 m in both north and south, decreasing from both ends to a point where there is no appreciable semi-diurnal range near Port Sudan and Jeddah. In the Gulf of Aden the tide is generally diurnal, with the extreme range being about 3 m at Aden and Djibouti. Eastwards the tidal system becomes more semi-diurnal, though the diurnal inequality remains great, with ranges up to 3 m.

Biological characteristics of the region

The Red Sea has become one of the most important repositories of marine biodiversity in the world. Its relative isolation has given rise to an extraordinary range of biological diversity and endemism, particularly among reef fishes and reef-associated organisms. The coral reef systems of the Region are legendary. They are comprised of more than 250 species of scleractinian corals, representing the highest diversity in any section of the Indian Ocean. The coasts of the northern Red Sea and the Gulf of Aqaba are fringed by an almost continuous band of coral reef, which physically protects the shoreline. Corals assemblages in the shallow Gulf of Suez are less well developed. Further south the shelf becomes much broader and shallower; the fringing reefs gradually disappear and are replaced with shallow, muddy shorelines. Despite the seasonal upwellings in the Gulf of Aden, diverse and complex reefs and non-reef assemblages exist and well-developed coral systems occur around the Socotra Archipelago. (PERSGA, 2003).

Mangrove systems have developed where the continental shelf is wider and inter-tidal distances are greater. They assist in the accumulation and retention of sediments and prevention of coastal erosion. Mangroves are well developed in the southern part of the Red Sea, contributing their high primary productivity to the marine ecosystem and providing important nursery grounds for a wide range of marine fauna.

Seagrasses constitute the only group of higher plants to have adapted to a sub-aquatic habitat and inhabit shallow water areas with soft benthos. The Region's seagrass areas are highly productive ecosystems where many species of living marine resources abound. For example, in the Khor-Umeira lagoon in the west of the Gulf of Aden, Halodule spp. provide important feeding grounds for the green turtle *Chelonia mydas* and many species of sea cucumbers that form the basis of important artisanal fisheries.

The fisheries of the region

The fisheries of the Red Sea and Gulf of Aden are of considerable socio-economic importance to the coastal nations of the region in terms of national food security and income generation for rural communities, with the exception of Jordan, which has minimal fisheries in the Red Sea. Fishery resources are exploited by artisanal subsistence fishermen, local commercial fishers and foreign industrial fleets targeting invertebrates, demersal finfish and pelagic finfish. Many species cross national boundaries and are essentially shared stocks. Some are truly highly migratory, for example the tuna, some sharks and the small shoaling pelagic species of the Region (PERSGA/GEF, 2002).

Fisheries are also an important source of employment in the region. In the artisanal sector at least 29 500 fishermen and 9 000 vessels are employed in the Red Sea and at least 27 900 fishermen and 6 400 vessels in the Gulf of Aden. The Red Sea industrial sector includes at least 7 500 fishermen and 1 600 industrial vessels and the Gulf of Aden at least another 450 fishermen and 65 vessels. Artisanal fishermen use a range of gear including longlines, handlines, gillnets, trawls, trammel nets, tangle nets, set nets, traps and spears. Industrial vessels utilize purse-seine, trawl, longline and vertical drop-line gear.

The artisanal and industrial fisheries in the Red Sea and Gulf of Aden produced around 17 096 t of invertebrate species and 194 844 t of finfishes in 1998. These figures indicate a considerable increase in the region's production from 7 951 t of invertebrates and 135 904 t of finfishes in 1988 (PERSGA/GEF, 2002). Important commercial invertebrate species include penaeid shrimps in the Red Sea and cuttlefish and rock lobsters in the Gulf of Aden. Pelagic finfish catches are dominated by sardines, Indian mackerel, Spanish mackerel and yellowfin tuna. The demersal catch is dominated by species of snapper, jack, emperor, lizard-fish, grouper, seerfish, rabbitfish and sea-bream. In comparison, fish collecting for the aquarium trade is only significant in Saudi Arabia and Yemen. The former has at least seven aquarium fish exporters in operation

The greatest fishery production occurs in Yemen. In 1998 Yemen accounted for 56% of total production of invertebrates and 52% of total fin-fish production in the region. Egypt and Saudi Arabian are the next most important players. Artisanal fisheries are comparatively minor in Djibouti, Sudan and Somalia. However, declines in catches have been reported for several major fisheries e.g. Indian mackerel, kingfish, sharks, cuttlefish, shrimp, rock lobster and *Trochus*.

Marine aquaculture in the region includes shrimp farming in Egypt and Saudi Arabia and pearl-oyster farming in Sudan. Turtles are caught opportunistically by fishermen throughout the southern Red Sea and Gulf of Aden. Turtle meat and eggs are eaten and oil collected along the coasts of Sudan, Djibouti, Yemen and Somalia.

The exploitation of shark-like fishes in the Red Sea and Gulf of Aden region dates back several decades and in some cases even centuries. Small-scale fishing boats are commonly used but in some places larger fishing vessels with long-range capabilities also take part in the fishery. The catches have been modest for most part of this century but a considerable increase in landings has been observed since the mid-1970s. According to FAO statistics, the main shark-fishing nation in the region is Yemen, with the Kingdom of Saudi Arabia, Egypt, and Eritrea reporting smaller catches of sharks. Information on shark landings in other countries of the region is lacking mainly due to problems of political unrest or absence of a proper general system for monitoring fishery landings. Nevertheless, it is known from other sources that shark fishing also takes place in Somalia and probably Sudan, although none of these countries report shark catches to FAO. According to Marshall (1996) the total shark catch of Somalia is estimated at around 6 700 t/yr, although this figure is very uncertain. FAO statistics for 1998 indicate that Yemen reported 5 000 t of sharks, Saudi Arabia, 1 500 t, Egypt, 135 t (not including Mediterranean catches), and Eritrea, 15 t. This makes an estimated total catch of about 14 000 t of shark-like fishes per year for the entire region. However, this is likely to be an underestimate because of the lack of information of the catches in Sudan, and the likely underestimate of most of the reported catches given the limited coverage of the monitoring systems in many of the countries of the region.

The countries fishing for sharks and rays in the Red Sea and Gulf of Aden share common problems. The principal and most pressing problem is that none of these countries has any kind of control in the form of management measures to make sure that the shark and ray populations remain healthy for the fisheries to continue on a sustainable basis. Furthermore, there is a general lack of knowledge of how many species of shark and rays are found in the region, which are the main species in the catches, and even what is the real size of the catches and the amount of fishing effort put by the fishermen in the region. It is not surprising then that without such essential information, there are no stock assessments for the shark-like populations of the region. Given the trend of increase in the catches of these resources, it is urgent that the countries in the region increase their capability to monitor, assess and manage the shark and ray resources they are exploiting.

The shark resources of the Region are heavily fished especially in Sudan, Djibouti, Yemen, around the Socotra Archipelago, and off Somalia where there are signs of stock depletion. This is attributed to a lack of control over national shark fisheries and also an increase in illegal fishing by fishermen working outside their normal territorial boundaries for the south-east Asia shark-fin market. Some of the current problems in the shark fisheries include: lack of reliable (and species-specific) catch data gathering systems; heavy exploitation of newborn sharks in pupping/nursery grounds that compromises the future recruitment to the reproductive stocks; the widespread use of species-unselective gear such as gillnets in the fishery, which together with shrimp trawls cause very high bycatch rates of non-target fish, sea-turtles and dolphins; shark carcasses are many times discarded once the fins are removed; poor quality control of shark products and lack of full utilization of sharks, wasting very useful parts such as the skins for the production of leather.

In the Red Sea, there are signs that industrial trawl fisheries for penaeid shrimps are placing considerable pressure on shrimp stocks. The large but unrecorded bycatch of non-target species taken by shrimp trawlers, which is dominated by juveniles, is having an unknown impact on the recruitment of other living marine resources. Despite the importance of fishing as a source of income and in terms of national food supply, the direct effects of fishing on fish stocks, especially vulnerable species such as sharks, cuttlefish, shrimps and rock lobster, and indirectly on the marine environment is largely unknown.

Although most of the coastal areas and the waters of the Region are considered still to be in a pristine state, this situation is changing. The accelerated growth and expansion in urban coastal centres during the 1980s and 1990s, coupled with a wide range of human activities, have increased the risk of environmental degradation, depletion of fisheries resources and the loss of the invaluable amenity of the Region's precious coastal and marine habitats and ecosystems

General remarks

The Class Chondrichthyes comprises a diverse group of fishes (chimaeras, sharks and batoids) whose most obvious common feature is the possession of a cartilaginous skeleton, as opposed to the bony skeleton of the Osteichthyes or bony fishes. The cartilaginous fishes form an ancient successful group dating back to the Devonian, in which basic models remain largely unchanged since their last large flourish during the Cretaceous. Despite their ancient origin, sharks and their relatives have evolved some of the most acute and remarkable senses found in the animal kingdom, allowing them to coexist successfully with the more modern teleost designs. The chondrichthyans are grouped into two main subclasses: the Holocephalii (chimaeras or ghostsharks, ratfishes and elephant fishes) with about 50 species that inhabit cool and deep waters; and the Elasmobranchii which is a large and diverse group (including sharks and batoids) with representatives in all types of environments, from fresh waters to the depths of marine trenches and from polar regions to warm tropical seas. The great majority of the commercially important species of chondrichthyans are elasmobranchs. The latter receive their name from their plated gills, which communicate to the exterior by means of 5 to 7 gill openings.

Although the elasmobranchs have traditionally been divided into two major groups, sharks and batoids, there is amounting evidence that the two groups are actually part of a single continuum. Typical sharks always have gill slits placed clearly on the sides of the body, have pectoral fins well separated from the head, and generally have fusiform bodies. Current knowledge indicates that there are almost 500 species of ‘typical’ sharks (Compagno, 2001). Batoids tend to have a body which is flattened to various degrees, gill openings always on the ventral side of the body, and pectoral fins fused to the sides of the head. Furthermore, batoids comprise a wide array of elasmobranchs with over 600 species, including skates, rays, guitarfishes, sawfishes and mantas.

One of the most attractive features of sharks is that they can be fully utilized, with each part of the shark used for different purposes. Shark meat is used for human consumption and is an excellent source of fat-free protein. The liver of sharks provides high quantities of oil that, depending on the species, can have very high contents of vitamin-A, or in other cases, a highly prized chemical compound known as squalene, which is used in the production of cosmetics, pharmaceuticals and paints. Shark skins can be turned into some of the most resistant and high-quality leathers known. Traditional Chinese cuisine uses shark fins as a base for a soup that attains very high prices in restaurants around the globe. The corneas of sharks have been used for human transplants and even the cartilage is now marketed as a presumed cure for all sorts of human ailments. Shark jaws and teeth also used to make souvenirs for tourists and collectors. Even the offal that remains after utilizing most of the shark is burned down for use in fishmeal and added as a complement to animal feed.

The incentive for increased shark fishing due to the high price of the fins, together with the ever expanding need for food supply globally, have meant that world elasmobranch catches have increased year-after-year, reaching an estimated total of 800 000 t of sharks and shark-like fishes (including skates, rays, etc.) in 1998 (FAO FishStat Database, 2000). However, the true total catch is probably larger by an estimated 50-100% due to unreported catches and bycatches (Bonfil, 1994). Almost every fishing nation has shark catches, but the larger part of the total catch is taken by only a few countries: Indonesia, Spain, India, Pakistan, USA, Taiwan (Province of China), Mexico, Japan, Argentina and Sri Lanka, are respectively the top shark fishing nations according to 1998 catch statistics, with a collective catch of 463 000 t (57% of the reported worldwide total). Naturally, for these nations sharks are an important asset, but sharks can be important also for nations where sharks contribute in a proportionally large amount to the total fishery production even though their shark catch might be small by international standards. This is the case of countries like Costa Rica, the Maldives, Tanzania, Oman, Cuba, Gabon, Yemen, Australia, Portugal and Brazil.

Fisheries for sharks and shark-like fishes face a major problem. The biological and ecological characteristics of these fishes make them highly prone to overexploitation. Most shark and many batoid species are long-lived and this, together with their typical slow growth, results in a late age of first sexual maturation, which commonly ranges between 3 and 25 years depending on the species. Most elasmobranchs have very low fecundity when compared with bony fishes or marine invertebrates; the number of young produced by each female is between 2 and 125 per litter, but most commonly about 12. The combination of the above factors translates into a low reproductive potential and means that the productivity of elasmobranchs and their ability to sustain fishing pressure are comparatively low.

The present guide is designed to help alleviate the lack of knowledge about the diversity of the elasmobranch fauna of the Red Sea and the Gulf of Aden region, and the pressing problem of inadequate fisheries data gathering that currently prevents the proper assessment and management of these important resources.