The Conservation Status of Pelagic Sharks and Rays

Report of the IUCN Shark Specialist Group
Pelagic Shark Red List Workshop
Tubney House, University of Oxford, UK, 19–23 February 2007

Compiled and edited by
Merry D. Camhi, Sarah V. Valenti, Sonja V. Fordham,
Sarah L. Fowler and Claudine Gibson

IUCN
SSC Species Survival Commission
Conservation International
Lenfest Ocean Program

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Glossary and Acronyms

Terms were mainly modified from Compagno (2001), Kelleher (1999), Last and Stevens (1994), Pogonoski *et al.* (2002), Maguire *et al.* (2006), and www.fao.org/fi/glossary. The IUCN Red List Category and Criteria definitions are from IUCN (2001). Refer to www.iucnredlist.org and the IUCN Red List Categories and Criteria for more information on Red List definitions.

APFIC – Asia Pacific Fisheries Commission. **RFB** responsible for capture fisheries and aquaculture of this region (www.apfic.org).

Area of occupancy – the region defining the **extent of occurrence** for a taxon, excluding cases of vagrancy. This reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases the area of occupancy is the smallest area essential at any stage of the life cycle to the survival of existing populations of a taxon.

Artisanal fishery – small-scale traditional fisheries involving fishing households (as opposed to commercial companies) which input a relatively small amount of capital and energy, and catch fish mainly for local consumption (some catch may be exported). Artisanal fisheries can be **subsistence** or **commercial fisheries**.

Bathymetric distribution – the vertical distribution of a marine organism, referring to its depth of occurrence.

Batoid – a **ray** or flat shark, a species of the Order Rajiformes: the sawfish, sharkray, wedgefish, guitarfish, thornrays, panrays, electric rays, skates, stingrays, stingarees, butterfly rays, eagle rays, cownose rays and devilrays.

Bathypelagic – the lower part of the oceanic zone from 1,000m to 6,000m or greater depth.

Beach meshing – an active fishing method utilising nets or baited drumlines to remove sharks from the local area for the purpose of bather protection. Employed in Australia and in South Africa.

Benthic – organism living on the bottom of the ocean; bottom-dwelling.

Biological extinction – See **Extinction**

Biomass – the total weight of organisms in a given area.

Bycatch – the part of a catch taken incidentally in addition to the target species. In a broad context, this includes all non-targeted catch including **byproduct** and **discards**.

Byproduct – the part of the catch which is retained due to its commercial value, but which is not the primary target (see **target catch**).

Cartilaginous fishes – species of the Class **Chondrichthyes**.

CBD – Convention on Biological Diversity (www.cbd.int).

CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources. **RFMO** responsible for management of living marine resources of the Southern Ocean (www.ccamlr.org).

CCSBT – Commission for the Conservation of Southern Bluefin Tuna. **RFMO** responsible for management of fisheries for southern bluefin tuna and related species in the Pacific (www.ccsbt.org).

CECAF – Fishery Committee for the Eastern Central Atlantic. **RFB** with advisory mandate to promote the sustainable utilisation of living marine resources in this area (www.fao.org/fishery/rfb/cecaf).

CFP – Common Fisheries Policy. Principal instrument for management of European Union (EU) marine fisheries (http://ec.europa.eu/fisheries/cfp_en.htm).

Chimaera – a species of the order Chimaeriformes within the subclass **Holocephali**.

Chondrichthyan – referring to the class **Chondrichthyes**.

Chondrichthyes – the class Chondrichthyes: the cartilaginous fishes which include the **elasmobranchs** and the **holocephalans**.

Circumglobal – distributed worldwide.

Circumtropical – distributed throughout the tropical regions worldwide.

CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora. An international conservation agreement which aims to ensure that international trade in specimens of wild fauna and flora does not threaten the survival of species (see Section 5.5.2) (www.cites.org).

CMS – The Convention on the Conservation of Migratory Species of Wild Animals. An international conservation agreement that recognises the need for countries to cooperate in the conservation of animals that migrate across national boundaries, if an effective response to threats operating throughout a species' range is to be made (see Section 5.5.1) (www.cms.int).

Codend – the end of a fishing net in which the catch collects.

COFI – **FAO** Committee on Fisheries.

Commercial fishery – a fishing operation that targets species for sale.

Common name – the informal vernacular name for an organism, which may vary from location to location.

Continental shelf – the gently sloping, shelf-like part of the seabed adjacent to the coast, extending to a depth of about 200m.

Continental slope – the often steep slope of the seabed extending from the edge of the **continental shelf** to a depth of about 2,000m.

Contracting Parties – countries or entities that have signed, or otherwise agreed to abide by the terms of, an international agreement.

CPCs – Contracting Parties and Cooperating non-Contracting Parties, Entities or Fishing Entities to an **RFMO**.

CPUE – catch-per-unit-effort: a measure of the catch rate of a species standardised for the amount of **fishing effort** put into catching it.

Deepsea – that part of the oceans below 200m depth. Deepsea chondrichthyans are those species whose distribution is predominantly restricted to, or which spend the majority of their life-cycle at, depths below 200m.

Demersal – occurring or living near or on the bottom of the ocean (cf. **pelagic**).

Diel – Diel cycles are cycles of activity occurring over a 24-hour period (e.g. movement towards the surface at night and into deeper water during the day).

Discards – the component of a catch returned to the sea, either dead or alive. Primarily made up of non-target, unwanted species, but can include juveniles and damaged or unsuitable individuals of the target species.

Discard/release mortality – the proportion of fish that die as a result of being discarded after capture. Discard mortality is often hard to assess as individuals returned to the sea alive may die later due to the effects of being caught.

Dropline fishing – a method of deepwater fishing using a vertical line bearing baited hooks.

Ecosystem – the living community of different species, interdependent on each other, together with their non-living environment.

EEZ – Exclusive Economic Zone: A zone under national jurisdiction (up to 200-nautical miles wide) declared in line with the provisions of 1982 United Nations Convention of the Law of the Sea, within which the coastal State has the right to explore and exploit, and the responsibility to conserve and manage, living and non-living resources (see Section 5.5.3).

Elasmobranch – referring to the subclass **Elasmobranchii**.

Elasmobranchii – the subclass Elasmobranchii, a major subdivision of the Class **Chondrichthyes**, encompassing the living **sharks**, **batoids** and their fossil relatives.

Endemic – native and restricted to a defined region or area.

Epibenthic – the area just above and including the seabed; epibenthic species live on or near the bottom.

Epipelagic – the upper part of the **oceanic** zone from the surface to depths of about 200m.

Extent of occurrence – the area contained within the shortest continuous boundary which encompasses all known, inferred and projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat).

Extinction – (Biological) extinction is the complete disappearance of a species from the Earth.

FADs – Fish-Aggregating Devices. Used to concentrate fishes for capture.

Family – one of the taxonomic groups of organisms, containing related **genera**; related families are grouped into **orders**.

FAO – United Nations Food and Agricultural Organization (www.fao.org).

Fauna – the community of animals peculiar to a region, area, specified environment or period.

Fecundity – a measure of the capacity of the maternal adult to produce young.

FFA – Pacific Islands Forum Fisheries Agency. **RFB** with advisory mandate for sustainable tuna fisheries in the Pacific Islands (www.ffa.int).

Filter-feeding – a form of feeding whereby suspended food particles are extracted from the water. Gill rakers are used for this purpose by filter-feeding elasmobranchs.

Finning – the practice of slicing off a shark's fins and discarding the body at sea.

Fishery-independent survey – an experimental or scientific survey of the **fauna** or catch within a fishery or area, conducted independently of the fishing industry.

Fishing effort – the amount of fishing taking place; usually described in terms of the gear type and the frequency or period which it is in use.

Fishing mortality – the proportion of fish that die due to fishing activities; often expressed as a percentage of the total **population** caught each year.

FL – fork length: a standard morphometric measurement used for sharks, from the tip of the snout to the fork of the caudal fin.

Generation period– measured as the average age of parents of newborn individuals within the **population**.

Genus (plural: genera) – one of the taxonomic groups of organisms, containing related **species**; related genera are grouped into **families**.

Gestation period – the period between conception and birth in live-bearing animals.

GFCM – General Fisheries Commission for the Mediterranean. **RFMO** responsible for the management of fisheries and aquaculture in the Mediterranean Sea (www.gfcm.org).

Gillnet – a type of fishing net designed to entangle or ensnare fish.

Habitat – the locality or environment in which an animal lives.

High Seas – International waters, beyond the **EEZ** boundaries that mark the territorial waters of coastal states (EEZs have not yet been established in the Mediterranean Sea by most States).

Holocephalan – the subclass **Holocephali**.

Holocephali – the subclass Holocephali, a major subdivision of the class **Chondrichthyes**, containing the living **chimaeras** (elephant fishes, chimaeras, ghost sharks, silver sharks, ratfishes, spookfishes) and their fossil relatives.

Holotype – a single specimen cited in the original description of a species which becomes the 'name-bearer' of the species. The Holotype is used to validate the species and its accompanying **scientific name** by anchoring it to a single specimen.

IATTC – Inter-American Tropical Tuna Commission. **RFMO** responsible for the management of fisheries for tunas and other species taken by tuna-fishing vessels in the eastern Pacific Ocean (www.iattc.org).

ICCAT – International Commission for the Conservation of Atlantic Tunas. **RFMO** responsible for the management of fisheries for "tuna and tuna-like species" in the Atlantic Ocean (www.iccat.int).

ICES – International Council for the Exploration of the Seas. **RFB** that promotes marine research and provides management advice concerning living resources in the North Atlantic (www.ices.dk).

Incidental catch – see **bycatch**.

Intertidal – shoreline between high and low tide marks that is exposed daily to the air by tidal movement.

Intrinsic rate of increase – a value that quantifies how much a **population** can increase between successive time periods; this plays an important role in evaluating the sustainability of different harvest levels and the capacity to recover after depletion.

IOTC – Indian Ocean Tuna Commission. **RFMO** responsible for the management of fisheries for "tuna and tuna-like species" in the Indian Ocean and adjacent seas (www.iotc.org).

IPOA-Sharks – UN **FAO** International Plan of Action for the Conservation and Management of Sharks.

IUCN – International Union for Conservation of Nature. A union of sovereign States, government agencies and non-governmental organisations (www.iucn.org).

IUU – Illegal, Unreported and Unregulated (refers to fishing activities).

K-selected species – species selected for its superiority in a stable environment; a species typified by slow growth, relatively large size, low natural mortality and low fecundity (cf. **r-selected species**).

Littoral zone – part of the ocean that is over the continental and insular shelves, from the **intertidal** to 200m depth.

Local extinction – the loss of the last individual of a particular species from a particular region or area.

Longevity – the maximum expected age, on average, for a species or **population** in the absence of human-induced or **fishing mortality**.

Longline fishing – a fishing method using short lines bearing hooks attached at regular intervals to a longer main line. Longlines can be laid on the bottom (**demersal**) or suspended (**pelagic**) horizontally at a predetermined depth with the assistance of surface floats. Oceanic longlines may be as long as 150km with several thousand hooks.

Mesh-size – the size of openings in a fishing net. Limits are often set on mesh size to protect the young of target species, allowing them to reach maturity or optimal size for capture (minimum mesh size); or to protect larger breeding individuals (maximum mesh size).

Mesopelagic – the intermediate part of the **oceanic** zone from 200m to 1,000m depth.

Migration – the systematic (as opposed to random) movement of individuals from one place to another, often related to season and breeding or feeding. Knowledge of migratory patterns helps to manage shared **stocks** and to target aggregations of fish.

MPA – Marine Protected Area. Any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.

MSY – maximum sustainable yield. The largest theoretical average catch or yield that can continuously be taken from a stock under existing environmental conditions without significantly affecting the reproductive process.

NAFO – Northwest Atlantic Fisheries Organization (www.nafo.int). **RFMO** responsible for the management of fisheries in the Northwest Atlantic (www.neafc.org).

Natural mortality – the proportion of fish that die other than due to fishing, i.e. due to ageing, predation, cannibalism and disease; often expressed as a percentage of the total population dying each year.

NEAFC – North East Atlantic Fisheries Commission. **RFMO** responsible for the management of fisheries of this area (www.neafc.org).

nm – nautical miles.

nei – not elsewhere included. Used to indicate that catch data for a number of species have been grouped under one heading, and not identified to species level (e.g. "Rays, stingrays, mantas nei").

Non-target species – species which are not the subject of directed fishing effort (cf. **target catch**), including the **bycatch** and **byproduct**.

Oceanic – living in the open ocean, mainly beyond the edge of the **continental shelf**.

OLDEPESCA – Latin American Organization for Fisheries Development. **RFB** with an advisory mandate for fisheries of Latin America (www.oldepesca.org).

Order – one of the taxonomic groups of organisms, containing related **families**; related orders are grouped into classes.

OSPAR – The Convention for the Protection of the Marine Environment of the Northeast Atlantic (www.ospar.org).

Pelagic – occurring or living in open waters or near the water's surface with little contact with or dependency on the sea floor (cf. **demersal**).

Population – a group of individuals of a species living in a particular area. (This is defined by IUCN (2001) as the total number of mature individuals of the taxon, with subpopulations defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less).)

Precautionary approach – A strategy that acts to ensure the well-being of a species, population, or habitat even when full scientific certainty is lacking.

Productivity – the potential population growth rate. Productivity of a fish **stock** is determined by several factors. Highly productive **stocks** are characterised by high birth, growth and mortality rates, can usually sustain higher exploitation rates and, if depleted, could recover more rapidly than comparatively less productive **stocks**.

r-selected species – a species selected for its superiority in variable or unpredictable environments; a species typified by rapid growth rates, small size, high natural mortality and high fecundity (cf. **K-selected species**).

Ray – see **batoid**.

Red List of Threatened Species – listing of the conservation status of the world's flora and fauna, administered by **IUCN** (www.iucnredlist.org).

Rebound potential – a measure of the ability of a **species** or **population** to recover from exploitation.

Recruitment – used in this report to refer to the number of fish added to a **stock** in a fishing area each year, through the processes of growth (a fish grows to a size where it becomes catchable) or migration (a fish moves into the fishing area). The term can also mean simply the relative number of young that survive to occupy nursery habitats.

RFB – Regional Fishery Body. Organisations focused on formulating technical advice and/or management regulations for international fisheries (see Figure 5.1). Those RFBs implementing management are known as Regional Fisheries Management Organisations or **RFMOs**.

RFMO – Regional Fisheries Management Organisation. An intergovernmental body responsible for developing and implementing fishery management and regulations for international waters (see Figure 5.1).

Scientific name – the formal binomial name of a particular organism, consisting of the **genus** and specific names; a **species** only has one valid scientific name.

SCRS – **ICCAT**'s Standing Committee on Research and Statistics.

SEAFDEC – Southeast Asian Fisheries Development Center. **RFB** with an advisory mandate to promote sustainable fisheries in this region (www.seafdec.org).

SEAFO – South East Atlantic Fisheries Organization. **RFMO** responsible for the management of fisheries of this area (www.seafo.org).

Seamount – a large isolated elevation in the open ocean, characteristically of conical form; often a productive area for deepwater fisheries.

Seine netting – a fishing method using nets to surround an area of water where the ends of the nets are drawn together to encircle the fish (includes purse seine and Danish seine netting).

Semipelagic – species that penetrate oceanic waters but are concentrated close to continental landmasses over the **continental slopes** and rises.

Shark – a term generally used for the **cartilaginous fishes** other than the **batoids** and the **chimaeras**. However, the term can be used more broadly to include all of these groups, as suggested by Compagno (2001) and as is the practice of the IUCN **SSG**.

SIOFA – South Indian Ocean Fisheries Agreement. **RFMO** responsible for the management of high seas fisheries (other than for tuna) of this region (www.fao.org/newsroom/en/news/2006/1000360/index.html).

SPC – Secretariat of the Pacific Community. **RFB** with an advisory mandate for all living resources of the Pacific Islands region (www.spc.int).

Species – a group of interbreeding individuals with common characteristics that produce fertile (capable of reproducing) offspring and which are not able to interbreed with other such groups, that is, a **population** that is reproductively isolated from others; related species are grouped into **genera**.

Squalene – a long-chain hydrocarbon found in the liver oil of some **cartilaginous fishes**, and harvested from some deepwater species for medicinal, industrial and cosmetic uses.

SSC – Species Survival Commission. One of six volunteer commissions of **IUCN**.

SSG – Shark Specialist Group (part of the **IUCN** Species Survival Commission network).

Stock – a **population** or group of populations subject to actual or potential utilisation, and which occupy a well defined geographical range independent of other populations of the same species. Usually regarded as an entity for fisheries management and assessment.

Subpopulation – geographically or otherwise distinct groups in a **population** between which there is little exchange.

Subsistence fishery – a fishery where the fish landed are shared and consumed by the families and kin of the fishers instead of being sold on to the next larger market.

SWIOFC – Southwest Indian Ocean Fisheries Commission. **RFB** with an advisory mandate for living marine resources of this area (www.fao.org/fishery/rfb/swiofc).

TAC – Total Allowable Catch. The amount of fish permitted to be taken from a population within a specified time period (usually a year) by all fishing vessels; designated by a regulatory authority, based (at least in theory) on scientific advice for sustainable removals. Usually allocated in the form of fishing quotas.

Target catch – the catch which is the subject of directed **fishing effort** within a fishery; the catch consisting of the **species** primarily sought by fishers.

Taxon (plural: taxa) – a formal taxonomic unit or category at any level in a classification (**family**, **genus**, **species**, *etc.*).

Taxonomy – the science of classification of flora and **fauna**.

TL – total length: a standard morphometric measurement for **sharks** and some **batoids**, from the tip of snout or rostrum to the end of the upper lobe of the caudal fin (c.f. **FL**).

Transboundary – Crossing or existing across national boundaries.

Trawling (trawl netting) – a fishing method utilising a towed net consisting of a cone or funnel shaped net body, closed by a **codend** and extended at the openings by wings. Can be used on the bottom (**demersal** trawl) or in midwater (**pelagic** trawl).

UNCLOS – United Nations Convention on the Law of the Sea (www.unclos.com) (see Section 5.5.3).

Undescribed species – an organism not yet formally described by science and which does not yet a have a formal binomial **scientific name**. Usually assigned a letter or number designation after the generic name, for example, *Squatina* sp. A is an undescribed species of angel shark belonging to the **genus** Squatina.

UNFSA – United Nations Agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (see Section 5.5.4) (www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm).

WCPFC – Western and Central Pacific Fisheries Commission. **RFMO** responsible the management of fisheries for highly migratory fish stocks and bycatch and dependent species in this region (www.wcpfc.int).

WECAF – Western Central Atlantic Fishery Commission. **RFB** with an advisory mandate for living marine resources of this area (www.fao.org/fishery/rfb/wecafc/1/en).

FAO Fisheries Areas

(Refer to ftp://ftp.fao.org/fi/maps/Default.htm#CURRENT)

01 Africa – Inland Waters
02 North America – Inland Waters
03 South America – Inland Waters
04 Asia – Inland Waters
05 Europe – Inland Waters
06 Oceania – Inland Waters
08 Antarctica – Inland Waters
18 Arctic Seas
21 Northwest Atlantic
27 Northeast Atlantic
34 Eastern Central Atlantic
37 Mediterranean and Black Seas
41 Southwest Atlantic
47 Southeast Atlantic
48 Antarctic Atlantic
51 Western Indian
57 Eastern Indian
58 Antarctic Indian
61 Northwest Pacific
67 Northeast Pacific
71 Western Central Pacific
77 Eastern Central Pacific
81 Southwest Pacific
87 Southeast Pacific
88 Antarctic Pacific

1 Introduction

Sharks and their relatives, including skates, rays and chimaeras, collectively referred to as chondrichthyan fishes,[1] form a relatively small (approximately 1,115 described species) and evolutionarily conservative group that has functioned successfully in diverse ecosystems for over 400 million years. Despite their evolutionary success, many species are increasingly threatened with extinction as a result of their low reproductive rates in the face of human activities, primarily overfishing. Generally, chondrichthyans are characterised by slow growth, late maturity, and low fecundity. Because of these characteristics, sharks and their relatives have very low rates of population increase and limited potential to recover from overfishing (direct or indirect) and other threats, such as pollution and habitat destruction (Compagno 2005; Musick 2005).

1.1 The IUCN Species Survival Commission's Shark Specialist Group

IUCN, the International Union for Conservation of Nature, is the world's largest global environmental network. It is a membership union with more than 1,000 government and non-governmental member organisations and almost 11,000 volunteer scientists in more than 160 countries. This unique assemblage aims to influence, encourage, and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable (IUCN 2009a).

The IUCN Species Survival Commission (SSC) is a science-based network of some 7,500 volunteer experts from almost every country of the world, all working together towards achieving the vision of "a world that values and conserves present levels of biodiversity." Most members are deployed in more than 100 **Specialist Groups and Task Forces**. Some groups address conservation issues related to particular groups of plants or animals, while others focus on topical issues, such as reintroduction of species into former habitats or wildlife health. Members include researchers, government officials, wildlife veterinarians, zoo and botanical institute employees, marine biologists, protected area managers, and experts on plants, birds, mammals, fish, amphibians, reptiles and invertebrates. Working in close association with IUCN's Species Programme, SSC's major role is to provide information to IUCN on biodiversity conservation, the inherent value of species, their role in ecosystem health and functioning, the provision of ecosystem services, and their support to human livelihoods. SSC members also provide scientific advice to conservation organisations, government agencies and other IUCN members, and support the implementation of multilateral environmental agreements. The **technical guidelines** produced by the SSC provide guidance to specialised conservation projects and initiatives, such as reintroducing animals into their former ranges, handling confiscated specimens, and halting the spread of invasive species (IUCN 2009b).

The SSC established the Shark Specialist Group (SSG) in 1991, in response to growing awareness of and concern about the severe impact of fisheries on chondrichthyan populations around the world. The SSG aims to promote the conservation of the world's chondrichthyan fishes, effective management of their fisheries and habitats and, where necessary, the recovery of their populations. It is now one of the largest and most active of the IUCN SSC Specialist Groups, with 180 members from 90 countries distributed among 12 ocean-region subgroups, all of whom are involved in chondrichthyan research, fisheries management, marine conservation, or policy development and implementation.

1.2 The SSG's Red List programme

One of the SSG's central roles is the preparation of species assessments for the *IUCN Red List of Threatened Species*™. The IUCN Red List is the world's most comprehensive inventory of the global status of plant and animal species. It uses a single standardised set of Red List Criteria to evaluate the extinction risk of thousands of species and subspecies worldwide. Each assessment is supported by detailed documentation, including information on ecology, life history, distribution, habitat, threats, population trends and conservation measures (IUCN 2009c). The IUCN Red List Categories and Criteria are widely recognised as the most objective system available for assessing the global risk of extinction for species (Vié *et al.* 2008). With its strong scientific base and international scope, the IUCN Red List is the most authoritative guide to the status of global biological diversity. The overall aim of the Red List is to convey the urgency and scale of conservation problems to the public and policy makers, and to motivate the global community to try to reduce species extinction rates. It is among the most widely used tools for focusing attention on species of conservation concern and for identifying, documenting, and monitoring trends. Additional uses include supporting the development and implementation of policy and legislation, and guiding development and conservation planning, conservation actions for individual species and scientific research. The IUCN Red List also provides information on the status of biodiversity and changes over time, identifying the main drivers of declines and biodiversity loss and monitoring the long-term effectiveness of management and conservation actions (Fowler *et al.* 2005; Vié *et al.* 2008). The SSG will use the IUCN Red List to measure and monitor changes in the status of shark biodiversity and our knowledge of the taxa.

The SSG's ten-year programme to assess all of the chondrichthyan fishes for the IUCN Red List has now been completed for every species described in the scientific literature before the end of 2007. It provides the first fully comprehensive assessment of all members of a major marine taxonomic group and represents an important baseline for monitoring the global health of marine species and ecosystems.

This *Global Shark Red List Assessment* has been undertaken primarily through a series of regional and thematic workshops to facilitate detailed discussions and the pooling of resources and regional expertise (Fowler *et al.* in prep.) In 2007, as a part of this programme, the SSG convened an expert workshop with the aim of using the IUCN Red List Categories and Criteria to assess the conservation status of pelagic sharks and rays. Many pelagic sharks and rays are globally distributed and wide-ranging in the world's oceans, and therefore input from experts from all regions was required to synthesise their global status. Other thematic Red List workshops relevant to pelagic sharks and rays were the SSG's Deepsea workshop (held in 2003 in

1 Chondrichthyan fishes include all species of sharks and batoids – collectively known as elasmobranchs, and the chimaeras or holocephalans. The term "shark" is often used by the UN Food and Agriculture Organization, IUCN and other bodies to include all chondrichthyan fishes.

New Zealand) and the Batoid workshop (held in 2004 in South Africa).

This report provides a detailed summary of the IUCN Red List assessment for these species, highlighting species of conservation concern as well as identifying species assessed as Least Concern and Data Deficient. An overview of pelagic shark and ray fisheries and the major issues involved in the management and conservation of these species is also presented. This report is intended to inform the development of research, conservation and management priorities for this group of species.

2 Pelagic sharks and rays

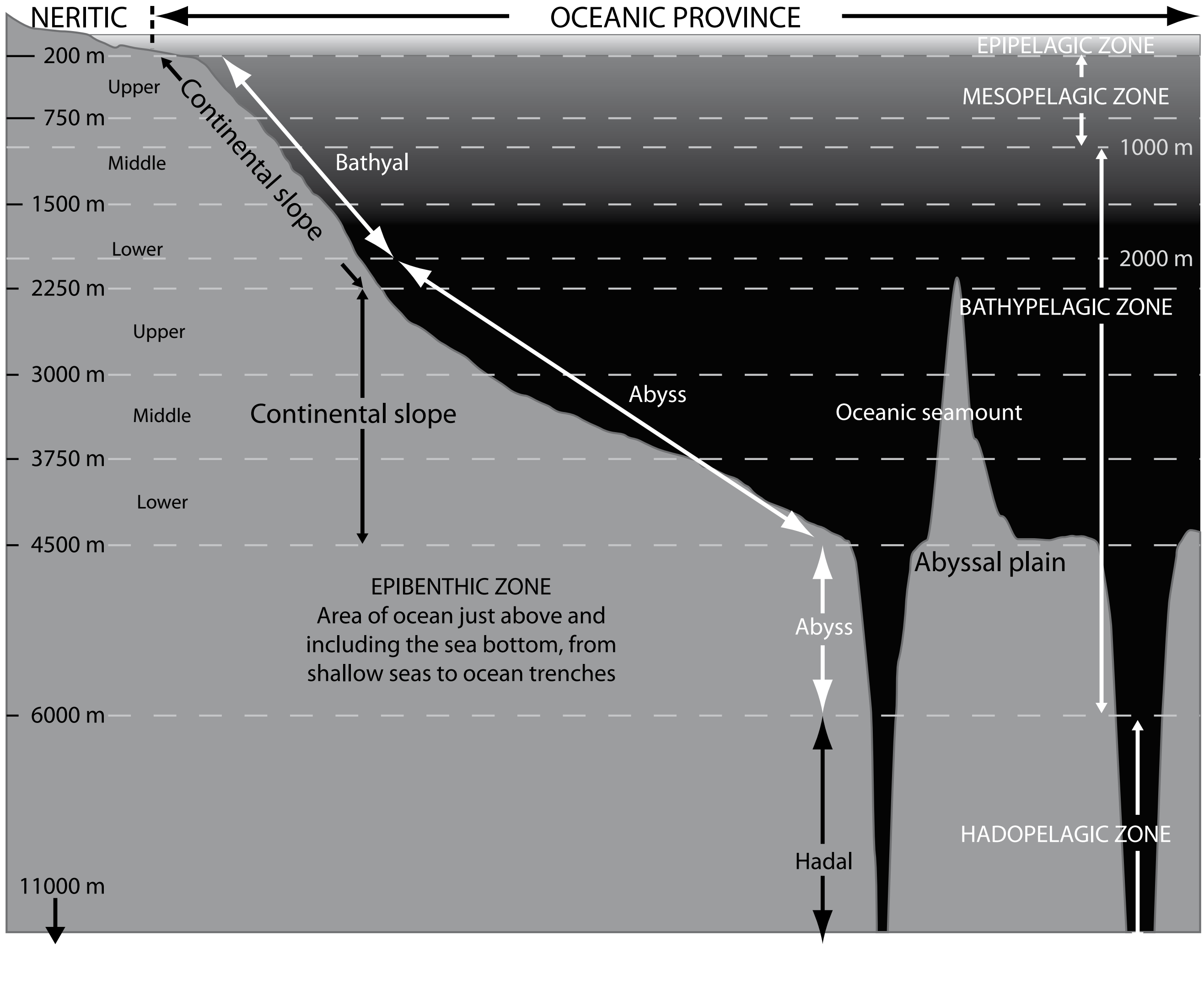
Compagno (2008) provides an annotated checklist of pelagic sharks and rays, along with a discussion of their diversity. The classification system used in this report broadly follows Compagno (2008), and this section is summarised primarily from that source. Pelagic sharks and rays are a relatively small group, representing only about 6% of the world's total chondrichthyan fish species and having low diversity compared to the shelf- and slope-dwelling chondrichthyans. They are active, free-swimming species that live in the water column and are not closely associated with the sea bottom. No chimaeras are known to be pelagic.

The pelagic sharks and rays include both "oceanic" and "semipelagic" species. Oceanic species live wholly or partly in ocean basins away from continental landmasses, although some approach the edges of continental and insular shelves and may move close inshore to feed or breed. These species live in one or more of three zones of oceanic habitat: the sunlit epipelagic zone, from the surface to 200m deep; the mesopelagic zone, from 200m to 1,000m deep, where little light penetrates; and the sunless bathypelagic zone, below 1,000m to 6,000m or more (Figure 2.1). Semipelagic species penetrate oceanic waters but are concentrated close to continental landmasses over the continental slopes and rises. Many oceanic and semipelagic sharks and rays also enter the littoral zone, that part of the oceans over the continental and insular shelves, from the intertidal to 200m depth. Pelagic sharks are best known from the epipelagic zone. Electronic tagging is providing new data on the lower depth distribution of some of the larger species formerly associated only with epipelagic waters, including whale sharks *Rhincodon typus* (Graham *et al.* 2006), basking sharks *Cetorhinus maximus* (Gore *et al.* 2008; Skomal *et al.* 2009) and porbeagle sharks *Lamna nasus* (Pade *et al.* 2009). The difficulties involved in collecting specimens from deep pelagic waters, however, mean that less is known about mesopelagic and bathypelagic sharks.

All 64 species of pelagic sharks and rays are listed in Appendix I. Whereas the dominant habitat preference of some of these species is poorly defined, roughly half of them are considered oceanic and the other half semipelagic. Some of the species defined here as semipelagic may occur across several habitats or be semipelagic in part of their range only (see Appendix I for each species' habitat, according to Compagno (2008)). The oceanic species are largely from the orders Squaliformes and Lamniformes, and the semipelagic species are from the Carcharhiniformes, Rajiformes and Squaliformes.

An analysis of the global Red List status of 21 species – 16 oceanic pelagic sharks and five rays – caught regularly in high-seas fisheries was presented in Dulvy *et al.* (2008). Most of these species are wide-ranging in the world's oceans,

Figure 2.1 Oceanic zones. Courtesy of Marc Dando.



occur in the epipelagic zone, and are highly migratory, undertaking long-distance movements. They are particularly vulnerable to the large fishing fleets that operate in the open ocean with pelagic gear, including longlines, purse seines and gillnets. The sharks in the oceanic group include several species of rarely recorded dogfish and several dwarf species (cookiecutter, pygmy and taillight sharks) that are generally too small to be taken in great numbers by pelagic fishing gear.

The order Carcharhiniformes makes up a third of the semipelagic sharks and rays, including tope shark *Galeorhinus galeus*, ten requiem sharks *Carcharhinus* spp., *Galeocerdo cuvier*, and three hammerhead sharks *Sphyrna mokarran, S. lewini, and S. zygaena*. Some of these species, such as the hammerhead sharks, are taken regularly in both pelagic and shelf fisheries and are therefore subject to fishing pressure from international fleets in offshore waters and domestic fleets within the Exclusive Economic Zones (EEZ) of coastal States. Several batoids are semipelagic, including the bat ray *Myliobatis californicus*, two eagle rays *Aetobatus narinari, Aetomylaeus vespertilio*, pitted stingray *Dasyatis matsubarai,* and Atlantic torpedo ray *Torpedo nobiliana*.

Pelagic sharks occur in international waters and most migrate across national borders. Because they move regularly between the EEZs of different countries and into the high seas, they do not fully benefit from regulations that apply only to the waters or fleets of a single country. To ensure the conservation of these species and maximise the benefits gained from domestic management efforts, international cooperation to impose management measures by region or across entire ocean basins is also necessary (IUCN SSG 2007; Camhi *et al.* 2008a; Anonymous 2008).

3 Methodology

3.1 Workshop procedure

In February 2007, the SSG convened an IUCN Red List workshop. Seventeen experts from 12 countries participated, drawn from government agencies, universities, private institutions and IUCN. They included authors of published papers on shark and ray population status and experts who develop stock assessments and advice on shark management for domestic and Regional Fisheries Organizations. The aim of the workshop was to evaluate the conservation status of the pelagic sharks and rays and to discuss priorities for their conservation and management.

Workshop experts compiled existing Red List assessment documentation, contributed additional information, and completed global Red List assessments for each species they had elected to assess, working either alone or in small groups. Many of these global assessments were compiled from several separate regional assessments developed during previous regional Red List workshops. Experts debated draft assessments in plenary and agreed final results by consensus.

Participants assessed all species using the IUCN Red List Categories and Criteria Version 3.1 (IUCN 2001). The nine Red List Categories are: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient and Not Evaluated. Classification of species into the Threatened categories (Critically Endangered, Endangered and Vulnerable) applies a set of five quantitative criteria based on biological factors related to extinction risk, including rate of population decline, population size, area of geographic distribution and degree of population and distribution fragmentation. These IUCN Red List Categories and Criteria are summarised in Appendix II.

3.2 Assessing marine fishes – application of the Red List Categories and Criteria

Workshop experts performed assessments with reference to the *Guidelines for Using the IUCN Red List Categories and Criteria*, which are reviewed annually and updated on the Red List web site (www.iucnredlist.org/static/categories_criteria). Participants assessed species against all of the IUCN Red List Criteria, but Criterion A (population decline) is the only criterion that has been found to apply to Threatened pelagic sharks.

The SSG recognises that some chondrichthyan species are the target of fisheries and therefore may show a decline in population size under a sustainable management regime. Under the IUCN Red List Criteria, such taxa could be assigned a Threatened status under Criterion A (declining population). Some SSG members expressed concern that such a listing might not reflect extinction risk, especially if the decline is a consequence of a management plan designed to achieve a goal such as maximising the sustainable yield from a fishery (although there is no species-specific management in place for sharks and rays on the high seas). The IUCN Red List Guidelines (IUCN 2008a) state that such listings should not be problematic in the medium to long term. This is because, although a managed population may currently exhibit characteristics consistent with assignment of a Threatened category, effective management will result in the population stabilising at a target level, at which time the decline will end. The taxon would then no longer qualify for a Threatened listing and the assessment could be reviewed. If, however, population declines continued, the reason for concern and therefore the Threatened listing would still apply (IUCN 2008a).

Where possible, the SSG uses the results of fishery-independent surveys to indicate species abundance. This type of information, however, is rarely available for sharks. Catch per unit effort (CPUE) may therefore be used as an index of abundance to estimate percentage reductions in the number of mature individuals of exploited species (IUCN 2008a). The SSG stresses that this measure is used with caution because changes in CPUE may underestimate population declines. For example, if the population aggregates even at small sizes (e.g. scalloped hammerhead *Sphyrna lewini*), catches may remain high with the same level of effort even while the population declines. Changes in fisheries regulations, fishing methods and efficiency and market demand also need to be considered (IUCN 2008a).

3.3 The precautionary approach

The IUCN guidelines recommend that assessors adopt a precautionary but realistic approach when applying criteria, and that all reasoning should be explicitly documented (IUCN 2008a). For example, where a population decline is known to have taken place (e.g. as a result of fisheries), but no management has been applied to change the pressures on the population, it can be assumed the decline is likely to continue in the future. If fisheries are known to be operating, but no information is available on changes in CPUE, data from similar fisheries elsewhere may be used by informed specialists to extrapolate likely population trends. Additionally, where no life-history data are available, the demographics of a very closely related species may be applied (Fowler and Cavanagh 2005).

3.4 Global assessments

Many pelagic shark and ray species are wide-ranging, occurring in more than one ocean basin. The assessment of the regional and global status of many of these widely distributed species had begun at earlier SSG regional and thematic workshops, and needed to be compiled to form one global assessment.

3.5 Regional assessments

Some species have been assigned a regional or subpopulation Red List category in different areas of their range, indicating that their status varies regionally. Regional assessments are not displayed separately on the IUCN Red List web site, but are detailed within the published documentation for the global Red List assessment.

3.6 Geographically distinct populations

The IUCN Red List recognises the separate assessment of geographically distinct populations. These subpopulations are defined as "geographically or otherwise distinct groups in the [global] population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)" (IUCN 2001). Subpopulation assessments are displayed separately on the IUCN Red List web site.

3.7 Review and consensus process

The SSG has been appointed by the IUCN Species Survival Commission as the Red List Authority for chondrichthyan assessments. It considers full and open consultation with its membership, through workshops and correspondence, to be essential for the preparation of accurate and robust Red List assessments (Fowler 1996). Some species assessments developed at the Pelagic Shark workshop in 2007 have been reviewed and updated *via* e-mail correspondence. Prior to their submission to the IUCN Red List, however, all species assessments are circulated to the entire SSG global network, to ensure thorough and transparent review. Therefore, the resulting assessments are a product of scientific consensus on each species' status, supported by relevant literature and other data sources. All assessments have been submitted to the IUCN Red List Unit using the Species Information Service Data Entry Module (SIS-DEM).

Once assessments have been submitted and accepted onto the IUCN Red List, they are periodically revisited and can be updated as new information becomes available. The IUCN Red List is currently updated annually. Unfortunately, because of the particularly large number of assessments prepared for other taxonomic groups in 2007, new chondrichthyan fish assessments were not included in the 2008 Red List. The global shark assessment should now be released in 2009 (Fowler *et al*. in prep), with updates in subsequent years. Readers are therefore urged to always consult the current IUCN Red List (www.iucnredlist.org) to view the most up-to-date assessments.

4 Results and discussion

The SSG assessed all 64 known species of pelagic sharks and batoids for the IUCN Red List of Threatened Species. Experts also produced separate regional and subpopulation assessments for a number of these species. The rationales that summarise the global and regional documentation supporting these Red List assessments are presented in Section 8 of this report. All species of pelagic sharks and rays, their Red List status, and assessment dates are listed in Appendix I. Assessments submitted for listing after 2007 should be released on www.iucnredlist.org later in 2009 (Fowler *et al.* in prep).

4.1 Summary of Threatened status

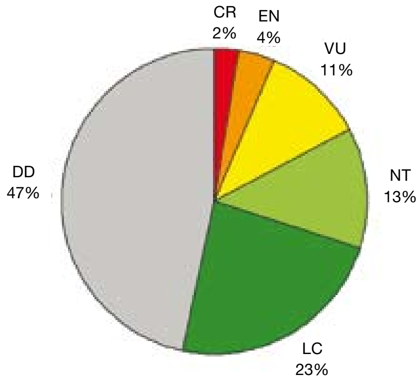
Table 4.1 presents the number of pelagic sharks and rays assigned to each Red List Category globally. Figure 4.1 compares the overall global status of (a) all pelagic sharks and rays, as well as evaluating the (b) oceanic and (c) semipelagic categories separately (see Section 2). Globally, 32% percent of all pelagic sharks and rays are Threatened (6% Endangered and 26% Vulnerable). A further 24% are considered to be close to meeting the criteria for a Threatened category, being assessed as Near Threatened, 19% are assessed as Least Concern, and 25% are considered Data Deficient. The proportion of Threatened oceanic and semipelagic species is the same: 31%. However, almost twice as many semipelagic as oceanic species are classified as Near Threatened (31% versus 16%). A slightly larger proportion of oceanic than of semipelagic species are Data Deficient (28% versus 25%), and nearly twice as many are classified as Least Concern (25% versus 13%). Dulvy *et al.* (2008) presented the global conservation status of 21 species of oceanic sharks and rays caught regularly in high-seas fisheries. The proportion of these species that are Threatened (52%) is higher than for all pelagic sharks and rays, largely because they are taken in very large quantities in unmanaged fisheries.

The overall conservation status of pelagic sharks and rays is also significantly worse than for the entire chondrichthyan group. Globally, of the 1,045 chondrichthyan species assessed, 17% are Threatened, 13% are Near Threatened, 23% are Least Concern, and 47% are Data Deficient (Figure 4.2) (Fowler *et al.* in prep). A table listing all pelagic sharks and rays, their habitats and Red List status is provided in Appendix I.

Table 4.1 Number of pelagic shark and ray species assigned to each IUCN Red List Category.

IUCN Red List Category	Global threat status of pelagic sharks and rays
Critically Endangered (CR)	0
Endangered (EN)	4
Vulnerable (VU)	16
Near Threatened (NT)	15
Least Concern (LC)	12
Data Deficient (DD)	17
Total number of species	**64**

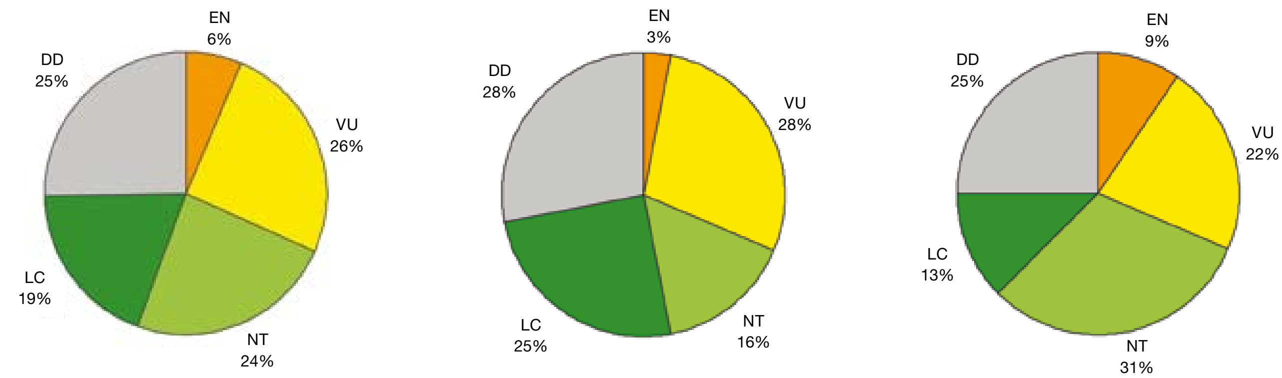
Figure 4.2 Percentage distribution of all globally assessed chondrichthyan species by IUCN Red List Category (2009 data).



4.2 Threatened species

Twenty species (32%) of pelagic sharks and rays are considered Threatened (Critically Endangered, Endangered, or Vulnerable) according to the IUCN criteria (IUCN 2008a; Table 4.2). The K-selected life-history characteristics of chondrichthyans make them intrinsically vulnerable to fishing pressure, and the threat status of pelagic sharks appears to be highly dependent on the interaction between their capacity to withstand exploitation and the intensity and scale of fishing pressure (Dulvy *et al.* 2008). The pelagic sharks and rays identified as Threatened tend to mature late and produce few young after a long gestation period, resulting in extremely limited capacity to withstand continued exploitation and recover from depletion. For example, the

Figure 4.1 Percentage distribution of pelagic sharks and rays by IUCN Red List Category.



a) All pelagic sharks and rays (n=64). b) Oceanic sharks and rays (n=32). c) Semipelagic sharks and rays (n=32).

oceanic giant devilray *Mobula mobular*, which produces only a single pup per litter (either annually or biennially), is assessed as Endangered. This epipelagic, Mediterranean near-endemic ray has a relatively small geographic range compared with most other oceanic pelagic species and suffers high mortality from bycatch in intensive pelagic fisheries (Cavanagh and Gibson 2007; Dulvy *et al.* 2008). Other seriously Threatened taxa include the semipelagic hammerhead sharks: the scalloped hammerhead *Sphyrna lewini* and great hammerhead *S. mokarran* are classified as Endangered, and the smooth hammerhead *S. zygaena* is Vulnerable. These species are exposed to fisheries throughout their life-cycle in many areas of their range. Juveniles occupy shallow coastal nursery habitat and are taken with a variety of gear in inshore fisheries while adults are taken both in shelf fisheries and by offshore, pelagic fleets. Estimated declines of 64–99% have been reported in several areas of their range, including the Northwest and Western Central Atlantic, Southwest Indian Ocean, Mediterranean Sea, and Eastern Central Atlantic (Baum *et al.* 2003; Dudley and Simpfendorfer 2006; Denham *et al.* 2007; Dulvy *et al.* 2008; Ferretti *et al.* 2008).

Many commercially exploited species are also at high risk, including the thresher sharks *Alopias* spp., mako sharks *Isurus* spp., porbeagle shark *Lamna nasus* and several of the large carcharhinid sharks. These species are assessed as Vulnerable globally; however, several stocks have been identified as being at a higher level of threat. For example, the bigeye thresher *Alopias superciliosus* is assessed as Endangered in the Northwest and Western Central Atlantic, and the shortfin mako *Isurus oxyrinchus* is assessed as Critically Endangered in the Mediterranean Sea. These species are a valued bycatch of pelagic fisheries targeting tuna and billfishes and are also targeted for their meat and fins. The combination of intense, often unregulated pelagic fishing efforts, rising value of shark products, and low reproductive rates has led to severe declines in these species' populations (Dulvy *et al.* 2008).

Improved monitoring and further research is needed to further our understanding of pelagic sharks, particularly of these 20 Threatened species. Priority should be placed on gaining information on the biology, threats, conservation needs and critical habitats of these species, particularly in regions where threats are evident but little information is currently available. Management and recovery plans are urgently needed in most regions. Because the species identified as Threatened occur in international waters and/or migrate across national borders, collaborative multilateral management is required to ensure the success of initiatives by single range States and the effective conservation of wide-ranging populations (IUCN SSG 2007; Camhi *et al.* 2008a; CMS 2008).

4.3 Near Threatened species

Fifteen species (24%) of pelagic sharks and rays are assessed as Near Threatened, indicating that they are close to qualifying for a Threatened category and could be reclassified as Threatened in the near future (Table 4.8). These include seven carcharhinid sharks, such as the silvertip shark *Carcharhinus albimarginatus*, which may be unable to withstand continued indirect fishing pressure from pelagic and shelf fisheries. In fact, it is likely that some of these species may be found to meet the criteria for a threat category if or when additional information becomes available. For example, the silky shark *Carcharhinus falciformis* is classified as Near Threatened globally, but has regional assessments of Vulnerable in the Eastern Central and Southeast Pacific and the Northwest and Western Central Atlantic. Landings data also suggest that silky shark fisheries have collapsed off Sri Lanka (FAO 2009), in the Indian Ocean. Further data from other areas of its range are required to determine whether the extent of global decline actually warrants a Vulnerable listing for this species. Difficulties with misidentification of this and other species of carcharhinid shark hamper accurate assessment of species-specific trends. Improvements in monitoring and the collection of accurate species-specific fisheries data are needed to improve conservation assessments and management advice.

The blue shark *Prionace glauca* is also assessed as Near Threatened. This species is (or was) arguably the most widespread and abundant chondrichthyan fish and is the

Table 4.2 Threatened pelagic sharks and rays.

Species	Common name	Red List Category	Classification	Depth range (m)
Endangered				
Aetomylaeus vespertilio	Ornate eagle ray	**EN**	Semipelagic	110
Mobula mobular	Giant devilray	**EN**	Oceanic	surface–>200?
Sphyrna lewini	Scalloped hammerhead	**EN**	Semipelagic	surface–>275
Sphyrna mokarran	Great hammerhead	**EN**	Semipelagic	surface–>80
Vulnerable				
Rhincodon typus	Whale shark	**VU**	Oceanic	surface–>1,000
Odontaspis ferox	Smalltooth sand tiger	**VU**	Semipelagic	20–850
Alopias pelagicus	Pelagic thresher	**VU**	Oceanic	surface–>152
Alopias superciliosus	Bigeye thresher	**VU**	Oceanic	surface–723
Alopias vulpinus	Thresher shark	**VU**	Oceanic	surface–366
Cetorhinus maximus	Basking shark	**VU**	Semipelagic	surface–>1,250
Carcharodon carcharias	Great white	**VU**	Oceanic	surface–>1,000
Isurus oxyrinchus	Shortfin mako	**VU**	Oceanic	surface–>500
Isurus paucus	Longfin mako	**VU**	Oceanic	?
Lamna nasus	Porbeagle shark	**VU**	Oceanic	surface–>700
Galeorhinus galeus	Tope shark	**VU**	Semipelagic	1–800
Carcharhinus longimanus	Oceanic whitetip shark	**VU**	Oceanic	surface–>200
Carcharhinus obscurus	Dusky shark	**VU**	Semipelagic	surface–400
Carcharhinus plumbeus	Sandbar shark	**VU**	Semipelagic	surface–280
Carcharhinus signatus	Night shark	**VU**	Semipelagic	surface–600
Sphyrna zygaena	Smooth hammerhead	**VU**	Semipelagic	surface–>200

most frequently caught shark species (Dulvy *et al.* 2008). Its fins dominate the Hong Kong shark fin market, and an estimated 10.7 million individuals are killed for the global fin trade each year (Clarke *et al.* 2006a). Much smaller numbers are utilised for their meat. Although it is among the best studied of chondrichthyans, assessment of this species' global status was hampered by its wide geographic range and the paucity and/or poor quality of demographic and catch data, with different catch-rate analyses showing different rates of decline even in the same ocean basin. Fishing pressure is likely to intensify on this species as a result of the increasing value of its fins and meat, decreased availability and shrinking quotas for the tunas and billfishes with which it is captured, further depletion of less productive sharks, and lack of management. Monitoring and the introduction of precautionary limits on blue shark landings are therefore particularly important.

Near Threatened pelagic sharks include several deepwater species: crocodile shark *Pseudocarcharias kamoharai,* frilled shark *Chlamydoselachus anguineus*, and bluntnose sixgill shark *Hexanchus griseus,* although the latter two are primarily demersal shelf- and slope-dwellers that can occur well off the sea bottom and may be semipelagic in some places (Compagno 2008; see Appendix I). Deepwater chondrichthyans tend to have particularly low reproductive potential and therefore a high vulnerability to depletion in fisheries (Kyne and Simpfendorfer 2007). The crocodile shark, the only truly oceanic species of the three, is regularly taken as bycatch in pelagic longline fisheries and will likely be affected if pelagic fishing effort continues to increase worldwide. In addition, three batoids are assessed as Near Threatened: spinetail devilray *Mobula japanica,* manta ray *Manta birostris* and spotted eagle ray *Aetobatus narinari*, although the latter is primarily a shelf-dweller that may be semipelagic as well as benthic and littoral (see Appendix I).

It is essential that the status of all species assessed as Near Threatened be monitored closely. Management action is needed to prevent them from becoming listed as Threatened in the future.

4.4 Least Concern species

Nineteen percent of pelagic sharks and rays are classified as Least Concern (Table 4.4). These species are not considered to be at threat of extinction now or in the foreseeable future, but may still benefit from management action where they are taken in fisheries. The salmon shark *Lamna ditropis* was taken in relatively large numbers in pelagic drift gillnet fisheries for Pacific salmon and flying squid during the 1950s and 1960s and has low reproductive capacity. These drift net fisheries have now ceased. In the Northeast Pacific, catches are now limited to a tightly controlled recreational fishery and there is a small directed fishery in the Northwest Pacific (Dulvy *et al.* 2008; Goldman and Musick 2008). The population appeared to be rebuilding following the cessation of the drift net fisheries, which is why this species is assessed as Least Concern. More recent information, however, indicate a declining trend for salmon sharks in Prince William Sound, Alaska, (see below) emphasising the need for continued monitoring and control of catches, given that it is as biologically vulnerable to exploitation as its Threatened sister species, the porbeagle shark.

The pelagic stingray *Pteroplatytrygon violacea* is classified as Least Concern, despite its capture in very large numbers as

Table 4.3 Near Threatened pelagic sharks and rays.

Species	Common name	Classification	Depth range (m)
Chlamydoselachus anguineus	Frilled shark	Semipelagic	51–1,440
Hexanchus griseus	Bluntnose sixgill shark	Semipelagic	surface–2,000
Aetobatus narinari	Spotted eagle ray	Semipelagic	surface–60
Manta birostris	Manta	Oceanic	surface–>200?
Mobula japanica	Spinetail devilray	Oceanic	?
Pseudocarcharias kamoharai	Crocodile shark	Oceanic	surface–>590
Carcharhinus albimarginatus	Silvertip shark	Semipelagic	surface–>800
Carcharhinus brachyurus	Bronze whaler	Semipelagic	surface–100
Carcharhinus brevipinna	Spinner shark	Semipelagic	<5–>75
Carcharhinus falciformis	Silky shark	Oceanic	surface–>500
Carcharhinus galapagensis	Galapagos shark	Semipelagic	2–>180
Carcharhinus leucas	Bull shark	Semipelagic	surface–>152
Carcharhinus limbatus	Blacktip shark	Semipelagic	surface–30
Galeocerdo cuvier	Tiger shark	Semipelagic	surface–140
Prionace glauca	Blue shark	Oceanic	surface–350

Table 4.4 Least Concern pelagic sharks and rays.

Species	Common name	Classification	Depth range (m)
Etmopterus gracilispinis	Broadband lanternshark	Semipelagic	70–1,000
Etmopterus pusillus	Smooth lanternshark	Semipelagic	surface–1,998?
Euprotomicrus bispinatus	Pygmy shark	Oceanic	surface–300
Heteroscymnoides marleyi	Longnose pygmy shark	Oceanic	45–502
Isistius brasiliensis	Cookiecutter shark	Oceanic	surface–1,000
Isistius plutodus	Largetooth cookiecutter shark	Oceanic	60–120
Squaliolus aliae	Smalleye pygmy shark	Oceanic	200–2,000
Squaliolus laticaudus	Spined pygmy shark	Oceanic	200–500
Pteroplatytrygon violacea	Pelagic stingray	Oceanic	surface–238
Myliobatis californicus	Bat ray	Semipelagic	surface–108
Mitsukurina owstoni	Goblin shark	Semipelagic	<30–>1,000
Lamna ditropis	Salmon shark	Oceanic	surface–>600

Table 4.5 Data Deficient pelagic sharks and rays.

Species	Common name	Classification	Depth range (m)
Miroscyllium sheikoi	Rasptooth dogfish	Semipelagic	340–370
Trigonognathus kabeyai	Viper dogfish	Semipelagic	150–360
Scymnodalatias albicauda	Whitetail dogfish	Oceanic	150–500
Scymnodalatias garricki	Azores dogfish	Oceanic	~300
Scymnodalatias oligodon	Sparsetooth dogfish	Oceanic	surface–200?
Scymnodalatias sherwoodi	Sherwood dogfish	Oceanic	400–500
Zameus squamulosus	Velvet dogfish	Semipelagic	surface–1,450
Euprotomicroides zantedeschia	Taillight shark	Oceanic	458–641
Isistius labialis	South China cookiecutter shark	Oceanic	~520
Mollisquama parini	Pocket shark	Semipelagic	~330
Torpedo microdiscus	Smalldisk torpedo	Semipelagic	180–280
Torpedo nobiliana	Atlantic torpedo	Semipelagic	surface–800
Dasyatis matsubarai	Pitted stingray	Semipelagic	0–60
Mobula tarapacana	Sicklefin devilray	Oceanic	?
Odontaspis noronhai	Bigeye sand tiger	Oceanic	600–1,000
Megachasma pelagios	Megamouth shark	Oceanic	5–166
Carcharhinus altimus	Bignose shark	Semipelagic	12–430

bycatch in high-seas fisheries. This species is one of the most productive of the live-bearing elasmobranchs; its annual rate of increase of 31% is more than triple that of some of the Threatened oceanic sharks and rays. It therefore has a higher capacity to withstand fishing pressure (Dulvy *et al.* 2008). Pelagic stingrays are currently of little commercial value and are discarded in most areas. Survival rates are thought to be low because the rays usually sustain serious jaw damage during release. As a result, stocks of this species should be monitored to ensure this species remains within the Least Concern category.

Other species assessed as Least Concern include small cookiecutter sharks *Isistius* spp., pygmy sharks *Euprotomicrus bispinatus, Heteroscymnoides marleyi* and *Squaliolus* spp., and lanternsharks *Etmopterus* spp. Currently, these species are not generally captured by pelagic fisheries. Most are widespread and are too small and/or too deeply distributed to be taken in any great numbers in most of today's pelagic fisheries. For example, the spined pygmy shark *Squaliolus laticaudus* is widespread in deep waters (200–500m) of most ocean basins and measures only 28cm in length, which is too small to be susceptible to most fishing gears.

4.5 Data Deficient species

The SSG has categorised one quarter (25%) of pelagic sharks and rays as Data Deficient because available information is insufficient to assess accurately their extinction risk (Table 4.5). In many cases this is due to a lack of research, species rarity, and/or limited geographic distribution. Poorly understood and apparently rare dogfishes make up almost half of the pelagic species deemed Data Deficient. Several of these dogfish species are documented from only a few specimens taken in deep water from a limited area; examples include rasptooth dogfish *Miroscyllium sheikoi*, viper dogfish *Trigonognathus kabeyai* and Azores dogfish *Scymnodalatias garricki*. In other cases, there is a lack of accurate fisheries or survey data with which to determine population trends. For example, the bignose shark *Carcharhinus altimus* is a known bycatch of deep-set pelagic longline fisheries, however, catches are underreported and therefore cannot be used to assess mortality and population trends. Therefore, bignose shark is assessed as Data Deficient globally, but concerns remain because it may have limiting life-history characteristics similar to its sister species, the sandbar shark *Carcharhinus plumbeus*, which is classified as Vulnerable. Similarly, adequate data on fisheries and population trends are lacking for some stocks of several of the wide-ranging species assessed as Threatened globally. It is therefore important to direct research towards these Data Deficient species and stocks as well as those in Threatened categories (Cavanagh *et al.* 2003). A Data Deficient listing does not mean that a species is not of concern. Indeed, unless fisheries management improves immediately and dramatically, enhanced knowledge will undoubtedly result in more Data Deficient chondrichthyan species qualifying for Threatened categories (Gibson *et al.* 2008).

5 Overview of fisheries, conservation and management

5.1 Fisheries

Pelagic sharks and rays are caught in fisheries in all of the world's oceans. In most regions, their catch in longline, purse-seine, and gillnet fisheries is well known but poorly documented because it is often discarded and/or of low priority in data collection programmes. These highly migratory species range largely outside the jurisdictions of coastal countries, and their low priority relative to the more productive tunas and billfishes in high-seas fisheries has left them neglected by fisheries managers. Indeed, pelagic sharks and rays have fallen through the management cracks in both domestic and international waters. Although requirements for reporting catches, landings, and discards for pelagic elasmobranchs are increasing, compliance is poor. Moreover, catch limits to reduce the mortality of these species are rare on the national level and virtually nonexistent at the international level. Yet the demand for shark products, especially fins, continues to rise. Fishing is outpacing the productivity of these slow-growing species, which are known for their low intrinsic growth rates (Hoenig and Gruber 1990; Cortés 2000, 2008a; Smith *et al.* 2008a), resulting in their overexploitation, depletion, and inclusion in the Threatened categories of the IUCN Red List.

5.1.1 Availability of data

It has been long and widely acknowledged that fisheries information for elasmobranchs is woefully inadequate; this is particularly true for species taken on the high seas (Bonfil 1994; Camhi *et al.* 1998; Fowler *et al.* 2005; Camhi *et al.* 2008b; Dulvy *et al.* 2008; ICCAT 2008a). The conservation status of many of the species addressed in this report is intricately linked to the lack of data concerning their catch and discards.

One of the first global calls for collecting improved fisheries data for elasmobranchs was advanced by the Convention on International Trade in Endangered Species (CITES) in 1994, when Contracting Parties were requested to collect biological and trade information on sharks taken in their fisheries (Resolution Conf. 9.17). Since then, many authoritative papers and books have been published elucidating elasmobranch biology and ecology, but the extent and impact of fisheries on these species remain poorly documented. In 1999, the UN Food and Agriculture Organization (FAO) reiterated the call for improved chondrichthyan catch, effort, landings, and trade data when it adopted its International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks; FAO 1999). Requested improvements in fisheries data from member States, including landings and discards by species, have been painfully slow and simply inadequate. This situation is highly regrettable, given the profound vulnerability of most of these species to overfishing and the resulting declines in their populations.

The FAO is the primary collator of global fishery data. In 2007, 134 fishing countries voluntarily submitted shark landings data to FAO's capture production database (FAO 2009). Although FAO offers the most comprehensive fisheries database available for elasmobranchs, its quality is contingent on the reporting efforts of the world's fishing nations, and therefore suffers from the low research and management priority afforded to sharks and rays (Bonfil 1994). The result has been widespread underreporting, as well as intentional misrepresentation of shark catches. In addition, FAO's reporting only of landings, not discards, misses much chondrichthyan mortality. For instance, FAO data do not reveal the substantial number of blue sharks thrown back to the sea. Second only to shrimp trawling, longline fishing for highly migratory species has an average discard rate of 28%, and the blue shark is the most commonly discarded species from longlines (Maguire *et al.* 2006).

Of particular consequence to pelagic shark management is the lack of species-specific fisheries data. Although FAO reported landings for about 102 elasmobranch species or groups in 2007, only 19.5% of the biomass was reported at the species level. The remainder of the landings were amalgamated by species groups such as "Sharks, rays, skates, *etc.* nei" (37%) and "Rays, stingrays, mantas nei" (18%) (FAO 2009; nei=not elsewhere indicated). Species-specific reporting is highest in the Atlantic (29%), followed by the Pacific (17%), Indian (9%) and Southern (6%) Oceans. The FAO database reported 2007 landings for at least 15 pelagic sharks and rays covered in this report, in addition to a few pelagic species groupings (Table 5.1). Experts consider that these data greatly underestimate the actual level of mortality and even landings for these species. Discrepancies are revealed when compared to fin trade statistics and other studies (Stevens 2000; Campana *et al.* 2005; Clarke *et al.* 2006a). The lack of species-specific catch and discard data also compromises the utility of the FAO database for assessing the effects of fishing on population status.

As shark products are exported globally, trade statistics can supplement fisheries data to develop more robust estimates of annual shark mortality. Analysis of the Hong Kong shark fin market, which imports between 50% and 85% of the world's fins (Vannuccini 1999; Clarke 2004), suggests that the global catch of sharks may be three to four times higher than the official statistics reported by FAO (Clarke *et al.* 2006a). In an extensive study of the Hong Kong auctions, corroborated by forensic DNA analysis of the fins, Clarke *et al.* (2006b) estimated that pelagic sharks accounted for at least one-third of the fins sold there (see below).

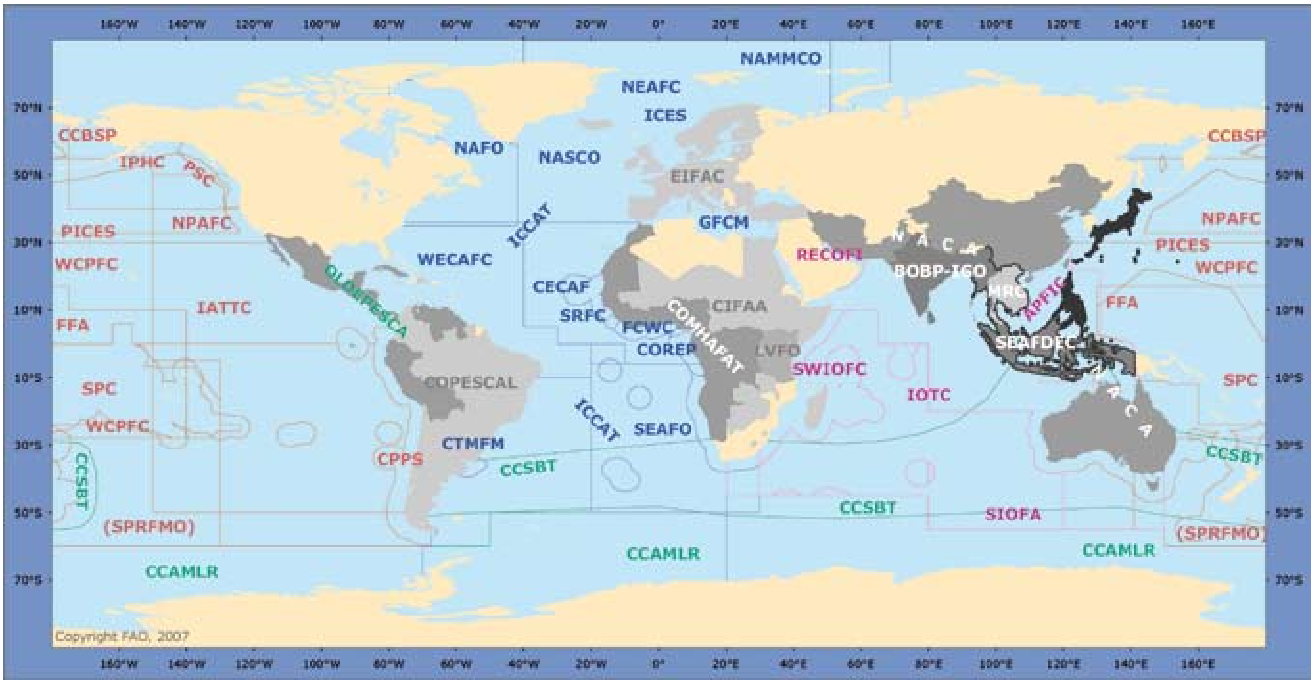
Sharks are often a significant, if not the largest, component of the catch from fisheries targeting "tunas and tuna-like fishes." The vast majority of these longline, purse-seine, and gillnet fisheries in international and transboundary waters are now subject to varying degrees of monitoring and management under the auspices of the regional fisheries management organisations (RFMOs) (Figure 5.1). Other fisheries bodies, such as the North Atlantic-focused International Council for the Exploration of the Sea (ICES) and the Secretariat of the Pacific Community (SPC) in the Pacific, coordinate regional research and provide scientific and technical advice for fisheries management to fishing nations and fisheries commissions. Unlike the case for tunas and salmon, no RFMO has been established specifically for sharks and rays (although many have a duty to consider impacts upon non-target and associated or dependent species, including sharks and rays under international law and their own conventions; Lack and Sant 2006). Elasmobranchs still suffer from a lack of priority within these existing fisheries bodies and their member fishing nations. Over the past decade, however, most of the RFMOs overseeing the world's largest tuna and billfish fisheries have begun to examine shark catches and population status, usually through working groups on bycatch or ecosystems. RFMOs have also adopted multiple

Table 5.1 Landings (t) of pelagic elasmobranch species and species groups in 2007, by ocean basin[a] (FAO 2009).

Species or species group	Common name	Atlantic	Indian	Pacific	Total
Alopias pelagicus	Pelagic thresher	*	*	2,556	2,556
Alopias spp.	Thresher sharks nei	4	830	15,049	15,833
Alopias superciliosus	Bigeye thresher	210	*	100	310
Alopias vulpinus	Thresher	210	2	236	448
Carcharhinus falciformis	Silky shark	69	983	1,433	2,485
Carcharhinus longimanus	Oceanic whitetip shark	14	*	*	14
Carcharodon carcharias	Great white shark	*	*	<0.5	<0.5
Cetorhinus maximus	Basking shark	82	*	7	89
Isurus oxyrinchus	Shortfin mako	4,496	407	866	5,769
Isurus paucus	Longfin mako	2	*	*	2
Isurus spp.	Mako sharks	33	*	120	153
Lamna nasus	Porbeagle shark	808	9	70	887
Manta spp., *Mobula* spp.	Mantas, devilrays nei	*	*	3,310	3,310
Prionace glauca	Blue shark	35,706	3,843	5,538	45,087
Pseudocarcharias kamoharai	Crocodile shark	7	*	*	7
Sphyrna lewini	Scalloped hammerhead	150	*	52	202
Sphyrna spp.	Hammerhead sharks, etc. nei	3,389	119	137	3,645
Sphyrna zygaena	Smooth hammerhead	181	*	138	319
Subtotal pelagic species		45,361	6,193	29,612	81,166
Total elasmobranchs		**296,150**	**221,971**	**262,762**	**781,326[b]**

[a] * = no FAO landings reported from this ocean in 2007.
[b] Total includes 4,037t from the Southern Ocean.

Figure 5.1 Regional Fishery Bodies (RFB) – Map of Competence and Coverage Areas.



Courtesy of FAO © 2008–2009. (See Glossary and acronyms for RFBs relevant to pelagic sharks).

resolutions and recommendations (containing binding and non-binding measures) calling for the increased collection of and improvement in the quality of species-specific shark landings from their Contracting Parties, as well as their Cooperating non-Contracting Parties, Entities or Fishing Entities (CPCs) (Table 5.2).

There are at least 50 countries actively fishing for tuna and billfish throughout the Atlantic and Mediterranean. All take pelagic sharks as bycatch, secondary catch or intentionally. The International Commission for the Conservation of Atlantic Tunas (ICCAT) is the RMFO responsible for managing fisheries for "tuna and tuna-like species" in the majority of this region (Figure 5.1). ICCAT has been working to improve the collection of species-specific shark catch data since 1995, but few of its Contracting Parties (47 plus the European Community) have heeded ICCAT's call (Table 5.2). The "very low level of compliance" by ICCAT members in shark data collection is decried by ICCAT's own scientific committee (SCRS) as "greatly hampering, when not completely impeding, the assessment of the status of exploited sharks" (ICCAT 2008b, p.166). Despite this criticism, aimed mainly at ICCAT fishing nations for their lack of cooperation rather than at the Commission itself, the

Table 5.2 Active resolutions, recommendations and conservation and management measures by regional fisheries management organisations for elasmobranchs (for RFMO action specific to finning bans, see Table 5.7).

Ocean	RFMO[a]	Year	Resolution/ Recommendation No.[b]	Title	Main actions
Atlantic	ICCAT	1995	Res. 95-2	Resolution by ICCAT on cooperation with the Food and Agriculture Organization of the United Nations with regard to study on the status of stocks and by-catches of shark species	• Urges members to collect species-specific data on biology, bycatch and trade in shark species and provide these data to FAO
Atlantic	ICCAT	2003	Res. 03-10	Resolution by ICCAT on the shark fishery	• Requests all members to submit data on their shark catches, effort by gear, landings and trade in shark products • Urges members to fully implement a NPOA
Atlantic	ICCAT	2004	Rec. 04-10	Recommendation by ICCAT concerning the conservation of sharks caught in association with fisheries managed by ICCAT	• Requires members to annually report shark catches and effort data • Requires full utilisation • Bans finning • Encourages live release • Commits to reassess shortfin mako and blue sharks by 2007 • Promotes research on gear selectivity and to ID nursery areas
Atlantic	ICCAT	2005	Rec. 05-05	Recommendation by ICCAT to amend Recommendation 04-10 concerning the conservation of sharks caught in association with fisheries managed by ICCAT	• Requires annual reporting of progress made toward implementation of Rec. 04-10 by members • Urges member action to reduce North Atlantic shortfin mako mortality
Atlantic	ICCAT	2006	Rec. 06-10	Supplementary recommendation by ICCAT concerning the conservation of sharks caught in association with fisheries managed by ICCAT	• Acknowledges little progress in quantity and quality of shark catch statistics • Reiterates call for current and historical shark data in preparation for blue and shortfin mako assessments in 2008
Atlantic	ICCAT	2007	Rec. 07-06	Supplemental recommendation by ICCAT concerning sharks	• Reiterates mandatory data reporting for sharks • Urges measures to reduce mortality of targeted porbeagle and shortfin mako • Encourages research into nursery areas and possible time and area closures • Plans to conduct porbeagle assessment no later than 2009
Atlantic	ICCAT	2008	Rec. 08-07	Recommendation by ICCAT on the conservation of bigeye thresher sharks (*Alopias superciliosus*) caught in association with fisheries managed by ICCAT	• Urges live release of bigeye thresher sharks, to the extent practicable • Requires bigeye shark catches and live releases be reported
Atlantic	NAFO	2009	Mgt. Measure Article 17	Conservation and management of sharks	• Requires reporting of all current and historical shark catches • Promotes full utilisation • Bans finning • Encourages live release • Promotes research on gear selectivity and to ID nursery areas
	SEAFO	2006	Conservation measure 04/06	Conservation measure 04/06 on the conservation of sharks caught in association with fisheries managed by SEAFO	• Same provisions as ICCAT Rec. 04-10 except does not include stock assessments
Mediterranean	GFCM	2005	GFCM/2005/3	Recommendation by ICCAT concerning the conservation of sharks caught in association with fisheries managed by ICCAT	• Same provisions as ICCAT Rec. 04-10
Mediterranean	GFCM	2006	GFCM/2006/8(B)	Recommendation by ICCAT to amend Recommendation [04-10] concerning the conservation of sharks caught in association with fisheries managed by ICCAT	• Same provisions as ICCAT Rec. 05-05
Indian	IOTC	2005	Res. 05/05	Concerning the conservation of sharks caught in association with fisheries managed by IOTC	• Requires members to report shark catches annually, including historical data • Plans to provide preliminary advice on stock status by 2006 • Requires full utilisation and live release • Bans finning • Promotes research on gear selectivity and to ID nursery areas
Indian	IOTC	2008	Res. 08/01	Mandatory statistical requirements for IOTC members and cooperating non-contracting parties (CPCs)	• Requires members to timely submit catches and effort data for all species, including commonly caught shark species and less common sharks, where possible
Indian	IOTC	2008	Res. 08/04	Concerning the recording of catch by longline fishing vessels in the IOTC area	• Mandates logbook reporting of catch by species per set, including for blue, porbeagle, mako and other sharks
Pacific	IATTC	2005	Res. C-05-03	Resolution on the conservation of sharks caught in association with fisheries in the Eastern Pacific Ocean	• Promotes NPOA development among members • Work with WCPFC to conduct shark population assessments • Promotes full utilisation • Bans finning • Encourages live release and gear-selectivity research • Requires species-specific reporting for sharks, including historical data

Table 5.2 *cont'd.* Active resolutions, recommendations and conservation and management measures by regional fisheries management organisations for elasmobranchs (for RFMO action specific to finning bans, see Table 5.7).

Ocean	RFMO[a]	Year	Resolution/ Recommendation No.[b]	Title	Main actions
Pacific	IATTC	2006	Res. C-04-05 (REV 2)	Consolidated resolution on bycatch	• Requires prompt release of sharks, rays and other non-target species • Promotes research into methods to avoid bycatch (time-area analyses), survival rates of released bycatch and techniques to facilitate live release • Urges members to "provide the required bycatch information as soon as possible"
Pacific	WCPFC	2008	Cons. & Mgt. Measure 2008-06 (replaces CMM-2006-05)	Conservation and management measure for sharks in the Western and Central Pacific Ocean	• Urges members to implement the IPOA and report back on progress • Requires annual reporting of catches and effort • Encourages live release and full utilisation • Bans finning for vessels of all sizes • Plans to provide preliminary advice on stock status of key sharks by 2010
Southern	CCAMLR	2006	32-18	Conservation of sharks	• Prohibits directed fishing of sharks • Live release of bycatch sharks

[a] ICCAT = International Commission for the Conservation of Atlantic Tunas; NAFO = North Atlantic Fisheries Organization; GFCM = General Fisheries Commission for the Mediterranean; SEAFO = South East Atlantic Fisheries Organization; IATTC = Inter-American Tropical Tuna Commission; WCPFC = Western and Central Pacific Fisheries Commission; IOTC = Indian Ocean Tuna Commission; CCAMLR = Commission for the Conservation of Antarctic Marine Living Resources.

[b] The weight of Recommendations and Resolutions varies by RFMO. For example, all ICCAT Recommendations are binding, whereas Resolutions are not.

ICCAT database (ICCAT 2009) currently provides the most complete picture of pelagic shark catches for any ocean basin. It is an improvement over the FAO shark database because it provides a greater degree of species-specific data and includes shark discards (Miyake 2001; Babcock and Nakano 2008). Furthermore, some CPCs (e.g. Spain[1]) declare larger catches to ICCAT and in their national fisheries statistics than they do to FAO.

The Pacific supports the largest industrial tuna fisheries in the world (Williams 1999). Given the preponderance of sharks in the "bycatch" of many Pacific longline and net fisheries, it is likely that the lower FAO-reported shark landings from the Pacific are a result of underreporting (see Table 5.1). The Oceanic Fisheries Program of the Secretariat of the Pacific Community has highlighted shark and ray bycatch in its tuna fisheries since the early 1990s, however, few bycatch data have been reported to species (Williams 1999; West *et al.* 2004). Efforts to improve Pacific shark catch data are moving forward under the auspices of two Pacific RFMOs, the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC) (Figure 5.1). IATTC established a bycatch working group in 1997 and has passed annual resolutions since 1999 to evaluate and reduce the bycatch and mortality of sharks, rays, and other non-target species (Table 5.2). The recently established (in 2004) WCPFC holds some promise for improving the understanding and management of shark catches in the wider Pacific. In 2008, it passed a management measure mandating that its CPCs report annual shark catches (including discards) and effort data (at the species level for blue, oceanic whitetip, mako, and thresher sharks) in preparation for a future stock assessment (Table 5.2) and recently amended its shark finning ban to apply to all vessels. There is no RFMO currently managing tuna fisheries in the North Pacific, although studies of shark bycatch in Japanese tuna fisheries in the region have been conducted (Matsunaga and Nakano 1996; Kleiber *et al.* 2001).

Reported elasmobranch landings from the Indian Ocean have been increasing, but record-keeping by fishing vessels in the region has been extremely poor or inaccurate (e.g. finned sharks are not recorded in logbooks), and catches are rarely reported to species (IOTC 2008a; Smale 2008). Prior to 2002, less than 10% of the database of the Indian Ocean Tuna Commission (IOTC) – the RFMO overseeing tuna fisheries in the region – was identified to species (Figure 5.1). To address growing concerns over the take of non-target species, IOTC established a Working Group on Ecosystems and Bycatch in 2002 and passed a resolution in 2005 (Res. 05/05) requiring that CPCs submit annual and historical data on shark catches in accordance with IOTC reporting procedures (Table 5.2). Because there was little improvement in the reporting rate, IOTC issued another resolution in 2008 (Res. 08/01) reiterating the mandatory reporting requirements on the most commonly caught shark species, and "where possible" for the less common sharks. Currently, observer coverage in most IOTC longline and purse-seine fisheries is very low and only one IOTC Contracting Party (Australia) is fully reporting nominal shark fisheries catch data (IOTC 2008b).

As the Red List assessments highlighted in this report indicate, time is running out for many pelagic shark and ray species targeted or taken as bycatch in high-seas fisheries. The urgent need for improved species-specific landings and discards is now widely acknowledged by RFMOs, as evidenced by their repeated resolutions requesting and/or requiring such data. Yet there is a clear lack of political will on the part of their CPCs to supply these data, which are key to improving the conservation status of oceanic elasmobranchs (Lack and Sant 2006; Hurry *et al.* 2008). Such wilful noncompliance, however, should not be rewarded with continued, unlimited fishing opportunities: Protection for Threatened species and precautionary catch limits for other pelagic elasmobranchs should be implemented and enforced until data allow for fine-tuned management for these species.

[1] Landings data for pelagic sharks reported by Spain to ICCAT far exceed that reported to FAO. For example, annual Atlantic blue shark landings reported by Spain to ICCAT in 2007 were ~26,000t, (ICCAT SCRS 2008) compared with global landings of all pelagic sharks reported to FAO, which totalled 23,737t. Furthermore, the Spanish Ministry has reported that Spain caught 39,000t of blue shark and a total catch of pelagic sharks of >45,000t in 2007 (Spanish Ministry of Fisheries 2008).

5.1.2 Global landings

FAO first began recording fisheries data in the 1950s. Global landings of chondrichthyans averaged 405,000t in the 1960s and 630,000t in the 1980s. Worldwide landings of sharks and rays increased steadily at a rate of 2% per year between 1988 and 2002 (Figure 5.2; FAO 2009). Average landings in the current decade have been 830,000t with a peak of about 900,000t in 2003 (Table 5.3; FAO 2009).

In 2007 (the latest available FAO data), 781,326t of chondrichthyans were reported (Table 5.3). These landings were fairly evenly split among the three main ocean basins: 38% from the Atlantic, 34% from the Pacific, and 28% from the Indian Ocean (Figure 5.2). Although the Atlantic has traditionally charted the largest share of the global catch (possibly due to higher reporting rates), fisheries taking elasmobranchs in the Indian Ocean have expanded at a greater rate since the 1960s, when they were responsible for about 20% of the reported elasmobranch landings (FAO 2009).

There were 21 major shark-fishing nations in 2007 (FAO 2009), defined as those reporting more than 10,000t of elasmobranch landings per year (Bonfil 1994). The top five – Indonesia, India, Taiwan, Spain, and Mexico – accounted for 42% of the 2007 landings (Table 5.3 and Figure 5.3). The major players have not changed much since 2002, except for a few countries that reported much lower elasmobranch landings: Maldives landings declined by 93% from a high of 11,522t in 2003 to only 800t in 2007, Sri Lanka's declined by 85% since 2003, and Pakistan's have dropped by 67% since 2002 (FAO 2009).

In 2007, pelagic sharks and rays accounted for about 10% (81,166t) of all elasmobranch landings reported to FAO (Table 5.1; FAO 2009). Almost 56% of these were from the Atlantic (36% were from the Pacific and 8% from the Indian Ocean), but this is likely an artefact of better species-level reporting. For example, pelagic shark landings from the Western Central Pacific – whose fisheries just recently came under the purview of the newly established WCPFC – were first reported to FAO in 2003, but by 2007 this region reported the highest landings (18,033t) of the 14 FAO regions reporting pelagic sharks. Globally, blue sharks *Prionace glauca* were the most commonly reported species, representing 56% of the pelagic shark catch (45,087t), followed by threshers *Alopias* spp. at 24% (19,197t). Only 5,924t of mako sharks *Isurus* spp. were reported (7%). Pelagic batoids, including mantas and devilrays *Manta birostris* and *Mobula* spp., were only reported as a group, with 3,310t. The top three countries, reporting 68% of the pelagic shark landings, were Spain (23,737t), Indonesia (18,950t), and Portugal (12,484t).

5.1.3 Atlantic Ocean and Mediterranean Sea

Pelagic sharks are caught in a variety of gear in this region, including longlines, gillnets, hand lines, rod and reel, trawls, trolls, and harpoons. According to FAO, chondrichthyan landings in the Atlantic declined steadily from a high of 343,428t in 1997 to a low of 278,685t in 2006, and then rose in 2007 to 296,150t (Figure 5.2; FAO 2009). About 15% of the 2007 Atlantic landings by weight were identified as pelagic sharks and rays (Table 5.1), but species-specific reporting remains notoriously poor, despite ICCAT's call for improved shark catch statistics (ICCAT 2008a, 2009b).

Most pelagic elasmobranch landings from the Atlantic and Mediterranean are taken in multispecies fisheries primarily targeting tunas and swordfish. For these high-seas fisheries, the notion of sharks as "bycatch" is becoming an anachronism. Some longline fleets from Canada, Portugal, Spain and the United States, for example, are increasingly pursuing shortfin mako *Isurus oxyrinchus* or blue sharks, or increasing their retention of these "secondary target" species when their traditional targets are less available (Campagna *et al.* 2004; Mejuto *et al.* 2006a; Hareide *et al.* 2007; Aires-da-Silva *et al.* 2008). In some regions of the Atlantic and Mediterranean, pelagic sharks have been targeted for decades. The best documented are those for porbeagle *Lamna nasus*, whose meat is highly prized. Despite evidence of population collapse (Campana *et al.* 2008), directed fishing for porbeagle sharks continues in the Atlantic (Jung 2008; see below). In 2007, France, Spain, and Canada reported porbeagle landings of 356t, 275t and 94t, respectively.

Figure 5.2 Reported elasmobranch catch from 1980 to 2007 by ocean (FAO 2009).

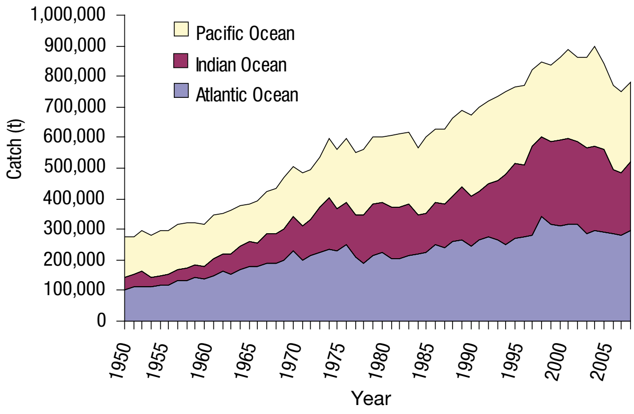


Figure 5.3 Reported elasmobranch catch from 1980 to 2007 for the top ten shark-fishing nations (in 2007; FAO 2009).

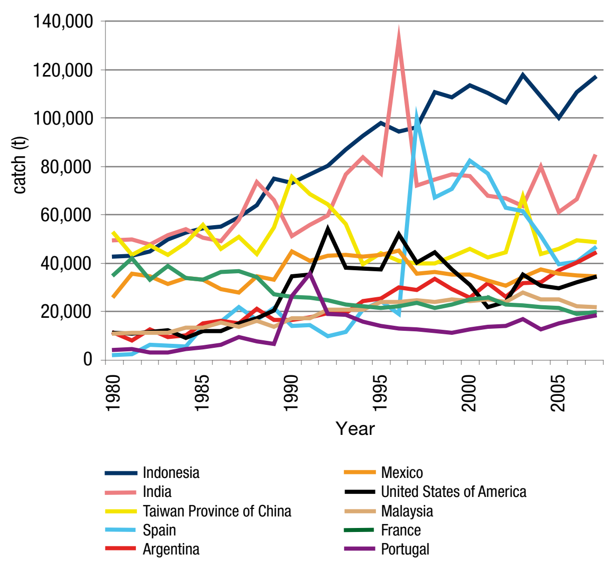


Table 5.3 Landings (t) of all elasmobranchs of the major shark-fishing nations from 1980 to 2007[a].

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Indonesia	42,855	43,174	45,019	49,877	52,764	54,536	55,087	58,887	63,982	74,907	73,272	76,828	80,159
India	49,656	50,012	47,758	51,442	54,000	50,470	49,094	57,850	73,495	66,281	51,230	55,925	59,730
Taiwan	52,260	43,656	47,244	43,459	48,491	55,768	45,994	50,756	43,899	54,790	75,731	68,632	64,512
Spain	2,052	2,392	6,303	6,116	5,704	13,718	15,771	22,022	16,682	21,413	14,163	14,578	9,946
Argentina	11,261	8,289	12,808	9,517	10,162	15,267	16,113	15,342	21,141	16,513	16,687	17,628	19,320
Mexico	26,551	35,690	34,641	31,433	34,113	33,310	29,397	27,903	34,610	33,114	44,880	41,169	43,267
USA	11,221	10,996	11,708	12,393	9,338	11,906	12,092	15,204	17,169	20,445	34,576	35,510	54,093
Malaysia	10,855	11,452	11,165	11,230	13,512	13,328	15,388	13,877	16,194	13,678	17,360	17,161	20,771
France	35,267	42,091	33,359	39,053	33,961	33,146	36,375	36,634	34,400	27,298	26,310	25,895	24,705
Portugal	4,095	4,499	3,114	3,068	4,423	5,306	6,233	9,376	7,850	6,732	26,563	35,675	18,991
New Zealand	6,590	7,332	8,025	9,721	10,834	10,355	7,566	8,496	11,234	9,708	10,108	9,809	9,617
Japan	54,298	49,041	47,580	43,698	45,682	39,435	44,412	42,877	28,616	33,904	32,103	33,362	38,466
Brazil	23,321	25,848	31,259	29,123	25,229	29,604	25,729	27,761	24,263	24,872	24,690	23,730	20,500
Thailand	9,456	10,189	9,550	8,470	8,093	9,226	13,522	14,359	11,438	11,211	10,950	11,056	7,576
Pakistan	64,975	62,898	68,802	18,243	20,852	29,502	27,366	28,634	30,324	27,633	40,043	45,098	45,745
Nigeria	21,476	11,940	14,002	12,000	13,000	14,156	9,334	9,494	9,494	6,942	8,402	7,229	8,912
Iran[b]	*	*	*	*	*	*	*	*	*	*	*	*	*
Yemen	1,772	1,360	1,180	798	448	1,407	1,030	915	704	1,329	639	2,749	6,067
Korea, Rep. of	18,029	21,521	20,450	22,294	20,533	22,888	20,954	16,172	21,682	20,847	15,721	21,400	12,250
Venezuela	5,041	5,408	5,387	6,010	6,889	6,073	7,826	6,997	8,879	7,049	6,762	6,811	7,970
Canada	7,809	3,831	3,146	3,505	3,012	3,186	3,724	4,746	6,241	3,464	5,835	5,348	4,987
Other	65,401	62,863	64,807	73,689	78,212	78,979	77,705	83,559	70,762	63,623	58,015	62,206	69,565
Total	**608,938**	**612,055**	**619,497**	**568,146**	**601,983**	**626,483**	**629,360**	**663,270**	**689,371**	**675,122**	**699,000**	**720,949**	**736,763**

[a] Data are from the FAO database (FAO 2009); major shark-fishing nations are defined as those landing >10,000t in 2007.
[b]* = no FAO landings reported from Iran in these years.

ICCAT began collating Atlantic shark catch data by Contracting Parties in 1995. At least 26 fishing nations reported elasmobranch landings to ICCAT in 2007 (ICCAT 2009). The top producers that year were (in order) Spain, Portugal, Japan, Brazil and Taiwan. Argentina – which is not a member of ICCAT – posted the largest annual elasmobranch landings in the Atlantic since 2005 (44,089t in 2007), but these are almost exclusively non-pelagic rays (FAO 2009). By contrast, Spain's Atlantic landings have long been dominated by blue sharks; this species accounted for 90% of shark bycatch in 2007, and averaged just below 25,000t per year between 2000 and 2007 (ICCAT 2009). Furthermore, China's tuna longline fleet in the Atlantic has expanded from four vessels in the early 1990s to 37–38 vessels more recently, and takes significant numbers of poorly documented catches of sharks and rays (ICCAT 2008a).

Spain has been among the world's top five elasmobranch-fishing nations over the past decade (FAO 2009; Table 5.3), with distant-water pelagic fleets in all major oceans. Its shark catches are also relatively well documented, partly because a large portion of its bycatch, including blue sharks, is retained instead of discarded (Mejuto *et al.* 2006b). In the Spanish surface longline fleet targeting primarily swordfish in the Atlantic, pelagic sharks accounted for 70% of the total landed catch by weight from 2000 to 2004 and 93% of the "bycatch." Of the shark catch, almost 87% was blue sharks and 10% was shortfin mako (Mejuto *et al.* 2006a).

In the Mediterranean, there are no large-scale fisheries targeting pelagic sharks and rays, but these species are taken as bycatch in surface longline fisheries (blue shark, pelagic stingray *Pteroplatytrygon violacea*, thresher *Alopias vulpinus*, shortfin mako, porbeagle, smooth hammerhead *Sphyrna zygaena*, sixgill *Hexanchus griseus*, requiem sharks *Carcharhinus* spp. and devilray), various gillnet fisheries (blue, thresher and basking sharks *Cetorhinus maximus*), and large driftnet fisheries (blue, thresher, shortfin mako, porbeagle, requiem sharks, basking shark, hammerheads *Sphyrna* spp., devilray and pelagic stingray; see Hareide *et al.* 2007). Large-scale drift netting is prohibited by European Union Member States in the Mediterranean, but this ban is not well enforced and drift netting is still practiced illegally and by other fishing nations.

More detailed discussion of fisheries taking pelagic elasmobranchs in the Atlantic and Mediterranean can be found in Hareide *et al.* (2007), Camhi *et al.* (2008b, 2008c), Gibson *et al.* (2008) and Hazin *et al.* (2008), as well as in ICCAT's annual Collective Volume of Scientific Papers (available at www.iccat.int).

5.1.4 Pacific Ocean

The Pacific supports the world's largest industrial tuna fleet (Joseph 2003). Pelagic sharks are taken in large numbers in longline fisheries targeting tunas, swordfish, and marlin, but there is also a significant shark bycatch (especially of silky *Carcharhinus falciformis* and oceanic whitetip *Carcharhinus longimanus* sharks) in tuna purse-seine fisheries (Bailey *et al.* 1996; Stevens 2000).

FAO reported about 7.3 million tonnes of chondrichthyan landings from the Pacific during 1980 to 2007 (FAO 2009). In 2007, landings were 262,762t, down from a peak of 327,462t in 2003 (Figure 5.2). Pacific landings were reported by 33 countries, with Indonesia (81,305t), Taiwan (40,949t), Mexico (25,760t), New Zealand (17,403t), Malaysia (15,519t) and Japan (13,350t) reporting more than 10,000t that year. Just over 11% of the 2007 landings (29,612t) were recorded as pelagic species or species groups (Table 5.1). As a group, thresher sharks (*Alopias* spp.) top the reported landings at 15,049t, the vast majority reported by Indonesia, along with 3,310t of "mantas, devilrays nei" (Table 5.1). Reported FAO landings for blue sharks have been steadily increasing since the early 1990s, with 2007 the highest on record: Spain, Mexico, and New Zealand together accounted for 77% of the 5,538t blue sharks from the Pacific. That same year, Costa Rica reported the highest silky shark landings (1,049t), and Chile took the most shortfin mako (393t).

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
87,138	92,776	98,098	94,396	95,998	110,788	108,393	113,626	110,311	106,398	117,559	108,944	100,037	110,528	116,820
76,604	83,689	77,078	132,160	71,991	74,704	76,802	76,057	67,971	66,923	63,771	79,825	61,056	66,367	84,093
56,080	39,457	44,064	41,158	40,089	40,025	42,933	45,923	42,355	44,412	67,432	43,797	45,945	49,375	48,707
11,572	20,827	24,419	19,062	99,638	67,311	70,800	82,349	77,103	62,996	61,595	51,261	39,485	40,501	46,187
19,364	24,327	25,332	30,163	29,034	33,511	29,485	25,750	31,784	26,251	31,691	32,039	37,161	40,323	44,112
43,603	42,922	43,470	45,205	35,665	36,532	35,239	35,260	32,718	30,888	34,429	37,540	35,832	34,976	34,638
38,074	37,764	37,554	52,043	40,425	44,560	37,559	30,935	22,072	24,076	35,372	30,732	29,793	32,004	34,287
20,898	20,889	24,144	24,007	24,765	23,943	25,125	24,521	25,209	24,167	27,948	25,053	25,094	22,240	21,764
23,064	22,149	21,613	22,447	23,645	21,524	22,941	24,952	25,799	23,136	22,755	21,800	21,477	19,082	19,622
18,690	15,733	14,132	13,138	12,577	12,039	11,343	12,783	13,855	14,017	16,999	12,765	15,360	16,856	18,464
14,171	12,717	17,766	14,293	22,619	15,840	19,811	17,718	19,796	21,238	18,459	16,647	18,032	16,783	17,409
38,539	34,317	31,146	24,206	29,397	33,665	33,034	31,873	27,696	32,879	25,537	23,475	25,930	22,795	17,257
18,300	15,800	14,881	14,894	14,941	17,269	18,553	21,585	20,406	21,736	20,842	20,041	23,749	18,389	17,233
8,312	13,229	15,281	17,753	17,969	16,026	22,397	24,689	24,278	30,208	32,540	27,646	20,745	16,215	16,925
46,405	50,177	49,964	51,432	48,429	54,497	54,958	51,170	49,863	49,904	33,248	30,687	22,877	20,127	16,284
5,849	9,053	6,471	8,388	8,821	13,969	15,373	13,238	14,626	13,449	15,179	13,560	13,882	14,444	15,292
*	*	*	*	15,566	11,661	19,185	12,155	11,635	10,619	15,963	18,318	17,443	15,015	13,187
6,537	6,455	4,636	4,878	5,000	5,800	5,600	5,000	7,100	8,600	11,000	12,000	12,800	12,593	12,387
20,342	17,845	17,938	15,598	15,900	10,305	16,398	15,394	11,131	11,961	12,345	12,265	10,110	10,841	11,374
7,849	8,650	9,918	8,791	7,896	6,708	5,260	5,491	4,718	7,619	11,294	11,294	11,294	11,294	11,294
3,791	11,398	12,627	10,759	10,015	8,646	13,979	12,899	13,718	13,980	12,366	12,806	12,732	8,783	10,258
67,828	73,820	66,145	62,960	61,722	56,563	57,749	61,921	64,656	75,976	65,133	65,228	64,082	51,515	51,130
751,470	**766,841**	**772,705**	**822,742**	**845,697**	**836,339**	**863,244**	**889,117**	**859,996**	**863,433**	**899,927**	**841,277**	**771,604**	**752,131**	**781,326**

As in other oceans, analyses of specific fisheries reinforce concerns that the FAO database grossly underestimates catches of pelagic sharks in the Pacific. For example, incorporating species-specific catch rates, fishing effort and average shark weights, Stevens (2000) estimated that 45,100t to 232,400t of oceanic whitetip were caught in Pacific longline fisheries in 1994 alone. At the same time, Pacific landings for this species have never been reported to FAO. Stevens (2000) also estimated a catch of about 137,800t of blue, 72,400t of silky, and 4,100t of shortfin mako sharks on Pacific longlines. The two RFMOs in the region (WCPFC and IATTC) are making an effort to improve the quantity and quality of shark catch data, but success depends on better reporting by relevant CPCs.

A recent analysis of catches from the Spanish surface longline fleet targeting swordfish in the Pacific found that 43% of the total catch consisted of "bycatch" species, and that pelagic sharks made up almost 96% (by weight) of this landed bycatch (Mejuto *et al.* 2007). Of the shark "bycatch," blue sharks accounted for 59% by weight and numbers; shortfin mako was the second most prevalent species with about 39% by number. Mejuto *et al.* (2007) noted that blue sharks were being increasingly retained and that shark discards were now nearly nil in this fishery.

5.1.5 Indian Ocean

The Indian Ocean borders on the top two shark-fishing nations in the world, Indonesia and India, which together have accounted for 22% of the total FAO-reported chondrichthyan global landings since 2000, and almost 26% of the 2007 landings from all oceans (FAO 2009). Landings of these species have been steadily rising in both the Eastern and Western Indian Ocean since the 1950s, although there has been a slight decline since 2004 (Figure 5.2). Some of this increase is probably due to improved reporting rates (Anderson and Waheed 1999; Smale 2008), yet even less is known about the nature of the pelagic shark and ray catch here than in the Atlantic and Pacific. Only eight of the 33 countries taking chondrichthyans in the Indian Ocean in 2007 reported landings of pelagic species, and these accounted for less than 3% of the total chondrichthyan catch (6,193t) (Table 5.1; FAO 2009).

FAO reported 5,882,926t of elasmobranch landings from the Indian Ocean during the period 1980–2007. In 2007, reported landings were 211,971t. India (84,093t), Indonesia (35,515t), Pakistan (16,284t), Iran (13,187t) and Yemen (12,387t) accounted for 73% of these landings. Little is known about the species composition of these catches. India's and Yemen's data were amalgamated simply as "sharks, rays, skates, *etc.* nei," while Indonesia reported its landings to species groups only (e.g. "dogfish sharks nei" and "requiem sharks nei").

A better understanding of the elasmobranch catch from the Indian Ocean region can be gleaned from fishery research efforts (see Fowler *et al.* 2002; Mejuto *et al.* 2006b). At least 15 species of sharks are caught in open ocean fisheries in the Indian Ocean, with blue and silky sharks probably the most prevalent species (Smale 2008). In the Maldives, sharks are targeted in the longline shark fishery and taken as bycatch in tuna fisheries (Anderson and Waheed 1999). Silky sharks dominated the catch in both fisheries, accounting for about 80% by number of the directed shark catch. Oceanic whitetip has been the second most important shark species, followed by blue, shortfin mako, threshers and hammerheads (Anderson and Hafiz 2002). The same species, along with crocodile *Pseudocarcharias kamoharai* and whale *Rhincodon typus* sharks, are taken in the drift gillnet and/or longline fisheries of Sri Lanka (Joseph 1999), once a major shark-fishing nation, whose reported landings have rapidly declined since 2003 (FAO 2009). Silky sharks dominate (by weight and numbers) Sri Lanka's coastal and offshore fisheries. In February 2009, the Maldives shut down their reef shark fishery, and in February 2010 all shark exports from the country will be banned (C. Anderson pers. comm.).

Analyses of catches from the Spanish longline fleet, which has been targeting swordfish in the Indian Ocean since 1993, provide some recent insight into the sharks taken incidentally in this region. Between then and 2004, 86% of the overall bycatch by weight were large pelagic sharks, which together accounted for 47% of the total landed biomass in that fishery (Mejuto *et al.* 2006b). About 71% of the shark bycatch was of blue sharks, with shortfin mako being the second most prevalent "bycatch" species by weight (Garcia-Cortés and Mejuto 2005).

5.1.6 Recreational fisheries

In some parts of the world, pelagic sharks – especially shortfin mako, blue, porbeagle and thresher sharks – are highly sought by anglers. The countries that support significant recreational shark fisheries include Australia, New Zealand, the United States and the United Kingdom (Babcock 2008). In 1979, the United States established the Marine Recreational Fishery Statistics Survey to monitor recreational landings by anglers. Pelagic sharks (especially blue and shortfin mako) are particularly targeted by anglers off the US Mid-Atlantic and New England states. Just to the north, Canada's Atlantic recreational shark fishery is catch-and-release only. Tag-and-release of blue sharks by US anglers and scientists has provided valuable information about movements of this species throughout the Atlantic (Kohler and Turner 2008). Although the International Game Fish Association keeps records of the largest fish caught of each species, global estimates of recreational catches of pelagic sharks do not exist and there is no international repository for recreational catch data similar to that collected for commercial fisheries by FAO. Relative to the commercial sector, mortality of pelagic elasmobranchs from recreational fishing is minor globally, but this is not always the case locally. For example, significantly more thresher sharks (*Alopias* spp.) are landed by US anglers than by the US commercial pelagic longline fleet in the Atlantic (Cortés 2008b), and kill tournaments for sharks are on the rise after two decades in decline (B. Hueter pers. comm.). Angling can take a toll on shark populations, especially depleted ones, and therefore should be carefully monitored (Babcock 2008) and managed.

5.2 Commercially important pelagic sharks and rays

This section highlights the fisheries and use of some of the commercially important pelagic shark and ray species. (The literature cited below also offers a wealth of additional information.) In general, most of these species have experienced declines in catch rates of 50–90% over the past few decades (Camhi 2008). Much less is known about the non-commercial species that are taken as bycatch in the same and other fisheries, yet they are potentially no less vulnerable. Indeed, some of these species, by nature of their "invisible" status in the catch, may be at even greater risk of endangerment, as indicated in the Red List assessment section (Section 8).

5.2.1 Whale shark *Rhincodon typus*

Whale sharks *Rhincodon typus* are circumglobal in tropical and warm temperate seas, and long-distance migrants that range from oceanic to coastal waters (Compagno 2001). It is the world's largest fish and one of three filter-feeding sharks. Local, near-shore aggregations of whale sharks occur in association with plankton blooms, spawning events and schools of small bait fish, and are known to occur in waters off Australia, Belize, the Galapagos, India, Kenya, the Maldives, Mexico, the Philippines, the Seychelles and South Africa (Stevens 2007). Whale sharks are also found in association with schools of tuna (Anderson and Ahmed 1993).

There are no catch data for whale sharks in the FAO database (FAO 2009) and relatively little is published in the primary literature concerning their fisheries (Stevens 2007). Although scarce in most waters, their aggregations make whale sharks especially easy targets for net and harpoon fisheries. Unlike other pelagic sharks that are taken in very high numbers in large-scale fisheries, whale sharks are most often targeted in small fisheries where catches rarely exceed a few hundred individuals in a given year, and more often are much lower. For example, fewer than 10 whale sharks were known to be landed or finned at sea in Indonesia from 2001 to 2005, although it is likely that additional catches went undocumented (White and Cavanagh 2007). Estimated landings from the Taiwanese whale shark fishery in 1996 were 272 individuals (Chen *et al.* 2002), and 142 individuals were landed from 11 sites in the Philippines in 1997 (Alava *et al.* 2002). Other known target fisheries for meat and fins have taken place in China, Malaysia, the Maldives, Pakistan and Senegal. Whale sharks are also taken incidentally in gillnet, purse-seine and trap fisheries for tuna (Newman *et al.* 2002).

The whale shark is known as the "tofu shark" for its delicate, white flesh, a valued delicacy in Taiwan (Table 5.4; Rose 1996; Chen *et al.* 2002). Growing demand and high prices paid for whale shark meat in Taiwan and Hong Kong have driven fisheries in India (Hanfee 2001) and the Philippines (Alava *et al.* 2002). Although its huge fins are known to enter into the international fin trade, they do not figure prominently in the Hong Kong fin market (Clarke *et al.* 2006b) and are of value largely because of their size rather than their quality (Rose 1996; Chen *et al.* 2002). Historically, this species was targeted in the Maldives and in India during the 1980s and 1990s for its liver oil, which has been used traditionally to waterproof wooden boats (Anderson and Ahmed 1993). The gills, skin, cartilage and jaws are also used and enter into trade (Alava *et al.* 2002).

Relatively little is known about the biology, ecology or life history of the whale shark (Colman 1997; Stevens 2007), but it appears to be highly vulnerable to overfishing. Even traditional, localised fisheries taking only tens of individual whale sharks have proven unsustainable over the short term. Examples of declining catches despite increasing prices paid for meat and fins have come from India (Hanfee 2001), the Philippines (Alava *et al.* 2002) and Taiwan (Chen *et al.* 2002).

The whale shark has been the recipient of more species-specific protection and management than any other shark, and was the subject of its own international conference in 2005 (Irving and Keesing 2007). In 1999, *Rhincodon typus* was listed in Appendix II of CMS to encourage regional conservation efforts and was added to CITES Appendix II in 2002 to ensure that international trade in whale shark products does not have a detrimental impact on the survival of the species (Table 5.5; Section 5.5.5). At least 11 countries protect whale sharks within their EEZs or specific reserves (Table 5.5). Taiwan, one of the biggest markets for whale shark meat, recently put domestic limits on the number that could be fished each year, and since

July 2007 has implemented a complete ban on whale shark fishing, selling and trade. A complete ban on the take of whale sharks is under consideration in New Zealand, where it is still legal to land this species when taken as bycatch (targeting is prohibited; New Zealand Ministry of Fisheries 2008).

In many places where predictable whale shark aggregations occur (e.g. Australia, the Maldives, Mexico, the Philippines, the Seychelles), ecotourism has become an economically viable, if not an exceptionally lucrative, alternative to whale shark fishing (Newman *et al.* 2002; Norman 2005). In Belize, for example, it is estimated that each whale shark generates almost US$35,000 in ecotourism annually, or more than US$6 million over its 60-year lifetime (Graham 2004). On a global basis, whale shark tourism may be conservatively worth US$47.5 million annually (Graham 2004). Income generated can help support protection measures. Efforts are under way to ensure that this non-consumptive use is not detrimental to the species (Rowat and Engelhardt 2007).

Domestic protection alone, however, may not adequately protect this species from further declines: Whale sharks undertake very long migrations (Norman 2005) and recent genetic studies indicate interbreeding among populations, especially across the Pacific and Indian Oceans (Castro *et al.* 2007; Schmidt *et al.* 2009). This argues strongly for regional and international action, as intended by the CMS listing, so that whale shark protection in one part of their range is not undermined by fishing or other threats elsewhere (Rowat 2007). Established finning bans are also limited in their ability to curtail fishing mortality because whale sharks are taken largely for their meat.

No international catch limits have been established for this Vulnerable species, which is included in Annex I of UNCLOS (Table 5.6). IOTC ranked the whale shark as its top shark species of concern based on its life-history traits, international protection efforts and its vulnerability to fisheries in the region (IOTC 2007), but no action has been taken on its behalf nor is it mentioned in the 2008 report of IOTC's Working Party on Ecosystems and Bycatch (IOTC 2008). No other RFMOs have taken action on this pelagic species.

5.2.2 Thresher sharks *Alopias* spp.

There are three species of thresher shark in the Family Alopiidae: pelagic thresher *Alopias pelagicus*, bigeye thresher *A. superciliosus* and thresher shark *A. vulpinus*. The latter two occur in all oceans, but the pelagic thresher is restricted to the Indian and Pacific Oceans (Compagno 2001). All three are highly migratory and found in both coastal and oceanic waters in temperate and tropical seas. *Alopias vulpinus* tends to be more temperate and the most coastal of the three, while *A. pelagicus* is more oceanic and the most tropical. *Alopias vulpinus* and *A. pelagicus* are often misidentified and confused with each other in catch data, but *A. superciliosus* is readily identified by its large eyes (Smith *et al.* 2008). Threshers are taken on longlines, in fixed bottom and pelagic gillnets and in trawls (Maguire *et al.* 2006). In some places (e.g. US, New Zealand, UK, South Africa), threshers are a prized game fish.

Thresher sharks provide a high-quality meat: *A. vulpinus* is a preferred species, while the meat of the other two is not as highly regarded (Rose 1996). Although their fins are not as highly valued for shark fin soup as some other pelagic species, threshers collectively account for 2.3% of the identified shark fins in the Hong Kong fin market (Clarke *et al.* 2006b). This translates to 0.4 million to 3.9 million threshers that may enter the global fin trade each year (Clarke *et al.* 2006a).

Reliable, species-specific catch and discard data for thresher sharks are not available. The three thresher sharks, however, are reported by species and in the amalgamated group "thresher sharks nei" in the FAO database (FAO 2009). In 2007, a total of 19,197t of threshers were reported to FAO as landings. The majority of these records were not differentiated to species and came from the Pacific, particularly Indonesia (14,700t) (Table 5.1). When compared to shark fin trade statistics, which suggest that international fin trade represents a biomass of about 60,000t annually, it is clear that these reported landings underestimate the actual mortality of thresher sharks (Clarke *et al.* 2006a). Thresher liver oil is considered poor quality but usable; their skins are used for leather (Rose 1996).

Threshers are listed in Annex I of UNCLOS (Table 5.6) and therefore should be subject to its provisions for international fisheries management. In reality, few management measures have been adopted for these species in international or national waters (Table 5.5). The retention of bigeye thresher is prohibited in the US Atlantic and Gulf of Mexico. If enforced, finning bans in most international and some domestic waters should help reduce the number of threshers that are killed just for their fins. Survival of bigeye thresher caught on longlines is moderately high. In the Japanese tuna longline fishery in the Atlantic, 60–71% of the bigeye threshers were alive at gear retrieval (Semba *et al.* 2008). This suggests that mandatory release of threshers taken as bycatch would be good tool to improve their conservation status.

A recent ecological risk assessment found the bigeye thresher in the Atlantic to be the pelagic shark with the highest risk of overexploitation (Simpfendorfer *et al.* 2008). It may be particularly susceptible to longline and gillnet fisheries because it ranges through waters that are poorly regulated and monitored. There are few population trend analyses for threshers. Baum *et al.* (2003), however, estimated that thresher sharks (*A. vulpinus* and *A. superciliosus* combined) had declined by 80% from 1986 to 2000 in the Northwest Atlantic.

Although targeted commercial fisheries for thresher sharks are uncommon, these sharks are often retained when caught. Thresher *A. vulpinus* and bigeye thresher *A. superciliosus* (which is the more common of the two in the Northwest Atlantic) are taken as bycatch in the US commercial longline fishery in the Atlantic and Pacific (Hanan *et al.* 1993; Camhi 1999) and are targeted by recreational fishers in the Atlantic and Gulf of Mexico. Total annual thresher (*Alopias* spp.) landings in the Atlantic and Gulf since 1981 peaked in 2006 with 14,000 fish landed, 98% of which were by anglers (Cortés 2008b). *Alopias* spp. are taken in the bycatch of fisheries of many nations bordering the Northeast Atlantic, including Portugal (13–80t/yr), France (10–20t/yr since the 1990s) and the UK (4–12t/yr since 2000) (M. Clarke *et al.* 2008). Both threshers are a bycatch of the swordfish and other pelagic fisheries and artisanal net fisheries in the Mediterranean Sea, but their catch is poorly documented (Cavanagh and Gibson 2007). An illegal Moroccan large-scale driftnet fishery may be targeting sharks (especially threshers) near the Strait of Gibraltar (Tudela *et al.* 2005).

Information on thresher sharks from the Southwest Atlantic is limited. Thresher shark catches in South Atlantic longline fisheries have always been low (Hazin *et al.* 2007). Both *A. superciliosus* and *A. vulpinus* are caught in the Brazil Santos longline fishery, with the former strongly dominating the thresher catch (Arfelli and Amorim 1994).

In the Pacific, a targeted drift gillnet fishery for *A. vulpinus* operated off California from 1977 to 1990, and essentially removed all subadults from the population. Catch rate data from this fishery underscore the vulnerability of this species, even when under managed exploitation: Decades after targeted fishing stopped, the population is still recovering; thresher sharks are still taken as bycatch in the California swordfish fishery (Hanan *et al.* 1993). All three thresher species are taken in the artisanal, pelagic longline and gillnet fisheries targeting pelagic sharks off Mexico's Pacific Coast (Sosa-Nishizaki *et al.* 2008). *A. pelagicus* is caught by shark fishermen in large numbers in the Gulf of California, the Pacific coast of Mexico, the Red Sea and the Gulf of Aden.

All three thresher species occur in the Indian Ocean, where they are taken in target, bycatch and recreational fisheries, especially in the Eastern Indian Ocean. Together they accounted for about 1% of IOTC reported shark landings (about 650t/yr) from 2000 to 2002 (Smale 2008).

5.2.3 Basking shark *Cetorhinus maximus*

Basking sharks *Cetorhinus maximus* are widely distributed in coastal and continental shelf waters in temperate seas, except the Indian Ocean (Compagno 2001). They were targeted for centuries to supply liver oil, leather, meat and fishmeal (Table 5.4). Most fisheries for this species have undergone classic boom-and-bust cycles, with very high yields followed by population collapse. For example, a basking shark fishery at Achill Island, Ireland, took up to 1,800 sharks per year at its peak in the early 1950s, but landings had declined by more than 90% by the early 1970s. More than 30 years later, there are still few basking shark sightings in the area, suggesting that this population has yet to recover from overfishing that occurred more than a half century earlier. A similar pattern of overexploitation took place in the Japanese basking shark fishery during the 1960s and 1970s (Fowler *et al.* 2005). French landings from the Atlantic and Mediterranean have declined from a high of almost 4,300t in 1999 to 739t in 2006 (Poisson and Séret 2008).

Although the demand for liver oil from basking sharks subsided as markets shifted to synthetic oils, the very large and valuable fins of this giant shark still make them vulnerable to overexploitation for international trade. Trade in all basking shark parts should now be regulated and monitored, as the species is one of the few sharks listed by the Convention on International Trade in Endangered Species (CITES; see Section 5.5.5). Its 2002 listing in CITES Appendix II is intended to ensure that international trade in basking shark products is not detrimental to the survival of the species. In addition, a 2005 listing in Appendix I of the Convention on Migratory Species (CMS) has led to legal protection by many range States that are Party to the CMS treaty, while cooperative management should be introduced under its listing in CMS Appendix II (see Section 5.5.4). The species is also listed in Annex I of UNCLOS (Section 5.5.1). Given these safeguards and the depleted status of formerly exploited stocks, there is less scope for basking shark fishing or trade to take place today (Table 5.5).

Target fishing for basking sharks in the Northeast Atlantic ceased in 2006, in line with ICES advice and the CMS Appendix I listing, when retention of the species was legally prohibited throughout the European Union and Norway closed its basking shark fishery. The basking shark is also listed in the Appendices and Annexes of several regional Conventions (Barcelona, Bern and OSPAR). Bycatch and illegal landing of this species does continue in some coastal waters, such as in the Celtic Sea, off the Isle of Man and in the Mediterranean (Fowler *et al. 2005;* Clarke *et al.* 2008), including two fish within a week in March 2009 in Greece. ICES (2008) recently reaffirmed that basking sharks in Northeast Atlantic waters were still depleted and underscored their recommendation for a prohibition

Table 5.4 Pelagic elasmobranch species in the international trade in meat, fins, skin (for leather), liver oil and other products[a] (adapted from Camhi *et al.* 2008b).

Species	Common name	Meat	Fins[b]	Skin	Liver oil	Other[e]
Alopias pelagicus	Pelagic thresher	✔	✔ (2.3%)[c]	✔		
Alopias superciliosus	Bigeye thresher	✔	✔	✔		
Alopias vulpinus	Thresher	✔+	✔	✔	✔	
Carcharhinus falciformis	Silky shark		✔ (3.5%)		✔	
Carcharhinus longimanus	Oceanic whitetip shark		✔ (1.8%)	✔	✔	
Carcharodon carcharias	Great white shark		✔	✔	✔	teeth, jaws
Cetorhinus maximus	Basking shark		✔	✔	✔+	
Pteroplatytrygon violacea	Pelagic stingray					
Isurus oxyrinchus	Shortfin mako	✔+	✔ (2.7%)	✔+	✔	teeth, jaws
Isurus paucus	Longfin mako		✔		✔+	
Lamna ditropis	Salmon shark	✔	✔		✔	
Lamna nasus	Porbeagle shark	✔+	✔	✔+	✔	
Mobula spp.	Devilrays	✔				gills
Prionace glauca	Blue shark	✔	✔ (17.3%)	✔		
Rhincodon typus	Whale shark	✔	✔	✔	✔	gills
Sphyrna spp.	Hammerheads	✔	✔ (5.9%)[d]	✔+	✔+	

[a] ✔: frequently used; ✔+: preferred species, can vary regionally (from Rose 1996; Clarke *et al.* 2005).
[b] Percentage of world trade (in parentheses) is based on reported proportions in the Hong Kong shark fin market (Clarke *et al.* 2006b).
[c] Percentage for all three thresher shark species.
[d] Percentage includes three hammerhead species: smooth *Sphyrna zygaena*, scalloped *Sphyrna lewini* and great *Sphyrna mokarran.*
[e] These are the preferred species for the listed products: CITES 2002; Rose 1996; White *et al.* 2006.

Table 5.5 International and domestic management and protections for commercially important pelagic sharks and rays (adapted from Camhi *et al.* 2008[a]; see Table 5.7 for domestic and regional finning bans).

Species	Common name	Global Red List Category	UNCLOS	CITES	CMS	RFMO focus[a]	Barcelona Convention[b]	Domestic protection[c]	Domestic and regional catch limits[g]
Alopias pelagicus	Pelagic thresher	VU	✔	-	-	-	-	-	-
Alopias superciliosus	Bigeye thresher	VU	✔	-	-	ERA	-	US Atlantic and GOM[d]	-
Alopias vulpinus	Thresher	VU	✔	-	-	ERA	-	-	US Atlantic and GOM[h]
Carcharhinus falciformis	Silky shark	NT	✔	-	-	ERA	-	-	US Atlantic and GOM[h]
Carcharhinus longimanus	Oceanic whitetip shark	VU	✔	-	-	ERA	-	-	US Atlantic and GOM[h]
Carcharodon carcharias	Great white shark	VU	✔	App II	App I, II	-	Annex II	Australia[e]; Croatia; EU; Maldives; Malta; Mexico; Montenegro; Namibia; New Zealand; South Africa; all US waters except in the Western Pacific[d]	-
Cetorhinus maximus	Basking shark	VU	✔	App II	App I, II	-	Annex II	Australia[e]; Croatia; EU; Isle of Man; Malta; South Africa commercial; Turkey; UK; US Atlantic & GOM[d]; no targeted fishing in New Zealand	South Africa recreational bag limit
Isurus oxyrinchus	Shortfin mako	VU	✔		App II	PA; ERA	Annex III	-	New Zealand; US Atlantic and GOM[h]
Isurus paucus	Longfin mako	VU	✔		App II	ERA	-	US Atlantic & GOM[d]	-
Lamna ditropis	Salmon shark	LC	✔		-	-	-	Alaska (no comm. fishing)	Alaska recreational bag limit (2/yr)
Lamna nasus	Porbeagle shark	VU	✔	Proposed (2007)	App II	PA; ERA	Annex III	Canada closed small mating ground south of Newfoundland; Montenegro; Sweden[f]	Canada Atlantic; EU; New Zealand; US Atlantic and GOM[h]
Mobula spp.	Devilrays	EN (*Mobula mobular* only)		-	-	-	Annex II (*M. mobular* only)	*Manta birostris*: protected in the Philippines and under consideration for protection (in 2009) in Hawaii and New Zealand; *Mobula mobular* in Malta and Croatia; ray meat and skin export prohibited from Maldives; *M. japonica* under consideration for protection in New Zealand	-
Prionace glauca	Blue shark	NT	✔	-	-	PA; ERA	Annex III	-	New Zealand; US Atlantic and GOM[h]
Pteroplatytrygon violacea	Pelagic stingray	LC		-	-	ERA	-	-	-
Rhincodon typus	Whale shark	VU	✔	App II	App II	-	-	Australia[e]; Honduras; India; Malaysia; Maldives; Mexico; under consideration for protection in New Zealand; Philippines; Seychelles; South Africa longline fishery; Taiwan; Thailand; US Atlantic & GOM[d]	-
Sphyrna lewini	Scalloped hammerhead	EN	✔	-	-	ERA	-	-	US Atlantic and GOM[h]
Sphyrna mokarran	Great hammerhead	EN	✔	-	-	-		-	US Atlantic and GOM[h]
Sphyrna zygaena	Smooth hammerhead	VU	✔	-	-	ERA	-	-	US Atlantic and GOM[h]

[a] The only RFMO to undertake PAs and ERAs to date is ICCAT. PA = species subject to population assessment by ICCAT (for Atlantic blue sharks and shortfin makos; ICCAT 2005, 2008c) and Canada (for NW Atlantic porbeagle; see Campana *et al.* 2008); ERA = species subject to an Ecological Risk Assessment (ICCAT 2008c; Simpfendorfer *et al.* 2008). No RFMO has yet implemented catch limits.

[b] Barcelona Convention listings, which only address the Mediterranean Sea, require follow up action and are not fully implemented; only Malta and Croatia have provided legal protection for Annex II elasmobranchs. Annex II lists Endangered or Threatened species and Annex III lists species whose exploitation is (or should be) regulated.

[c] Fishing or retention not allowed. Ecuador, Egypt, Israel, Palau (for foreign vessels) and Republic of the Congo prohibit directed fishing for sharks in their territorial waters. Canada: catch and release only for recreational shark fishing and no retention of any shark (except spiny dogfish *Squalus acanthias*) caught by hook and line in Pacific waters; closed area on porbeagle mating ground, see Canada Fisheries and Oceans (2005). This list is not comprehensive; readers are encouraged to provide the SSG with domestic management updates for all elasmobranch species.

[d] Applies to all US vessels fishing in Atlantic and Gulf of Mexico (GOM) waters. Species is prohibited from commercial and recreational fishing as opposed to being protected under endangered species laws.

[e] Australia: protection for basking and whale sharks varies by jurisdiction; see www.daff.gov.au/__data/assets/pdf_file/0019/681013/shark-assess-report.pdf.

[f] Sweden, however, maintains a 1t share of the EU Total Allowable Catch for porbeagle.

[g] Australia: 20 sharks per vessel per trip retention limit in Commonwealth tuna and billfish fisheries; Canada has non-restrictive catch guidelines for blue sharks in the Atlantic; US has harvest guidelines for thresher shark *A. vulpinus* and shortfin mako off the US West Coast.

[h] US: subject to commercial quota, and commercial and recreational retention limits; see www.nmfs.noaa.gov/sfa/hms/Compliance_Guide/index.htm.

on targeted fishing and efforts to reduce their incidental take. Basking sharks are also a bycatch of deepwater trawls on hoki spawning grounds in New Zealand (the fins are exported under CITES provisions), but captures are relatively uncommon in oceanic fisheries (Bonfil 1994).

5.2.4 Shortfin mako *Isurus oxyrinchus* and longfin mako *Isurus paucus* sharks

Shortfin mako *Isurus oxyrinchus* is a coastal and oceanic circumglobal shark found in temperate and tropical waters of all the world's oceans (Stevens 2008). The longfin mako *I. paucus* is oceanic, found in warm waters and possibly circumglobal (Compagno 2001). Distribution of the longfin mako is not well documented because it is rarely encountered or misidentified as shortfin mako (Maguire *et al.* 2006). Shortfin makos are frequently taken as bycatch in longline and gillnet fisheries targeting tunas and billfish, usually second only to blue sharks *Prionace glauca* in the shark bycatch of these fisheries. Shortfin makos are discarded less often than other pelagic sharks (Mejuto *et al.* 2002). Indeed, makos are widely valued for their high-quality meat (fins and occasionally skin are also used). Although the longfin mako is a preferred species for shark liver oil, such product made from shortfin makos is considered only of average quality (Table 5.4; Rose 1996). Shortfin mako accounts for at least 2.7% of the Hong Kong shark fin trade, the estimated equivalent of nearly a million makos (biomass ~40,000t) a year (Clarke *et al.* 2006a, 2006b). The commercial importance of shortfin mako makes it one of the best documented sharks in pelagic fisheries. Landings data are less reliable for longfin mako sharks, for the reasons mentioned above.

Mako shark landings in the FAO database are reported in three categories: "shortfin mako," "longfin mako" and "mako sharks" (FAO 2009). In 2007, 5,924t, about 7% of the pelagic shark catch reported to FAO, were recorded as makos (Table 5.1). This included 5,769t shortfin, 2t longfin, and 153t unidentified mako shark. The vast majority of these sharks (76%) were reported from the Atlantic (mainly by Portugal, Spain, Namibia and South Africa), 17% from the Pacific (by Chile, Spain and the US) and 7% from the Indian Ocean (by Spain, Portugal and China). Once again, FAO landings grossly underestimate the actual size of the catch of these species.

In the North Atlantic, *I. oxyrinchus* is a significant component of the landed bycatch of the following fisheries, amongst others: the Spanish swordfish fleet (~10% of bycatch in the Atlantic; Buencuerpo *et al.* 1998; Mejuto *et al.* 2006a); Canada's pelagic longline fishery (averaging 60–80t/year; Campana *et al.* 2004); US commercial longline and recreational fisheries (370t in 2006; Cortés 2008b); Portuguese swordfish longline fisheries (100–700t/year from 1990–2000; Santos *et al.* 2002, M. Clarke *et al.* 2008); and the Japanese tuna longline fishery (landings of 120–240t/yr from 1994 to 2006, averaging 6,700 fish between 1994 and 2005; Matsunaga 2008). The shortfin catch in the western Mediterranean swordfish longline fishery consists almost exclusively of juveniles, suggesting that this region may be a nursery ground for the eastern Central Atlantic mako population. Even though driftnets were banned in the Mediterranean in 2002, shortfin makos and other pelagic sharks are a secondary target of an illegal Moroccan swordfish large-scale driftnet fishery that operates year-round in the Alboran Sea; catch rates and mean weight of this species are declining (Tudela *et al.* 2005).

Shortfin makos are commonly taken as a bycatch of South Atlantic pelagic fisheries, including the longline fleet off southern Brazil (Amorim *et al.* 2002), the Chinese longline fleet targeting bigeye tuna (10% of the shark bycatch; Hazin *et al.* 2008) and the Venezuelan tuna and swordfish longline fishery (7% of the shark bycatch; Arocha *et al.* 2002), among others.

In the Pacific, shortfin makos are taken as bycatch in the domestic longline fishery off eastern Australia, accounting for 5% of the retained bycatch species (Bromhead *et al.* 2005), the New Zealand tuna longline fishery, accounting for 6–7% of total landings by weight and 188t in 1997–1998 (Francis *et al.* 2001), and the Spanish swordfish longline fishery. In the latter, shortfin mako composed 30% of the bycatch from 1990 to 2005 (declining from 40% to 25% over this period) or an average of ~700t per year, ~20% of the total catch (Mejuto *et al.* 2007).

In the Indian Ocean, a total of 3,790t of shortfin mako landings are recorded in the IOTC database from 1970 to 2002. Although this species accounts for only 1% of the IOTC shark landings (2000–2002; Smale 2008), shortfin mako compose 10% of the Spanish longline fleet's shark bycatch (Mejuto *et al.* 2007). Shortfin mako are also taken in the South African longline fleet (about 133t in recent years; Smale 2008), in the drift gillnet and bottom longline fisheries of Sri Lanka (about 7% by weight of the total shark landings; Joseph 1999) and from the waters of India (Hanfee 1999).

In addition to its bycatch (or "secondary target") label, the shortfin mako may also be the most widely targeted pelagic shark in oceanic and coastal waters, by both commercial fleets and anglers. For example, juvenile shortfin makos were targeted in a coastal driftnet fishery off California during the late 1970s and an experimental longline fishery targeting makos in the same area operated from 1988 to 1991 (Holts *et al.* 1998). In the US Atlantic, recreational landings for shortfin mako peaked at 80,000 fish in 1985 and have declined since: Fewer than 3,400 were reported taken in 2006. These recent landings rival those of the US commercial fleet in the same waters (Cortés 2008b).

Longfin makos are taken in tropical pelagic longline fisheries and with hook and line (Maguire *et al.* 2006), but with much less frequency than its congener. As mentioned, this species may be confused with and misidentified as shortfin mako leading to underreporting of its catch. Landings from the Indian Ocean reported to the IOTC totalled about 87t from 1993 to 2002 (Smale 2008). Although relatively little is known about longfin mako conservation status or importance in fisheries, this species is considered vulnerable to overexploitation because it is rare wherever it occurs and is taken in many of the same fisheries that have depleted shortfin mako.

Because of their low reproductive capacity and vulnerability to pelagic fishing gear, shortfin and longfin makos are considered to be among the pelagic sharks at the greatest risk for overexploitation from Atlantic high-seas fisheries (Dulvy *et al.* 2008; Simpfendorfer *et al.* 2008). Their highly prized meat is a main reason for fishermen to both target these sharks and retain incidentally caught individuals. As a result, management measures beyond finning bans are particularly important for makos. Shortfin makos survive capture on longlines well (66–80% are alive when gear is retrieved; Semba 2008; Francis *et al.* 2001), suggesting that catch limits and mandatory release can be effective tools for limiting fishing mortality for this species.

Atlantic shortfin makos were the subject of population assessments by ICCAT scientists in 2004 and 2008, along with an ecological risk assessment (ICCAT 2005, 2008c). Although model outcomes varied, the 2008 assessment found that North Atlantic shortfin mako stock had declined by about 50% since the 1950s and that overfishing is probably occurring (ICCAT 2005, 2008c). These assessment results are considered to be highly uncertain due in part to data deficiencies, and recent biological data indicate that the productivity of shortfin mako is much lower than previously thought. The status of the South Atlantic shortfin mako stock could not be determined. In more localised assessments, Baum *et al.* (2003) found moderate declines in makos in the Northwest Atlantic from 1986 and 2000, and Baum and Myers (2004) estimated a 45% decline in unstandardised catch rates (for both makos) from the 1950s to the 1990s in the Gulf of Mexico.

In 2005, following ICCAT's first shortfin mako population assessment, which suggested overfishing of the North Atlantic population, ICCAT Members adopted a binding Recommendation calling on all its CPCs to reduce fishing mortality on the stock (Rec. 05-05; Table 5.2). ICCAT repeated this directive in 2007 and the EU proposed an ICCAT quota in 2008, but so far no international catch limits or concrete ICCAT measures to ensure a reduction in mortality have been agreed upon. Indeed, despite inclusion in Annex I of UNCLOS (Table 5.6), there are no international management measures in place for either mako species anywhere in the world (Table 5.5). The listing of these species in Appendix II of the Convention on Migratory Species in December 2008 may stimulate collaborative management under CMS (see Section 5.5.4).

There is limited protection for makos in some domestic waters. The longfin mako has been listed as a prohibited species for US fisheries in the Atlantic and Gulf of Mexico since the late 1990s, largely because of its unknown population status and unimportance to fisheries (Table 5.5). US Atlantic catches of shortfin makos are controlled through recreational bag limits and a multispecies pelagic shark quota for commercial fisheries, which was 488t dressed weight in 2009. More restrictive species-specific management of Atlantic shortfin makos is currently under review by US fishery managers. Shortfin makos are included in New Zealand's Quota Management System, which establishes annual catch limits for this species (New Zealand Ministry of Fisheries 2008).

5.2.5 Porbeagle *Lamna nasus* and salmon *Lamna ditropis* sharks

The porbeagle shark *Lamna nasus* is found in coastal and offshore temperate waters of the North Atlantic (with separate stocks in the Northeast and Northwest), and in the Southern Hemisphere, where it is circumglobal (Compagno 2001). Unlike many other pelagic sharks, porbeagle sharks have been intensely targeted since the 1920s (Francis *et al.* 2008). They are sought primarily for their high-quality meat, but are also a preferred species for skin to produce leather and for liver oil and fishmeal (Table 5.4; Rose 1996; Francis *et al.* 2008). Porbeagle fins are not particularly high value and do not appear to make a significant contribution to the Hong Kong shark fin trade (Clarke *et al.* 2008b), but this may simply be due to the low availability of this species today, compared with other large sharks.

Porbeagle landings have been reported continuously in the FAO database since 1950 (FAO 2009). In 2007, 887t were landed, the vast majority taken in the North Atlantic, primarily by France, Spain and Canada (Table 5.1). Porbeagle landings in the Southern Hemisphere appear minor in comparison, with New Zealand and Spain reporting landings from the Pacific, and Spain from the Indian Ocean. In the 1960s, reported worldwide porbeagle landings were 10 times what they are today, with a peak of more than 9,600t in 1964 taken from the North Atlantic.

Table 5.6 Oceanic sharks covered under UN Convention on the Law of the Sea (UNCLOS) as listed in Annex I.

Species or family	Common name
Hexanchus griseus	Sixgill shark
Cetorhinus maximus	Basking shark
Family Alopiidae	Thresher sharks
Rhincodon typus	Whale shark
Family Carcharhinidae	Requiem sharks
Family Sphyrnidae	Hammerhead sharks
Family Isuridae[a]	Mackerel sharks

[a] Currently Lamnidae and includes five species: great white shark, shortfin mako, longfin mako, salmon shark and porbeagle shark.

Today, porbeagles are still taken in targeted fisheries and as bycatch in the North and South Atlantic. Atlantic catches were reported to ICCAT in 2007 from France (354t by six drift longline vessels; Jung 2008), Canada (93t) and the United Kingdom (26t) (ICCAT 2008a). In the Southern Hemisphere, most of the porbeagle catch comes as bycatch in tuna longline fisheries, where landings are small but may be underreported (Francis *et al.* 2001, 2008). Porbeagle is also a target for anglers in countries such as Australia, Canada, Ireland, New Zealand, the United Kingdom and the United States (Babcock 2008).

Fisheries for porbeagle in the North Atlantic are among the best-studied shark fisheries in the world and offer the most complete picture to date of the effect that fishing can have on a highly migratory, wide-ranging shark (Camhi 2008; Campana *et al.* 2008). Indeed, the Northwest population has been subject to a full stock assessment – the first for any pelagic shark. The target fishery for Northeast Atlantic porbeagles began in the 1930s. Fisheries were intense and unregulated, and collapsed in the 1960s (Gauld 1989). In 1961, much of the effort shifted to the virgin Northwest Atlantic population, which also collapsed within a decade: Landings peaked at over 9,000t in 1964, but declined to about 200t in 1970 and hovered below 500t through the 1980s (Campana *et al.* 2002, 2008; FAO 2009). The target fishery (almost exclusively of Canadian vessels) expanded once again in the early 1990s, and once again collapsed: Catches in 1995 peaked at 1,395t, but declined by almost 90% to 146t by 2003 (FAO 2009). A Canadian quota of 250t, imposed in 2002, was inadequate to allow population recovery. Despite implementation of increasingly stringent Canadian management since 1994 in the Northwest Atlantic, the population hovers at about 11% of its 1961 virgin biomass. Scientists estimate that even if target fisheries were closed and strict limits placed on porbeagle bycatch, it could take at least 30–60 years for this population to recover. Scientists with the Committee on the Status of Endangered Species Wildlife in Canada (COSEWIC) declared porbeagle Endangered in 2004 and recommended the species for listing under Canada's Species at Risk Act. The proposal was rejected for economic and monitoring reasons. In 2008, the Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO) warned that mortality from a new porbeagle fishery in international waters just outside the Canadian EEZ, when added to Canadian landings, would lead to a population "crash" (NAFO 2008).

With the exception of the widely protected whale, white and basking sharks, porbeagle is subject to more species-specific management than any other pelagic shark, perhaps due to their high value and exceptionally depleted status in several regions (Table 5.5). In what may be the clearest management advice yet given for a pelagic shark, in 2006 ICES recommended that "no targeted fishing for [Northeast Atlantic] porbeagle should be permitted on the basis of their life history and vulnerability to fishing. In addition, measures should be taken to prevent bycatch of porbeagle in fisheries targeting other species, particularly in the depleted northern areas" (ICES 2006, p. 108). In 2006, ICCAT called on its members (Rec. 07-06) to "take appropriate measures to reduce fishing mortality in fisheries targeting porbeagle (*Lamna nasus*) and North Atlantic shortfin mako sharks (*Isurus oxyrinchus*)" (Table 5.2). Canada, however, is exempt because this binding ICCAT Recommendation does not apply to Parties who have conducted peer-reviewed stock assessments for the species (presently only Canada). The EU responded by establishing the first-ever EU fishing limit (581t) for porbeagle in 2008. ICES strengthened their advice for management of the Northeast Atlantic porbeagle population in 2008, by calling for a prohibition on landings of the species. Although the EU heeded this advice and originally proposed a zero porbeagle quota, it ultimately only reduced its 2009 total allowable catch by 25% with a size limit of 210cm fork length. The United States took the most significant action by reducing its domestic commercial quota for porbeagle from 92t to less than 2t, although it had originally proposed a complete prohibition on the retention of porbeagles. Additional US management action for porbeagle is awaiting the outcome of the joint ICCAT/ICES porbeagle assessment scheduled for June 2009.

Because porbeagles are primarily killed for their meat, finning bans alone will not improve their population status. Mandatory release of porbeagles taken as bycatch could help, as an estimated 54% are still alive on gear retrieval in the French Atlantic fishery (Jung 2008), and 25–68% arrive at the boat alive in the New Zealand fishery (Francis *et al.* 2001).

The porbeagle is a species considered to be at moderate risk of overexploitation (Simpfendorfer *et al.* 2008). In the North Atlantic, however, decades of target and incidental fishing have taken a serious toll on porbeagle sharks, resulting in Red List assessments of Critically Endangered in the Northeast Atlantic and Mediterranean and Endangered in the Northwest Atlantic (see Section 8). That porbeagle fishing in the North Atlantic collapsed not once but twice in just over 40 years of fishing – despite monitoring and management efforts – raises the question of whether sustainable fisheries for this species, and other equally vulnerable sharks, are indeed possible.

The salmon shark *Lamna ditropis* is less widely distributed than other pelagic sharks, being confined to the North Pacific in cold temperate to subarctic waters. Although there are no reported landings for salmon shark in the FAO database (FAO 2009), it has historically been taken in moderate numbers as bycatch in gillnets and on longlines of Japanese, Canadian and Russian fisheries in the North Pacific (McKinnell and Seki 1998; Goldman and Musick 2008). Currently there is no directed commercial fishery for salmon shark in the Northeast Pacific, but a small sport fishery in Alaska does target this shark (limited to two sharks per angler per year). There is also a small target fishery off Japan. The main source of mortality, however, is as bycatch in purse-seine fisheries for salmon and longline fisheries for halibut and sablefish, but salmon shark mortality from these fisheries is poorly documented (Goldman and Musick 2008). The salmon shark has been listed as a species of Least Concern because current known catches appear to be sustainable. Over the last four years, however, catches of salmon sharks in Prince William Sound, Alaska, have been declining. It is not clear whether this is due to a change in species distribution or a population decline, but no new fisheries have yet been identified that could explain the population decline (J. Musick pers. comm.).

5.2.6 Silky shark *Carcharhinus falciformis*

The silky shark *Carcharhinus falciformis* is one of the world's most cosmopolitan sharks, inhabiting coastal and oceanic waters throughout the tropics (Compagno 1984b). There may be four distinct populations of this highly migratory species (Bonfil 2008). It is one of the sharks most commonly targeted and taken as bycatch in tropical fisheries, especially those using longlines and purse seines to target tunas in the eastern tropical Pacific, the Gulf of Mexico, the Atlantic and Indian Oceans, and tropical Australian waters. Silky sharks are second in importance only to blue sharks in the bycatch of tuna longline fisheries in the western tropical Pacific (Williams 1999), accounted for 70-80% (by number) of the sharks caught in the Maldives (Anderson and Waheed 1999) and made up 9% of the IOTC shark records from 2000 to 2002 (Smale 2008). Multispecies fisheries that take large numbers of silky sharks occur in Mexico, Guatemala, El Salvador, Costa Rica, United States, Ecuador, Spain, Portugal, Sri Lanka, the Maldives, Yemen and the Ivory Coast (Bonfil 2008; FAO 2008). Although it is considered one of the mostly commonly caught oceanic sharks (Maguire *et al.* 2006), in 2007 only 2,485t of silky shark landings were reported to FAO. A little more than half of these landings came from the Pacific.

Available catch and landings data do not convey the true importance of this species in the bycatch of many oceanic fisheries. This situation is complicated by the fact that silky sharks have been frequently misidentified as blacktip sharks *Carcharhinus limbatus* (Bonfil 2008). Various RFMOs have called for improved reporting of catch and discards of silky sharks (and other sharks), but this species has not yet been highlighted as a priority for population assessment.

Bonfil (1994), on the other hand, estimated that 900,000 silky sharks were caught in tuna longline fisheries in the southern and central Pacific in 1989. Stevens (2000) estimated 84,000t of silky sharks were caught in 1994 in the Pacific. Although most countries do not report shark landings to FAO by species, Sri Lanka has consistently posted very high silky shark landings, which frequently exceed those for blue sharks (Joseph 1999). Although there are discrepancies in reporting, average annual Sri Lankan landings of silky sharks were about 13,000t in the 1980s and 17,000t in the 1990s, declining to 4,600t since 2000 (Bonfil 2008; FAO 2009). Silky sharks dominate the shark bycatch (34.4%) in the US pelagic longline fishery targeting swordfish and tuna in the Atlantic, where 69% of them were dead upon gear retrieval (Beerkircher *et al.* 2008).

Despite these large catches, very little is known about the population sizes or trends in abundance of silky sharks (Bonfil 2008). A number of studies, however, have suggested overfishing and declining catch rates for the silky shark, including in the Eastern Pacific. Baum and Myers (2004) estimated a decline of 91% of this species in the Gulf of Mexico since the 1950s; although there is controversy over the magnitude of the decline, there is agreement that the species is depleted in the region (Burgess *et al.* 2005).

The silky shark features significantly in the global shark fin trade: It contributed an estimated 3.5% of the identified fins in the Hong Kong fin auctions, making it third in importance after blue and hammerhead sharks (Clarke *et al.* 2006b; Table 5.4). As they are not a preferred species for their fins or meat, most silky sharks are taken for their fins. Although it is included in Annex I of the UN Law of the Sea (UNCLOS; Table 5.6), there is no international protection currently in place for silky sharks. Prohibitions on finning in most high-seas waters, if enforced, could help stem mortality of this Near Threatened species (Table 5.7). Based on its wide-ranging, oceanic and transboundary movements, the CMS Scientific Council concluded that it qualifies for listing under the Convention on Migratory Species (CMS; IUCN SSG 2007).

5.2.7 Oceanic whitetip shark *Carcharhinus longimanus*

The oceanic whitetip shark *Carcharhinus longimanus* is the only truly oceanic species of the *Carcharhinus* genus with a worldwide distribution in warm tropical and subtropical waters (Compagno 1984b). Its abundance increases with distance from the continental shelf (Bonfil *et al.* 2008). Oceanic whitetips are thought to be one of the most abundant oceanic sharks in all oceans (Bonfil *et al.* 2008; Maguire *et al.* 2006), but relatively low catches in oceanic

Table 5.7 International, regional and domestic actions on shark finning (through April 2009; bans are mandatory unless otherwise stated; adapted from Camhi *et al.* 2008a).

	Date	Area	Implementation[a]
International			
UN FAO	1999	All waters	International Plan of Action-Sharks: minimise waste and discards (voluntary).
UN General Assembly	December 2007	All waters	Calls on States to take immediate and concerted action to improve domestic and RFMO measures that regulate shark fisheries, including those conducted only for shark fins, and to consider "requiring that sharks be landed with each fin naturally attached."
IUCN	October 2008	All waters	Recommendation 4.113 urges all States to require sharks be landed "only if their fins are naturally attached to their bodies, though allowing for partial detachment of fins to permit efficient storage and species identification."
Regional[b]			
ICCAT	November 2004	Atlantic, Mediterranean and Gulf of Mexico	Full utilisation (only head, skin and guts may be discarded); landed fins are not to exceed 5% of landed shark weight; encourages, but does not require, live release of incidentally caught shark.
GFCM	2005	Mediterranean	Same measures as ICCAT.
IOTC	May 2005	Indian	Same measures as ICCAT.
IATTC	June 2005	Eastern Pacific	Same measures as ICCAT.
NAFO	September 2005	Northwest Atlantic	Same measures as ICCAT.
SEAFO	October 2006	Southeast Atlantic	Same measures as ICCAT.
WCPFC	December 2005, revised December 2008	Western and Central Pacific	Same measures as ICCAT, initial exemption for fishing vessels under 24m was removed in 2008.
CCAMLR	2006	Antarctic waters	All directed fishing for sharks is prohibited, but there are no concrete limits on shark bycatch.
NEAFC	2007	Northeast Atlantic	Same measures as ICCAT.
National[c]			
Australia[d]	October 2000	Commonwealth (federal) waters, three to 200 miles offshore	Finning is prohibited in tuna and billfish longline and all Commonwealth fisheries taking sharks and must be landed with fins attached (not necessarily naturally); additional regulations apply in some territorial waters (out to three miles); carcass must be landed with the fins in the Coral Sea fishery and Eastern tuna and billfish fishery, with limit of 20 sharks and their fins per trip.
Brazil[c]	August 1998	Brazil waters	Total weight of fins shall not exceed 5% of the total weight of carcasses.
Canada[c]	1994	Atlantic and Pacific	Finning is prohibited in Canadian waters and extends to any Canadian licensed vessel fishing outside the 200-mile EEZ; fins must not exceed 5% of dressed carcass landed weight.
Cape Verde	February 2005	Cape Verde waters	Finning is prohibited throughout EEZ.
Colombia	June 2007	National and foreign vessels	Fins must be attached to the body at the point of landings; permits are required for transporting and shipping fins once sharks have been landed; transshipping of fins at sea is prohibited.
Costa Rica	2001, revised February 2005	Costa Rica waters and wherever CR vessels fish and foreign vessels that offload in CR	Sharks must be landed with fins attached in a "natural manner" to carcass.
Ecuador	October 2004	All Ecuador waters, including Galapagos	Finning is prohibited in Ecuador waters and the sale or export of fins is strictly prohibited; targeted fishing for sharks is prohibited; incidentally caught sharks should be fully utilised.
Egypt	August 2005	Egyptian territorial waters in the Red Sea (12 miles)	Shark fishing is prohibited throughout the Egyptian Red Sea to 12 miles offshore.
El Salvador	December 2006	El Salvador waters and wherever Salvadorean vessels fish	Fins must remain at least one-quarter attached to the carcass.
European Union (27 Member States)[c, e]	September 2003	EU waters and wherever EU vessels fish	Finning is prohibited; fins must be landed attached to carcass; a "special fishing permit" allows fins to be landed or transhipped separately, if processing is undertaken on board, but "in no case shall the theoretical weight of the fins exceed 5% of the live weight of the shark catch."
French Polynesia	April 2006	French Polynesia waters	Finning is prohibited, as is the trade in all shark parts and products except for shortfin mako.

Table 5.7 *cont'd*. International, regional and domestic actions on shark finning (through April 2009; bans are mandatory unless otherwise stated; adapted from Camhi *et al.* 2008a).

	Date	Area	Implementation[a]
National *cont'd*			
Israel	1980	Israeli waters	All sharks have protected status in Israeli waters; shark fishing and finning (by default) are illegal.
Japan[c, f]	August 2008	All Japanese vessels *except* for far seas and coastal vessels operating and landing outside Japanese waters	Required to land all the parts of sharks (although heading, gutting and skinning are allowed).
Mexico[c]	May 2007	Mexican waters and wherever Mexican vessels fish	Finning is prohibited for all vessels catching sharks directly or incidentally; sharks may not be landed unless their carcasses are also onboard.
Namibia	Finning legislation pending?		Currently, law prohibits dumping of biological materials in territorial waters, which should preclude, but does not specify, finning; in general, discards are prohibited.
Nicaragua	2005	Nicaragua waters, including Lake Cocibolca	Fishing for sharks solely for their fins is prohibited; sharks must be landed with their corresponding carcasses; weight of fins shall not exceed 5% of the total landed weight of carcasses; to export fins, exporters must prove that they also marketed the meat.
Oman	Prior to 1999		No waste of any shark part at sea or on land; fins and tails must remain attached to carcass; license needed to export or handle any shark part.
Palau	2003	Palau waters	Shark fishing is banned in State waters, as is finning by foreign vessels; all incidentally caught sharks must be released dead or alive. A bill to allow shark fishing was pending in mid-2009.
Panama	March 2006	Panama waters	Commercial fisheries must land sharks with fins attached in a natural manner, with at least 25% of the fin-body union intact; boats with outboard motors of 60 hp or less may land fins separately, but fins must not exceed 5% of the landed shark meat; trade in fins requires certificate of origin.
Seychelles	February 2006	Seychelles waters for foreign vessels and all waters for domestic vessels 24m or less	Finning is prohibited by requiring that the weight of fins shall not exceed 5% of the landed dressed carcass weight.
South Africa	1998	South Africa waters and wherever SA vessels fish	Finning is prohibited; fins can be separated from carcasses but must be landed together with a fin:carcass (dressed weight) ratio of 8% for domestic vessels and 5% for foreign vessels.
Spain[c]	2002	Spain waters and wherever Spanish vessels fish	Finning is prohibited; fins must be landed attached to carcass; a "special fishing permit" allows sharks to be landed separately, but fins must not exceed 5% of whole carcass weight. Spanish rule was superseded by the EU finning ban in 2003.
United States[c]	March 2002 (since 1993 in Atlantic)	US waters and wherever US vessels fish	Finning is prohibited; in Atlantic and Gulf of Mexico all sharks must be landed with fins naturally attached; in Pacific fins must be landed with the corresponding carcass and fins must not exceed 5% of dressed carcass landed weight. National legislation for a "fins naturally attached" rule was pending in mid-2009.

[a] Refer to IUCN SSG Web page (www.iucnssg.org) for further details and updates.
[b] See Table 5.2 for RFMO Resolutions and Recommendations addressing finning.
[c] Major shark-fishing nations, defined as reporting >10,000t of elasmobranch landings to FAO in 2007 (FAO 2009); in 2007, there were 21, including three EU-member States (Spain, Portugal and France). Currently, only Spain, Portugal, Lithuania and the UK grant special fishing permits for at sea shark fin removal.
[d] Australia also banned finning in six State and Northern Territory waters (to three miles), including Queensland (2002), New South Wales (1999, landed with fins attached), Victoria (1972), Tasmania (2001, landed with corresponding body), Western Australia (2000, only whole sharks can be landed), and Northern Territory (equal number of trunks and fin sets).
[e] Based on Regulation EC n°1185/2003.
[f] Based on Japanese Regulation 60-2-2.

fisheries in some regions may belie this assumption (Domingo *et al.* 2007; Semba *et al.* 2008). There are few, if any, target fisheries for this species, but it is taken incidentally in pelagic longline fisheries, particularly those targeting tunas, as well as in gillnets, purse seines and pelagic trawls (Maguire *et al.* 2006; Bonfil *et al.* 2008).

On the basis of longline catch-rate data, Bonfil (1994) estimated that over 7,200 oceanic whitetips (145t) were taken annually in the North Pacific and another 540,000 (10,800t) in the Central and South Pacific in the late 1980s. These sharks were caught incidentally in the longline fisheries of Japan, South Korea, Taiwan and Australia. There are data to suggest that the Central Pacific (150°W to 180°W) just north of the equator (10°N) serves as a pupping ground for oceanic whitetip sharks (Bonfil *et al.* 2008). Stevens (2000) estimated that between 52,000t and 240,000t of oceanic whitetip sharks were taken on longlines and in purse seines throughout the Pacific in 1994. Similar basin-wide catch estimates are not available for the Atlantic or Indian Oceans (Bonfil *et al.* 2008). By comparison, FAO landings for this species are clearly underreported: In 2007, only 14t, all from Brazil, were recorded. Reported landings of oceanic whitetips first appeared in the FAO database in 2000 (638t) and have been declining ever since, with annual average landings of 238t (FAO 2009).

The oceanic whitetip is the second most prevalent shark (at 21%) taken in the shark bycatch of the tuna purse-seine fishery of the Eastern Pacific Ocean (silky shark *C. falciformis* accounted for 64%)(Román-Verdesoto and Orozco-Zöller 2005). Although IOTC reports that the oceanic whitetip is "taken by a range of fisheries in the Indian Ocean" and that it is vulnerable to overfishing, little is known of catches in this region (IOTC 2008b). This species accounted for only 3.5% of the shark bycatch in the US pelagic longline fishery in the Atlantic from 1992 to 1997 (Beerkircher *et al.* 2008), but they are significant in the bycatch of Brazilian longline fisheries in the South Atlantic (Hazin *et al.* 2008).

The large and distinctive fin of the oceanic whitetip shark contributes significantly to the global shark fin trade (Table 5.4). Clarke *et al.* (2006b) estimated that this species accounted for almost 2% of the identified fins in the Hong Kong shark fin auctions, but the trade data also suggest that reported catches to ICCAT may seriously underestimate (by 50-fold) the actual catch of this species in the Atlantic (Clarke 2008). It is a preferred species for its fins, but its liver oil and its skin (for leather) are only of average quality (Rose 1996; Table 5.4).

Until catch and abundance indices for *C. longimanus* become available, population assessments will not be possible for this species (Bonfil *et al.* 2008). Declining catch rates in some regions, however, are cause for concern, particularly because oceanic whitetips were found to suffer a moderately high level of risk of overexploitation (Simpfendorfer *et al.* 2008). In the Northwest Atlantic, oceanic whitetip catch rates since the mid-1980s may have declined by as much as 70% (Baum *et al.* 2003), with even greater declines in the Gulf of Mexico (Baum and Myers 2004). These findings, however, are not without controversy (Burgess *et al.* 2005).

Scientific observer data indicate relatively high survival rates (albeit varying by species and region) for sharks taken in the Japanese tuna longline fishery in the Atlantic: Of the eight oceanic whitetips caught, all were still alive when observed (Semba *et al.* 2008). More than 75% of oceanic whitetips caught in the US Atlantic longline fishery were alive when the gear was retrieved (Beerkircher *et al.* 2008). These data suggest that oceanic whitetips could greatly benefit from live release as encouraged (but not mandated) in the shark resolutions passed by most RFMOs (see Section 5.4).

5.2.8 Blue shark *Prionace glauca*

The blue shark *Prionace glauca* is widely distributed in temperate and tropical waters between 60°N and 50°S, although its abundance increases with latitude (Compagno 1984b; Nakano and Stevens 2008). This transoceanic migrant (Kohler and Turner 2008) may be the world's most abundant pelagic shark, but it is also the shark taken in the greatest numbers in pelagic longline and net fisheries, especially those targeting tunas and billfishes. Because of its prevalence in the catch, it is also one of the best-studied pelagic sharks, yet its conservation status remains uncertain and debated.

Historically of low commercial value, blue sharks were frequently discarded and their catches went unrecorded. They were first reported in the FAO database in 1978: Average landings during the 1980s and 1990s were about 100t and 5,000t per year, respectively (Table 5.1; FAO 2009). Reported landings have continued to rise, and were 45,087t in 2007, with the large majority (79%) reported from the Atlantic – likely an artifact of better species reporting from that ocean. Today, blue sharks account for over 55% of pelagic shark landings reported to species. In 2007, 28 countries reported their blue shark take: Spain posted the largest landings in all three oceans (48% of the total), followed by Portugal in the Atlantic and Indian Oceans, and Mexico in the Pacific. Large numbers of blue sharks are also taken by anglers in Australia, Canada, New Zealand, the United States and elsewhere, although recreational mortality is minor relative to commercial landings and discards (Campana *et al.* 2006; Babcock 2008; Cortés 2008b).

When compared to other databases and fin trade studies, it is clear that FAO-reported data greatly underestimate the actual annual blue shark mortality. For example, ICCAT reported that almost 46,000t of blue sharks were taken in Atlantic fisheries in 2007 (ICCAT 2009). Campana *et al.* (2005) calculated that the actual catch in the North Atlantic alone was more than 100,000t (almost four times the nominal catch), resulting in catch mortalities of 26,000–37,000t per year. Estimates for annual blue shark catches from the North Pacific high-seas fisheries range from about 100,000t (5 million individuals in 1988; Nakano and Watanabe 1992, cited in Nakano and Stevens 2008) to 140,000t (in 1994; Stevens 2000). Furthermore, Bonfil (1994) estimated that 6.2–6.5 million blue sharks were caught incidentally in the world's high-seas fisheries at the end of the 1980s. Unlike for other pelagic sharks, recent blue shark landings data are documented from many fisheries (in the bycatch working group reports of the relevant RFMOs), but there is almost universal agreement that these data grossly underestimate actual mortality in all oceans. In the Canadian Atlantic, for example, reported annual blue shark landings may only represent 5% of their actual catch and discards (Campana *et al.* 2005).

Historically, blue sharks were rarely targets of commercial fisheries and were traditionally discarded in huge numbers as unwanted bycatch because of the low desirability of their flesh. In some fisheries, blue sharks can exceed the catch of the primary target species, such as in the longline and gillnet fisheries targeting swordfish in the North and South Atlantic (Buencuerpo *et al.* 1998; Mejuto *et al.* 2007; Marin *et al.* 1998; Hazin *et al.* 2008). Since the late 1980s, however, the growing demand and high prices paid for shark fins have resulted in the increased retention of blue sharks, which were once released dead or alive (Buencuerpo *et al.* 1998; Camhi 1999; Mejuto *et al.* 2006a), while other fisheries are now targeting blue sharks, particularly when their teleost or higher-value shark targets are less available (Hurley 1998; Amorim *et al.* 2002; Marin *et al.* 2002; Clarke *et al.* 2007; Hareide *et al.* 2007; IOTC 2008b; Aires-da-Silva *et al.* 2008).

Indeed, blue sharks are the dominant species in the global shark fin trade, contributing at least 17% of the fins identified in the Hong Kong fin markets (Clarke *et al.* 2006b). As a result, about 11 million (range, 5–16 million) blue sharks – or about 200,000–620,000t – enter the international fin trade annually (Clarke *et al.* 2006a). Although its meat is not preferred because of the soft texture and strong flavour, it is consumed in Spain, France, Germany and Japan (Rose 1996). Blue shark is a preferred species for leather and cartilage products (Rose 1996). Recently, there has been a push to develop new markets for blue shark meat and other products to comply with the full utilisation mandates of various RFMOs.

Although the blue shark is currently listed as Near Threatened in the Red List, there is much uncertainty and concern associated with its global status, with considerable support for a Vulnerable listing, at least for the North Atlantic. The blue shark's moderately high reproductive rate (Cortes 2008; Dulvy *et al.* 2008; Smith *et al.* 2008), widespread distribution and abundance in all oceans suggest resilience – but not immunity – to overfishing and endangerment. It is difficult to reconcile the diverse catch-rate trends for blue sharks, which vary widely among studies and methodologies, often within the same ocean basin and/or time frame (Camhi 2008;

Nakano and Stevens 2008). The status of blue sharks in the Northwest Atlantic is probably the best studied. Analysis of logbook data from the US pelagic longline fishery indicated that blue sharks declined by 60% between 1986 and 2000 (Baum *et al.* 2003), and Canadian standardised catch-rate indices suggest a 5–6% decline per year since 1995 in North Atlantic blue sharks (Campana *et al.* 2006). Similarly, fishery-independent survey data indicate an 80% decline in male blue sharks from the mid-1980s to early 1990s (Hueter and Simpfendorfer 2008). In contrast, catch-rate trends over the past three decades for the Japanese longline fishery were stable in the North, South and entire Atlantic (Nakano 1996; Nakano and Clarke 2005).

Similar discrepancies exist regarding blue shark status in the Pacific, with some studies suggesting stability in catch rates in the North Pacific (Matsunaga and Nakano 1996; Kleiber *et al.* 2001) and South Pacific (Nakano 1996), and other studies indicating declines. For example, Nakano (1996) noted a 20% decline in Japanese longline catch rates in the North Pacific between the early 1970s and early 1990s, and Kleiber *et al.* (2009) recently determined a 30% probability that North Pacific blue sharks are overfished and a lesser probability that overfishing is occurring (based on catches from 1971 to 2002). A comparison of scientific survey data from the 1950s with longline observer data from the 1990s, however, found much steeper declines – almost 87% – in blue shark abundance in the Central Pacific (Ward and Myers 2005). A review of blue shark catches in the Western South Pacific estimated that annual catches including discards must be less than 4% of the unexploited biomass (of sharks six months or older) to be sustainable (West *et al.* 2004). Relatively little is known about the conservation status of blue sharks in the Indian Ocean.

Atlantic blue sharks were the subject of a population assessment by ICCAT scientists in 2004 and 2008, as well as an ecological risk assessment in 2008 (ICCAT 2005, 2008c). The risk assessment determined that, relative to other pelagic elasmobranchs, blue sharks are at lower risk of overexploitation from high-seas fisheries (Simpfendorfer *et al.* 2008). Although these assessment results are considered to be highly uncertain due in part to data deficiencies, it appears that blue shark populations are not currently overfished in the North or South Atlantic but may have already been reduced to levels associated with maximum sustainable yield. Improvements in the collection of landings and discard data will go a long way to improving our understanding of this ubiquitous but heavily fished species.

The transoceanic migrations of blue sharks strongly support arguments for regional and international management. Currently, there are no species-specific catch limits or other protections for blue sharks in international waters, nor is the trade in their meat or fins monitored, despite their prominence in the international trade (Rose 1996; Clarke *et al.* 2006a, 2006b). Because blue sharks have been subject to high rates of finning in the past, well-enforced shark finning bans could help to reduce blue shark mortality (Table 5.7). In addition, blue shark survival on longlines at gear retrieval is relatively high (69–90%; Francis *et al.* 2001; Diaz and Serafy 2005; Campana *et al.* 2006; Beerkircher *et al.* 2008), suggesting that mandatory release in conjunction with finning bans can be an effective tool to reduce blue shark fishing mortality. Domestic management for blue sharks is limited to a short list of fishing nations (Table 5.5). The US has established an annual quota (273t dressed weight for 2009) for blue sharks taken in the Atlantic and Gulf of Mexico. Although New Zealand has not implemented a complete finning ban, annual catch limits under their Quota Management System constrains the number of blue sharks that may be taken commercially (New Zealand Ministry of Fisheries 2008).

Fishing pressure on blue sharks will continue to grow as other target and secondary target species become less available and prices paid for shark fins increase (Clarke *et al.* 2007). Prompt management for blue sharks is needed to ensure that populations of this abundant species are not depleted.

5.2.9 Hammerhead sharks *Sphyrna* spp.

There are nine species of hammerhead shark (family Sphyrnidae). As a group, they tend to be less oceanic than many of the other species considered in this report, but are widely distributed in coastal and continental shelf waters in warm-temperate and tropical seas (Compagno 1984b). This means that they may be subject to intensive domestic fisheries within EEZs, as well as multinational fisheries on the high seas. The three largest, globally distributed and highly migratory species are considered here: the scalloped *Sphyrna lewini*, smooth *S. zygaena* and great *S. mokarran* hammerheads. *Sphyrna mokarran* is the most tropical of the three and is largely confined to the continental shelf. *Sphyrna lewini* may be the most common hammerhead in the tropics. All three species, however, are classified as Threatened under the IUCN Red List because of population declines resulting from intense fishing pressure combined with low reproductive rates; *S. lewini* and *S. mokarran* have been assessed as globally Endangered, and *S. zygaena* is categorised as globally Vulnerable (see Section 8).

Hammerhead fins are highly desired for the shark fin soup trade because of their size and high needle count (Rose 1996) (Table 5.4). Together, the three species considered here account for nearly 6% of the identified fins passing through the Hong Kong shark fin market (Clarke *et al.* 2007b). *Sphyrna lewini* and *S. zygaena* account for 4.4%, which suggests that 1.3 and 2.7 million sharks of these species, equivalent to a biomass of 49,000–90,000t, are used for the fin trade each year. Hammerhead meat is often considered unpalatable because of high urea concentrations, but it is consumed in various parts of Europe and Africa (Rose 1996). Common and scalloped hammerheads are preferred species for production of leather and liver oil (Rose 1996). They are also commonly taken by anglers in some coastal areas, particularly off the southeastern US coast.

Hammerheads are listed in Annex I of UNCLOS (Table 5.6) and therefore should be subject to its provisions concerning fisheries management in international waters. Like other sharks, however, no international catch limits have been adopted and few countries regulate hammerhead shark fishing (Table 5.5). In 2008, the European Community proposed a prohibition on retention of all hammerhead species under ICCAT, but the measure met with opposition from Asian nations and was defeated. Spain has stated an intention to protect hammerhead sharks in their waters, but has yet to follow through with associated regulations. Finning bans, if effectively enforced, could reduce the number of hammerheads killed just for their fins. Hammerheads are known to suffer high mortality from capture: In the Northwest Atlantic, estimated on-line mortalities (for all age groups) of scalloped and great hammerheads were 91.4% and 93.8%, respectively (Morgan and Burgess

2007). Therefore, mandates for live release are not likely to be sufficient to offset fisheries mortality. Changes in fishing gear and methods, as well as the establishment of protected areas, are also needed to rebuild and conserve hammerhead populations.

Species-specific landings data are again lacking in this case: Hammerhead catches are often amalgamated as *Sphyrna* spp., while *S. zygaena* and *S. lewini* are often confused and misidentified, even at the genus level. Despite their distinctive head morphology, hammerheads are largely underreported; discrepancies are evident when compared to trade statistics. The FAO database reports hammerheads in one of three categories – "hammerhead sharks, *etc.* nei," "smooth hammerhead" or "scalloped hammerhead." In 2007, these category landings were 3,645t, 319t and 202t, respectively, with the large majority of them coming from the Atlantic (FAO 2009). Collectively, hammerheads accounted for 1% (about 940t) of the identified shark landings reported to the Indian Ocean Tuna Organization (IOTC) from 2000 to 2002 (M. Smale pers. comm.). Hammerheads are increasingly targeted for their high-value fins, including in the Indian Ocean, where at least 120 vessels are illegally targeting hammerheads and giant guitarfish *Rhynchobatus djiddensis* for their fins (IOTC 2005; Dudley and Simpfendorfer 2006), as well as in illegal fisheries around the Galapagos Islands (Coello 2005).

Species-specific population trends for hammerheads are rarely available because of the amalgamation of catch data and confusion among species. As a group, catch rates associated with these large hammerhead species have registered significant declines in virtually all oceans. An analysis of US pelagic longline logbook data from the Northwest and Western Central Atlantic indicates that Sphrynidae (including *S. lewini, S. mokarran* and *S. zygaena*) have declined in abundance by 89% since 1986 (Baum *et al.* 2003; Jiao *et al.* 2009). In the Mediterranean Sea, compilation and meta-analysis of time-series abundance indices indicate that Sphrynidae (including the same three species) declined by an estimated >99% in abundance and biomass since the early 19th century (Ferretti *et al.* 2008). Reliable species-specific catch information from the shark nets set off the beaches of Kwa-Zulu Natal during 1978–2003 show about a 64% decline in CPUE for *S. lewini* and a 79% decline for *S. mokarran* over this 25-year period (Dudley and Simpfendorfer 2006). The highly vulnerable great hammerhead *S. mokarran* is believed to have undergone an 80% decline in the eastern Atlantic, where fisheries remain largely unmanaged and unmonitored (Anonymous 2002).

Sphyrna zygaena and *S. lewini* are targeted and taken in the bycatch of industrial as well as small-scale commercial fisheries in all three major oceans, as their ranges largely overlap. Both are caught on pelagic and bottom longlines, handlines, gillnets, purse seines and pelagic and bottom trawls (Bonfil 1994; Maguire *et al.* 2006). Their schooling nature, particularly for *S. lewini,* known for its large aggregations around seamounts and oceanic islands like the Galapagos and Cocos, make them particularly vulnerable to target fisheries. In general, larger individuals dominate the catch in pelagic fisheries and juveniles are more common in the inshore catch (Simpfendorfer 2005). Of particular conservation concern in some regions (e.g. Southwest Atlantic) is that both juveniles and adults from the same population are taken by different fisheries. In most fisheries, *S. zygaena* and *S. lewini* make up a minor component of the catch (e.g. in the Spanish longline fishery in the North Atlantic; Mejuto *et al.* 2002), but their prevalence increases in coastal and artisanal fisheries targeting sharks and around oceanic islands (e.g. Tres Marias Islands off Mexico's central Pacific coast; Perez-Jimenez *et al.* 2005).

In the South Atlantic, *S. zygaena* and *S. lewini* are taken in the bycatch of offshore domestic and distant-water longline fleets of Taiwan, Japan and other nations (Joung *et al.* 2005; Matsushita and Matsunaga 2002), as well as by bottom gillnets and trawlers in coastal fisheries, where juveniles predominate. In the North Atlantic, *Sphyrna* spp. are a minor component of the bycatch in pelagic longline and gillnet fisheries, including the Spanish swordfish fishery in the Atlantic and Mediterranean (Buencuerpo *et al.* 1998; Mejuto *et al.* 2002). In the Pacific, these species are targeted and taken as bycatch in artisanal and industrial fisheries along the eastern Pacific coast of the Americas, in the international purse-seine fishery targeting tunas (just over 5% for both species; Román-Verdesoto and Orozco-Zöller 2005) and in the directed shark fishery off southwestern Australia (Heald 1987). Hammerheads are not recorded to species in most Indian Ocean fisheries, but *S. lewini* is taken by both artisanal and commercial fleets, and is very susceptible to being caught in large-mesh nets associated with beach protection programmes (Dudley and Simpfendorfer 2006).

Sphyrna mokarran is targeted and taken as bycatch in many of the fisheries mentioned above (Dudley and Simpfendorfer 2006; Zeeberg *et al.* 2006). It is regularly caught in the tropics, with longlines, fixed bottom nets, hook-and-line and possibly pelagic and bottom trawls (L. Compagno, in prep.). The great hammerhead may be less susceptible to target fisheries than scalloped and smooth hammerheads because it is more solitary in nature, but this also implies that it is less abundant wherever it occurs. Fishing remains its primary threat: It is sought for its large and valuable fins. Although not targeted in the Northwest Atlantic and Gulf of Mexico, it is taken as bycatch on pelagic longlines, bottom longlines and gillnets in several fisheries, where it suffers greater than 90% vessel mortality. Landings of *S. mokarran* in West African fisheries have collapsed (Anonymous 2002).

5.2.10 Devilrays *Mobula* spp.

There are 10 species of manta or devilrays placed in two genera, *Manta* and *Mobula*. As a group, these large, pelagic rays (1–4m across) are widely distributed in tropical and warm-temperate waters (White *et al.* 2006). Although most species are considered migratory, their ranges are believed to be relatively small. Catch in fisheries is poorly documented, but they are known to be taken by surface gillnets, longlines, purse seines and harpoons, and kept for their meat and gill rakers (which are used in traditional Chinese medicine). Target fisheries taking *Mobula* spp. occur in the Gulf of California (seasonal harpoon fishery for four species), in Taiwan (harpoon and hook fisheries) and in India, Sri Lanka and Thailand. Devilrays are also taken as bycatch in Mexico (gillnets), New Zealand (purse-seine fishery for skipjack tuna), the Philippines and Indonesia (artisanal gillnet tuna fishery) (IUCN SSG 2007; White *et al.* 2006). Target fisheries for *Manta birostris* occur in the Philippines, Mexico, Mozambique, Madagascar, India, Sri Lanka, Brazil, Tanzania and eastern Indonesia (harpoon for manta and gillnets for mixed species).

The aptly named giant devilray *Mobula mobular* (the largest in the genus) occurs only in deep offshore waters of the Mediterranean Sea and possibly in the adjacent Atlantic (Notarbartolo di Sciara 2005). Although it is not targeted and generally not used, this species is taken as bycatch in pelagic driftnets targeting swordfish, on surface longlines and in fixed tuna traps in the Mediterranean (Muñoz-Chapuli *et al.* 1993; Cavanagh and Gibson 2007). There are also records of pregnant devilrays being caught in Mediterranean purse-seine fisheries targeting anchovy (Notarbartolo and Serena 1998, cited in Hareide *et al.* 2007). Because of this high mortality and vulnerable life history, this devilray is classified as globally Endangered in the IUCN Red List – the only such classification for an oceanic pelagic elasmobranch.

Increasing demand for the high-value branchial filter plates (gill rakers) of devilrays over the past decade is now driving targeted fisheries for these rays in Indonesia (where they were previously landed as bycatch). White *et al.* (2006) estimated that about 1,600 mobulid rays (~300t) were landed annually at one site in Indonesia and included five species: *Mobula japonica* (50.4%), *M. tarapacana* (23.5%), *M. thurstoni* (8.8%), *M. kuhlii* (2.0%) and *Manta birostris* (13.7%); relative species composition varied by location. Devilray filter plates can sell for US$30 per kilo and are exported to Hong Kong, Taiwan and Singapore for use in traditional Chinese medicines. The meat (often salted and dried for human consumption and used as bait), skins (dried and deep-fried) and cartilage are also used. In Brazil, devilray tails are dried and used as cattle whips (P. Charvet-Almeida pers. comm.). However, the most lucrative use for these species is often ecotourism. In the Maldives, where an export ban, low local demand and lack of net fishing have allowed manta rays to thrive, estimates of direct, annual revenue from manta-based ecotourism top US$9 million (C. Anderson pers. comm.).

Fishery catch data are insufficient to assess the effect that fishing is having on most devilray populations. There is, however, cause for serious concern given the very low reproductive capacity of most species, their migratory behaviour and the growing demand for gill rakers. As with most sharks, there are few limits on fishing of devilrays, although the giant devilray *M. mobular* is protected in Malta and Croatia as a result of its listing in Annex II of the Barcelona Convention (Table 5.5). Mantas have been protected in the Philippines since 2002 (Fisheries Administrative Order 193, which also protects whale sharks *Rhincodon typus*), but other mobulid species are not protected and are still taken in targeted and bycatch fisheries. A Mediterranean-wide ban on driftnets, if enforced, could reduce mortality of this species, as could protective action from the General Fisheries Council for the Mediterranean (GFCM), the region's RFMO. In 2004, CITES identified devilrays as a group associated with significant unregulated, unsustainable fishing pressures and severe population depletion (CITES 2004). These species have also been found to qualify for listing under the Convention on Migratory Species, according to the CMS Scientific Council (see Section 5.5.4; IUCN SSG 2007).

5.3 Use and trade

Chondrichthyans – including the pelagic species addressed in this volume – are remarkable among the world's living marine resources for the variety of uses that humans have found for their parts: their meat and fins for consumption, skins for leather, liver oil for lubricants, cosmetics and vitamin A, cartilage as a medicinal supplement (of unproven benefit), and jaws and teeth for curios (Table 5.4; Rose 1996; Vannuccini 1999).

Shark and ray meat provides an important source of fish protein for local communities in some coastal and developing nations (Rose 1996; Vannuccini 1999), and drives fisheries for a few high-value pelagic sharks (e.g. porbeagle and makos). However, it has become increasingly clear that the international demand for shark fins is the driving force behind most shark fisheries today (Clarke *et al.* 2007). In many waters, sharks are now targeted by fisheries that once discarded them (Buencuerpo *et al.* 1998; Camhi 1999; Mejuto *et al.* 2006a; Aires-da-Silva *et al.* 2008). Whereas this may seem a positive reduction in the waste of a valuable resource, most of these shark catches – especially in international waters – are poorly monitored, largely unmanaged and sometimes illegal (Lack and Sant 2008). Of greater consequence, however, is that most of these fisheries are currently unsustainable. Indeed, illegal, unreported and unregulated (IUU) fishing of these inherently vulnerable species is the main reason for their placement in Threatened categories of the Red List.

FAO collects information on the production of various shark products, including meat, fins and liver oil, which are made available in the Commodities Production and Trade database (FAO 2009). Like the FAO catch statistics, however, these data are fraught with problems associated with incomplete or inaccurate reporting by fishing nations. Given that species-specific data on shark catches are extremely limited, it is not surprising that shark trade data are even less species-specific (Lack and Sant 2008), making it difficult to monitor and control trade in species of concern. This role could potentially be filled by the Convention on International Trade in Endangered Species (CITES), but CITES Parties have been reluctant to adopt listings of the few commercially important shark species that have been proposed for inclusion in the Appendices (see below). Currently three shark species, which happen to be pelagic – white *Carcharodon carcharias*, whale and basking – are listed on CITES Appendix II, with all international trade in their products regulated under permit and recorded (by species and product type). Beyond these species (and sawfishes in family Pristidae, also listed under CITES) and the trade records provided by a very few countries, annual species-specific trade data for sharks are virtually nonexistent.

In 2005, the top five exporting nations for all shark products by weight were Taiwan, Spain, Japan, Panama and Costa Rica (representing 53% of total exports), and the top four importers were South Korea, Spain, Italy and Brazil (61% total). That same year, the biggest importers of fins were China, Malaysia, Indonesia, Thailand and Taiwan (Lack and Sant 2008).

Historically most sharks – especially those taken in high-seas fisheries – were discarded because of their low value and difficulties associated with storing their meat on board. This situation began to change in the 1980s when the demand for shark fin soup in Asian cultures began to grow (Cook 1990; Rose 1996; Clarke *et al.* 2007). Shark fins are one of the world's most expensive fishery products, and of much higher value than shark meat. In the last few years, for example, whole dried fins in the markets of Malaysia, Singapore and Thailand have been selling for US$200–$400/kg (SEAFDEC 2006). Shark fins account for 40% of the value in the reported shark trade, but comprise only 7% of the volume of this trade (Lack and Sant 2008).

Expanding international fin markets and high prices paid for fins has led to increased retention of pelagic (and other) sharks – or at least of their fins. The practice of "finning" of sharks that would have been previously discarded intact or released alive therefore became widespread in all waters, and particularly in tuna and swordfish fisheries.

Hong Kong dominates the global trade in shark fins, although its importance has declined somewhat in recent years (Clarke *et al.* 2007). During the past two decades, at least half of the shark fins traded by about 86 countries passed through the Hong Kong market (Vannuccini 1999; Clarke *et al.* 2006a), with the volume of trade increasing at about 6% per year during the 1990s (Clarke 2004). The global value of the shark fin trade was recently estimated to lie in the range of US$400–$500 million per year (Clarke *et al.* 2007). Clarke's extensive analysis of the Hong Kong shark fin market, combined with molecular genetic techniques for species identification (Clarke *et al.* 2006a, 2006b), have provided valuable insight into the importance of pelagic sharks in the global fin trade.

Experts estimate that the amount of shark fins passing through the Hong Kong fin market translate to the taking of 26 to 73 million sharks annually (Clarke *et al.* 2006a). This represents a biomass of 1.21 to 2.29 million tonnes, excluding sharks taken by fisheries whose fins do not reach this market, perhaps because they are discarded dead or consumed locally. As a group, pelagic sharks compose at least one-third of the identified fins passing through this market, although their contribution could be even higher given that 54% of the fins could not be identified (Clarke *et al.* 2006b). Fins of blue sharks were, by far, the most prevalent (17.3%), followed by hammerhead species (5.9%) and silky sharks (3.5%) (Table 5.4). These proportions may reflect the relative availability of these species in the catch, market preferences or a combination of both (Clarke *et al.* 2006b). These results suggest that between seven and 28 million pelagic sharks (including hammerheads *Sphyrna* spp.) are killed each year for their fins.

Shark meat has been consumed in coastal areas since the fourth century (Vannuccini 1999). More recently, shark meat was regarded as an undesirable, low-value product, largely because of the difficulty in handling the flesh, which is often tainted with urea. With the advent of refrigeration and the ability to process and freeze sharks onboard vessels, coupled with promotional marketing schemes, consumer demand for shark meat has expanded in some regions. In response, FAO-reported production of fresh, frozen and dried chondrichthyan meat and fillets tripled between 1985 and 2004, with Spain, Taiwan and Japan being the top producers of frozen meat (Hareide *et al.* 2007).

The species composition of shark meat in international trade (except for spiny dogfish *Squalus acanthias*) is even more poorly documented than that for fins. EU Member States imported 56% (while exporting 12%) of the global trade in shark meat in 2005; Spain and Italy were responsible for 67% of these imports (Hareide *et al.* 2007). Preferred species vary widely by country and region owing to differences in availability, cultural tastes and processing (Rose 1996; Vannuccini 1999) (Table 5.4). However, a number of species are known to have wide appeal throughout the world because of their high-quality flesh. Other than spiny dogfish, these are mainly pelagic species, especially shortfin mako, porbeagle and thresher *Alopias vulpinus* (pelagic *A. pelagicus* and bigeye *A. superciliosus* are less preferred than thresher), while whale shark is valued in Asia (Clarke *et al.* 2005). Despite widespread availability and prevalence in fisheries, blue sharks are not As widely consumed outside Spain and a few other markets because of the texture and taste of their flesh. Consumption of large pelagic sharks may pose a health risk to humans: As large predators at the top of the marine food web, sharks accumulate mercury in their body tissues (Moore 2000).

Even less is known about the quantity and species composition of elasmobranchs used in the production of leather or cartilage. However, the use of both fresh or frozen meat and skin from the same shark are often mutually exclusive. It is therefore unlikely that shortfin mako, thresher and porbeagle play much of a role in the leather market, since they are preferred species for their meat (Rose 1996).

Shark livers were sought in the 1930s for the production of lubricants and vitamin A supplements, but the liver oil markets collapsed after synthetic vitamin A became available (Rose 1996). Longfin mako *Isurus paucus* and hammerheads *Sphyrna* spp. are among the pelagic species known to have liver oil rich in vitamin A, while basking shark livers are preferred for their squalene content (Table 5.4). Blue, silky and thresher sharks are thought to have poor-quality but useable liver oil. In recent decades, deepwater sharks have become the most important source of liver oil. Shark liver oil is rich in various hydrocarbons and has also been used in the farming and textile industries, as lubricants, in cosmetics, as lamp fuel, as a traditional wood preservative on boat hulls and for a wide variety of functions in the pharmaceutical industry (Musick 2004). Norway, Korea and the Philippines are the only countries reporting recent trade in shark liver oil (Hareide *et al.* 2007).

Shark skeletons and teeth are also widely used. Shark cartilage, mainly from blue sharks, has been used in a number of pharmaceutical products touted primarily as treatments for joint pain and cancer. Little is known about the volume of production or trade in shark cartilage, but it appears to be a byproduct of sharks landed for their fins and meat rather than a driving force in shark fisheries. In addition, waste from the production of the various shark products discussed above may be used in the production of fishmeal (Rose 1996). Shortfin mako and white sharks are a preferred species by collectors of shark jaws and teeth (Kreuzer and Ahmed 1978; Rose 1996).

5.4 High-seas fisheries governance

It has been more than ten years since the Shark Specialist Group published *Sharks and Their Relatives* (Camhi *et al.* 1998), which drew attention to the vulnerability and conservation needs of chondrichthyan fishes. The intervening decade has seen considerable research on shark fisheries and biology, as well as science-based advocacy on behalf of shark populations around the world. Yet it remains true that "few shark fisheries are managed, and most of those are inadequately controlled" (Camhi *et al.* 1998).

Evidence abounds that most sharks are slow-growing, late to reproduce and give birth to relatively few young, resulting in a low reproductive potential. Indeed, sharks are among the latest-maturing and slowest-reproducing vertebrates on earth (Camhi *et al.* 1998; Musick 1999). As a group, pelagic sharks fall in the mid-range of shark productivity (Smith *et al.* 2008). Life-history traits, however, vary widely among the pelagic elasmobranch species, resulting in a wide range of reproductive potential: The bigeye thresher, shortfin mako and basking shark are among the least productive species, while the pelagic stingray and blue shark are among the most productive species (Au *et al.* 2008; Cortés 2008a; Smith *et al.* 2008; Dulvy *et al.* 2008). In addition, many elasmobranchs tend to aggregate by sex, age and reproductive stage, often increasing their vulnerability to fisheries. This intrinsic vulnerability to exploitation has resulted in high levels of threat: 16 of 21 evaluated species of oceanic elasmobranchs are now classified as Threatened or Near Threatened (this report; Dulvy *et al.* 2008). Therefore, fisheries that catch significant numbers of sharks (whether target or bycatch) may require a different management strategy than those for more resilient bony fish, if pelagic shark populations are to remain viable and their fisheries sustainable. As is the case for all highly migratory species, conservation actions in one area can be undermined by contrary actions (or lack of action) in another region or by other fishing nations. Effective management for pelagic sharks demands international, regional and national cooperation across their entire range. A recent review by Lack and Sant (2008), however, concludes that there is generally little effective management of shark stocks at either national or regional levels, and only a small number of species are subject to any international conservation measures. Where management is in place, it is generic (rather than species-specific), indirect (operating through controls on finning rather than controls on catch and mortality) and is generally poorly enforced.

The following sections are brief summaries of some of the international fisheries and wildlife conservation tools available to aid in the management of fisheries that catch pelagic elasmobranchs. Although these fisheries mainly take place in international waters, the affected species move between, as well as in and out of, the EEZs of coastal countries (i.e. they are characterised by transboundary movement). Unilateral action by fishing nations to manage and limit their vessels' shark catch wherever they fish is an important first step toward improving the conservation status of Threatened pelagic sharks (see IUCN SSG 2007; Camhi *et al.* 2008a).

5.4.1 Regional fisheries management bodies

The management of multinational fisheries in international waters is the responsibility of Regional Fisheries Management Organizations, (RFMOs; Figure 5.1). Other regional fisheries bodies (RFBs) primarily provide scientific assessment and management advice to RFMOs and their CPCs. A number of these have provided regular advice on elasmobranchs, including the International Council for the Exploration of the Sea (for the Northeast Atlantic) and the Secretariat of the Pacific Community (for the South Pacific). These advisory bodies do not regulate fisheries or implement the management measures they recommend. Such action is left to the RFMOs and individual fishing nations. As of 2007, all of the major shark-fishing nations and entities, except for Yemen, were members of at least one RFMO (Table 5.8).

Most of the world's RFMOs have been established to address the needs of fisheries for the most valuable bony fish, such as cod, flatfish, salmon, billfishes and tunas. Although collaborative, international management is particularly critical for pelagic sharks, given their wide-ranging movements, no RFMOs have been established specifically for elasmobranchs. Instead, these species in international waters fall under the purview of existing RFMOs. Most of these RFMOs focus on "tuna and tuna-like species," but have established bycatch and ecosystem working groups, and are slowly turning their attention to the management needs of sharks beginning with the collection of species-specific fisheries data (see Section 5.1). However, no RFMO has to date adopted a regional Shark plan in accordance with FAO's International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks; see below) or concrete limits on pelagic shark catches (Lack and Sant 2006; Camhi *et al.* 2008a; Cavanagh *et al.* 2008).

RFMOs and their actions on shark catches are listed in Table 5.2. Current resolutions and recommendations adopted by various RFMOs with respect to sharks are intended to:

- Improve the quantity and quality of species-specific data on catch and landings;
- Encourage live release;
- Prohibit finning and encourage full utilisation;
- Promote implementation of the IPOA–Sharks among their CPCs;
- Encourage research into gear selectivity, fishing techniques and shark habitat, to reduce bycatch and bycatch mortality; and
- Work toward population assessments for key shark species.

While the existing RFMO resolutions and recommendations are laudable, there are significant problems with their implementation and the extent to which they address the overfishing of pelagic sharks and rays. For one thing, not all actions in these resolutions are mandatory. Most render shark finning by their CPCs illegal, but other recommended actions (e.g. live release or research on gear selectivity and nursery habitat) are qualified by language such as "where possible," "are encouraged to," and "to the extent practicable." Even for the binding measures in these resolutions, such as finning bans and species-specific catch reporting, implementation by RMFO Contracting Parties is poor and there are no enforcement mechanisms or sanctions in place to encourage cooperation. Research is needed into gear modifications and fishing practices that could reduce the incidental catch of pelagic sharks and rays. It is likely, however, that such practices will only be adopted where the incentive to avoid sharks is greater than the incentive to retain them (Gilman *et al.* 2008).

As RFMOs expand their management of pelagic sharks, instances of illegal, unreported, and unregulated (IUU) fishing for sharks, especially hammerheads and silky sharks, are on the rise (Lack and Sant 2008). Known hotspots of IUU shark fishing occur off Central and South America and in the Western and Central Pacific. Given that pelagic sharks may be at even greater risk than their IUCN Red List status suggests (Dulvy *et al.* 2008), the persistent calls for improved data are important, but measures that effectively reduce shark fishing mortality are critical and urgent if we are to stem the ongoing depletion of these species.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is leading the way among RFMOs in addressing the management needs of pelagic sharks (Babcock and Nakano 2008). In response to the 1994 CITES Resolution concerning improved biological and trade data, ICCAT established a Sub-Committee on By-Catches in

1995 that requested all member countries to provide FAO with such data. In 2004, ICCAT passed a Recommendation (Rec. 04-10; Table 5.2) making it mandatory for its CPCs to report annual catch (Task I) and catch-effort data (Task II) for sharks. Although ICCAT collects landings data for at least 77 species of pelagic elasmobranchs taken in Atlantic fisheries, it has focused its attention mainly on blue, shortfin mako and porbeagle sharks. In 2004, ICCAT conducted preliminary assessments of Atlantic shortfin mako and blue sharks – the first such effort by an RFMO. This led in 2005 to a binding Recommendation that all ICCAT CPCs act to reduce fishing mortality for North Atlantic shortfin mako (Rec. 05-05). A 2007 ICCAT Recommendation (Rec. 07-06) reiterated its call for shortfin mako and imposed a similar mandate to reduce fishing mortality in fisheries targeting porbeagle, and committed to a porbeagle stock assessment by 2009.

Another critical finding of the 2004 assessment was that ICCAT's database was still too incomplete to enable full population assessments to be conducted. A call for improved catch data (including discards) was reiterated by ICCAT in 2006 (Recommendation 06-10). As concluded by an independent review of ICCAT's effectiveness, however, few ICCAT CPCs have taken these recommendations to heart and "there has been no measurable progress in the

Table 5.8 Total elasmobranch landings of major shark-fishing nations and participation in international and regional wildlife and fisheries agreements relevant to shark conservation[a], including the year their participation entered into force (adapted from Camhi *et al.* 2008a).

Country	Total 2007 landings (t)	CMS	CITES	UNCLOS	UNFSA	RFMO membership[b]	Shark Plan of Action status[c]
Indonesia	116,820	-	1979	1986	-	CCSBT, IOTC, *WCPFC*	Current status unknown
India	84,093	1983	1976	1995	2003	CCAMLR, IOTC	Current status unknown
Taiwan[d]	48,707					CCSBT, *ICCAT*, *IATTC*, WCPFC	Finalised in 2006
Spain[e]	46,187	1985	1986	1997	2003	CCAMLR, *CCSBT*, GFCM, *IATTC*, ICCAT, IOTC, NAFO, NEAFC, SEAFO, WCPFC	Covered under the EU Shark Action Plan, finalised in Feb. 2009
Argentina	44,112	1992	1981	1995	-	CCAMLR	Finalised in March 2009
Mexico	34,638	-	1991	1983	-	IATTC, ICCAT, *WCPFC*	Finalised in 2004
United States	34,287	-	1975	-	1996	IATTC, ICCAT, NAFO, WCPFC	Finalised in 2001
Malaysia	21,764	-	1978	1996	-	IOTC	Finalised in 2006
France[e]	19,622	1990	1978	1996	2003	CCAMLR, *CCSBT*, GFCM, *IATTC*, ICCAT, IOTC, NAFO, NEAFC,	Covered under the EU Shark Action Plan, finalised in Feb. 2009
Portugal[e]	18,464	1983	1981	1997	2003	CCAMLR, *CCSBT*, GFCM, *IATTC*, ICCAT, IOTC, NAFO, NEAFC,	Covered under the EU Shark Action Plan, finalised in Feb. 2009 SEAFO, WCPFC
New Zealand	17,409	2000	1989	1996	2001	CCAMLR, CCSBT, *NEAFC*, WCPFC	Finalised in 2008
Japan	17,257	-	1980	1996	2006	CCAMLR, CCSBT, GFCM, IATTC, ICCAT, IOTC, NAFO, *NEAFC*, WCPFC	Finalised in 2001, revised in 2009
Brazil	17,233	-	1975	1988	2000	CCAMLR, ICCAT	Drafted in 2006, awaiting adoption by fisheries agency
Thailand	16,925	-	1983	-	-	IOTC	Drafted in 2005, current status unknown
Pakistan	16,284	1987	1976	1997	-	IOTC	Current status unknown
Nigeria	15,292	1987	1975	1986	-	ICCAT	Current status unknown
Iran, Islamic Rep. of	13,187	2008	1976	-	1988	IOTC	Current status unknown
Yemen	12,387	2006	1997	1987	-	-	Current status unknown
Korea, Rep. of	11,374	-	1993	1996	2008	CCAMLR, CCSBT, ICCAT, IATTC, IOTC, NAFO, WCPFC,	Current status unknown
Venezuela	11,294	-	1978	-	-	IATTC, ICCAT	Drafted in 2005, awaiting official approval
Canada	10,258	-	1975	2003	1999	*CCAMLR*, *IATTC*, ICCAT, NAFO, *NEAFC*, WCPFC	Finalised in 2007
Total	**627,594**						

[a] Major shark-fishing nations defined as reporting >10,000t of elasmobranch landings to FAO in 2007 (FAO 2009).

[b] RFMOs in italics indicate Cooperating non-Contracting Parties, Entities or Fishing Entities. Entities are: CMS = Convention on Migratory Species; CITES = Convention on International Trade in Endangered Species; UNCLOS = UN Convention on the Law of the Sea; UNFSA = UN Fish Stocks Agreement; CCAMLR = Convention on the Conservation of Antarctic Marine Living Resources; CCSBT = Commission for the Conservation of Southern Bluefin Tuna; GFCM = General Fisheries Commission for the Mediterranean; IATTC = Inter-American Tropical Tuna Commission; ICCAT = International Commission for the Conservation of Atlantic Tunas; IOTC = Indian Ocean Tuna Commission; NAFO = Northwest Atlantic Fisheries Organization; SEAFO = South East Atlantic Fisheries Organization; NEAFC = North East Atlantic Fisheries Commission; WCPFC = Western and Central Pacific Fisheries Commission.

[c] International Plan of Action–Sharks (IPOA). See Cavanagh *et al.* (2008). The following six States also finalised an NPOA: Australia (2004, currently undergoing revision); Chile (2007); Ecuador (2005); Namibia (2004); Seychelles (2006); and Uruguay (2008). The following 22 States have reported varying degrees of NPOA progress but the current status is unknown: Brazil; Brunei Darussalam; Cambodia; Cape Verde; Colombia; Guinea; Guinea-Bissau; India; Indonesia; Malaysia; Maldives; Mauritania; Myanmar; Pakistan; Peru; Philippines; Senegal; Sierra Leone; South Africa; Thailand; The Gambia; and Vietnam.

[d] Within the UN, Taiwan is not recognised as a separate government from the People's Republic of China, which precludes their membership in UN agreements.

[e] These countries are members of the following RFMOs as a member of the 27-nation European Community (EC): Contracting party to CCAMLR, GFCM, ICCAT, IOTC, NAFO, NEAFC, SEAFO, WCPFC, and as a Cooperating non-Contracting Party of CCSBT and IATTC. In addition to their membership under the EC, some EC Member States hold separate seats at RFMOs on behalf of their overseas territories, including France and UK at IOTC; France and Spain at IATTC; France, Spain and UK at CCAMLR; France at NAFO; France at WCPFC; and France and Spain at GFCM.

quantity and quality of the overall shark catch statistics" (Hurry *et al.* 2008). For the 2008 ICCAT shark assessment, given these data limitations, ICCAT scientists undertook an ecological risk assessment (ERA) using fisheries and biological data as well as information from the IUCN Red List status assessments for 12 species of pelagic sharks and rays taken in ICCAT fisheries (Dulvy *et al.* 2008; ICCAT 2008c; Table 5.5). Scientists highlighted bigeye thresher as the Atlantic pelagic shark with the greatest inherent risk of overfishing in ICCAT fisheries and noted that the species was of low commercial value and easy to identify. Still, ICCAT CPCs rejected proposals to prohibit retention of this species, opting instead to require release of live individuals (Rec. 08-07). Such action does little to change the current situation, considering the lack of compliance on other shark measures and the absence of at-sea monitoring and enforcement.

To its credit, ICCAT was the first RFMO to prohibit the practice of finning (see below). Other RFMOs around the world have followed ICCAT's lead by adopting virtually identical resolutions mandating data collection, finning bans, full utilisation, and encouraging live release and implementation of the IPOA–Sharks (see Table 5.2). Still, compliance with such measures is low and no follow-up examination has been initiated. However, there are increasing reports of finning violations and illegal and unauthorised shark fishing, including incidents in protected waters (see Lack and Sant 2008).

Possibly one of the biggest impediments to ensuring sustainable pelagic shark fisheries is the failure of RFMOs to heed the advice of their own scientific committees or of other scientific advisory bodies (Dulvy *et al.* 2008). For example, in 2006 and again in 2007, ICES recommended no targeted fishing for Northeast Atlantic porbeagle sharks (ICES 2006, 2008). In response, however, ICCAT stopped short of concrete measures and instead called on its CPCs to reduce porbeagle fishing mortality and called on ICCAT and ICES scientists to convene a porbeagle assessment by 2009. In 2008, ICES heightened porbeagle warnings by calling for a prohibition on landings. The same year, NAFO scientists warned of a potential "crash" of the Northwest Atlantic porbeagle population from new, international fisheries and turned to ICCAT to take action for porbeagles (NAFO 2008). Rather than taking immediate action to stem fishing mortality, RFMO Contracting Parties called for a special RFMO meeting to be convened in 2009 to address the recommendations from the forthcoming June 2009 ICCAT/ICES porbeagle assessment. To date, no catch limits or other direct measures have been implemented by RFMOs for this Threatened species. Similarly, the North Atlantic Fisheries Organization (NAFO) set the world's first international quota for an elasmobranch (the thorny skate *Amblyraja radiata*) in 2005 (NAFO 2006), but at levels higher than the scientific advice. Since then, NAFO scientists have advised halving that limit, but NAFO members have not adopted the scientific recommendations.

In 2006, CCAMLR, the Commission for the Conservation of Antarctic Marine Living Resources took unprecedented action by adopting a moratorium on directed shark fishing until data become available to assess the impacts of fishing on sharks in the Antarctic region (Table 5.2). The live release of sharks taken as bycatch is encouraged but not mandated, thereby leaving room for unlimited take of incidentally caught sharks (Conservation Measure 32-18; CCAMLR 2006).

In summary, despite the Threatened Red List status of many pelagic elasmobranchs, there still are no regional or international catch limits for any pelagic shark or ray. Further analyses of the measures taken by RFMOs with respect to pelagic sharks can be found in Lack and Sant (2006), IUCN SSG (2007), Camhi *et al.* (2008a, 2008b) and Babcock and Nakano (2008).

5.4.2 Finning regulations

Demand for shark fins is now acknowledged to be a driver of shark mortality in directed and bycatch shark fisheries, especially in international waters (Clarke *et al.* 2007, Lack and Sant 2008). This is of particular consequence for pelagic shark species, which contribute a significant proportion of the shark fins in trade (Clarke *et al.* 2006a, 2006b). The expanding fin markets and very high value of shark fins relative to shark meat (dried fins sell on average for US$100/kg; Clarke *et al.* 2007) provide incentive to pursue the wasteful practice of shark finning (cutting off a shark's fins and discarding its carcass at sea), even while finning is now increasingly illegal in most international waters (Table 5.7).

Although much of the political will for banning shark finning results from the public's perception of cruelty, most domestic and international finning bans focus on the need to reduce waste and remove the incentive to target sharks just for their fins. By promoting full utilisation, the bans aim to reduce the number of sharks killed per trip by requiring that carcasses be retained on vessels along with fins. How effective these bans are in ending finning is contingent on how they are implemented and how well they are enforced. Sharks that are discarded dead at sea or whose carcasses are discarded after landing obviously result in no reduction in mortality (Lack and Sant 2006). Similarly, full utilisation of every shark caught will not result in sustainable fisheries or recovery of depleted populations if unsustainable numbers of sharks are caught in the first place.

Today, nine RFMOs whose fisheries take sharks have adopted mandatory prohibitions on finning, making finning illegal in most international waters of the world (Table 5.7; Figure 5.1). In addition, the EU (whose regulations apply to all 27 Member States, including Spain, France, and Portugal) and 21 additional fishing nations have adopted shark finning bans for their fishing vessels and waters. These bans, however, vary greatly in terms of the waters and fisheries they apply to. For example, Japan recently adopted a regulation banning shark finning by Japanese vessels *except* for far seas and coastal vessels operating and landing outside of Japanese waters (Regulation 60-2-2). In theory, fishing nations that have not adopted domestic finning bans are still subject to finning regulations of the RFMOs that they are party to and have committed to enact comparable measures for their own waters. The Western and Central Pacific Fisheries Commission (WCPFC) recently took an important step in extending its finning ban to all vessels of its CPCs (CMM 2008-06), not just those over 24m as previously mandated.

In most cases, including all RFMOs, finning bans are implemented through a fin-to-carcass weight ratio. Fin weights vary by species and method used to cut the fins. Adopting species-specific ratios, however, could impose an additional enforcement burden in mixed-species fisheries. Where a single fin-to-carcass ratio is used for all species, it should not exceed 5% of the dressed carcass weight as this value has been demonstrated as an upper limit in mixed shark fisheries that do not remove the entire caudal fin (Cortés and Neer 2006). The IUCN has also recommended a 5% dressed weight limit, estimating that using whole weight allows two or more sharks to be finned for each shark kept (IUCN 2003). The EU has the most lenient finning ban by limiting fin weights of up to 5% of the whole (or theoretical) shark and allowing fins and carcasses to be landed separately. Brazil also employs a 5% whole weight ratio, while 5% of the dressed shark weight is used in Canada and Pacific waters of the US (Table 5.7). As a result of these discrepancies, all RFMO finning bans currently fail to specify whether the 5% ratio refers to dressed or whole weight.

There is virtual consensus among conservationists and scientists that the most reliable and effective way to prevent shark finning is to require sharks to be landed with their fins *naturally* attached (IUCN 2003; Hareide *et al.* 2007). Such a policy simultaneously facilitates species-specific recording of landings and products in trade. To address storage concerns, fins can be partially cut (three-quarters of the way through) and laid flat against the carcass, which then can be frozen onboard ship. A number of countries, including Costa Rica, Panama, El Salvador, Ecuador, Columbia, and the United States (in Atlantic waters only), now require that sharks be landed with their fins naturally attached.

Recent concerns over problems with finning regulations (e.g. attempts to increase the fin-to-carcass weight ratios, allowing fins and carcasses to be landed separately, and difficulties identifying species without fins) led the IUCN World Conservation Congress to issue a policy recommendation on shark finning in 2008 (IUCN 2008b). Among other things, it "calls on those States with fisheries that capture shark, whether in directed fishery activities or as accidental by-catch of other fisheries, to require at the point of first landing that sharks be landed only if their fins are *naturally* attached to their bodies, though allowing for partial detachment of fins to permit efficient storage and species identification." In March 2009, nearly 70 conservation and recreational organisations petitioned the IOTC to require that shark fins remain naturally attached, which was in line with the preferred recommendation from its own Scientific Committee. Instead, the EU and Australia proposed, among other things, replacing the fin-to-carcass ratio with mandates to attach bags of fins to sharks. With several Asian countries objecting to that option and no Parties proposing that fins remain naturally attached, the IOTC finning ban remained unchanged in 2009 (Shark Alliance 2009).

The effectiveness of existing finning bans remains largely unknown because of the difficulty in monitoring and enforcing them, although seizures for ratio violations have occurred in domestic and international waters (Lack and Sant 2008). Whereas properly enforced finning bans may serve as a means to curb shark mortality (due primarily to limitations on vessel hold capacity), full utilisation of sharks is by no means a panacea. These are still indirect management tools focused largely on waste reduction, and cannot ensure healthy shark populations, especially when they contain enforcement loopholes. Recovery of Threatened pelagic shark species and sustainable use of others, as highlighted in this report, will require the establishment and enforcement of catch limits to cap, reduce or minimise shark mortality until better species-specific data and robust population assessments are available as a basis for management.

5.5 International and regional instruments relevant to the conservation of pelagic sharks and rays

The legal instruments discussed below fall into two main categories: those that are legally binding on their Contracting Parties ("hard law"), such as treaties and conventions, and those that are nonbinding ("soft law"), which include some resolutions and guidelines. As with the RFMOs, there are no international or bilateral treaties specifically committed to shark management, yet international initiatives are critical to the conservation of these highly migratory species (Weber and Fordham 1997; Fowler *et al.* 2005; Camhi *et al.* 2008a). A number of international agreements can be invoked to address the conservation needs of pelagic sharks, particularly those that are Threatened or severely depleted. These can be divided into two broad but overlapping categories: fisheries management (UNCLOS, UNSFA, IPOA–Sharks) and wildlife conservation (CMS and CITES) initiatives. These agreements, however, provide only a framework for management: RFMOs and fishing nations must still implement and enforce the measures necessary to ensure the well-being of pelagic shark populations.

The discussion that follows pertains to the application of these agreements specifically to pelagic elasmobranchs (see Camhi *et al.* 2008a). See Weber and Fordham (1997), Fowler *et al.* (2005), and Cavanagh *et al.* (2008) for a more general discussion of the potential, provisions, and pitfalls of these instruments, and Lack and Sant (2008) for a review of illegal, unreported, and unregulated (IUU) shark fishing.

5.5.1 United Nations Convention on the Law of the Sea

Adopted in 1982 and in force in July 1994, UNCLOS provides a legal framework giving coastal nations the right to manage resources within their EEZ (to 200 nautical miles), and establishes maximum sustainable yield, qualified by environmental and economic factors, as a fishery management goal. Many of the oceanic sharks covered in this report are listed as "highly migratory species" under Annex I of UNCLOS and are therefore subject to the provisions of this convention (Table 5.6). This includes the obligation on fishing nations to ensure that overexploitation does not endanger these species in the waters under their jurisdiction, and the requirement that fishing and coastal nations cooperate (such as through bilateral or international agreements) in the conservation of these species throughout their ranges. The implementation of UNCLOS has been facilitated and amplified in the provisions of the UN Fish Stocks Agreement (see below). As of March 2009, 157 nations have ratified the Law of the Sea, including 16 major shark-fishing nations (in 2007), and signatories are therefore bound by its provisions (Table 5.8). However, as demonstrated by the inability of RFMOs to stem dramatic declines in pelagic sharks, effective implementation of UNCLOS objectives has yet to be realised for these (indeed also for most other) target pelagic species.

5.5.2 United Nations Agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks

The UN Fish Stocks Agreement (UNFSA) was adopted in 1995 and came into force in December 2001; it is binding on the countries that ratify it. As of March 2009, 75 nations have ratified the Agreement, including 11 of the 21 major shark-fishing nations in 2007 (Table 5.8). UNFSA's management goal is "to ensure the long-term conservation and sustainable use" of straddling (i.e. those that move between EEZs, or between EEZs and the high seas) and highly migratory fish stocks. As the most detailed and comprehensive fishery agreement to date for highly migratory species (Weber and Fordham 1997), UNFSA embodies a key provision that is of the utmost relevance to the management of pelagic sharks: the precautionary approach. This approach urges cautious but expeditious management action even when information is "uncertain, unreliable, or inadequate," which is frequently the situation for fisheries taking pelagic sharks. The agreement also sets out mechanisms for cooperation among fishing nations and calls for the strengthening of existing fishery regimes and establishing new regimes where they are needed. The WCPFC is one such new agreement: Its provisions therefore come closest (of all RFMOs) to reflecting the intention of UNFSA.

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

In acknowledging the threat that fishing poses to shark populations around the world, as well as its obligation to address these threats under the framework of the Code of Conduct for Responsible Fisheries, FAO developed the International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks) in 1999. The Plan encompasses the precautionary approach, and its objective is to ensure the conservation and management of sharks and their long-term sustainable use by calling on all fishing nations and RFMOs to assess the status and conservation needs of elasmobranchs under their purview (via a Shark Assessment Report). It further directs countries and RFMOs whose fisheries catch sharks to prepare and implement a National (NPOA) or Regional Shark Plan, in accordance with the technical guidelines provided, to ensure that the catch is sustainable. These Shark Plans should assess threats to sharks in all waters where their vessels fish, identify species particularly at risk, minimise waste, improve species-specific fisheries data and cooperate in research and management initiatives with other fishing nations (FAO 1999).

This initiative pertains to all chondrichthyans in all waters and so is not specific to pelagic sharks. The IPOA–Sharks guidelines emphasise the need for regional plans where international cooperation is necessary. This would certainly be the case for ocean-going sharks and rays, which are targeted or taken as bycatch in multinational fisheries in international and transboundary waters.

Of significant consequence is that the IPOA–Sharks is wholly voluntary. Given the wide agreement over the declining status of many chondrichthyans, progress toward the implementation of the IPOA–Sharks has been slow (Cavanagh *et al.* 2008). FAO requested all shark-fishing nations to submit their Shark Plans by 2001. Of the 134 shark-fishing nations, NPOAs have been adopted to date by a total of 40 States: 13 countries plus the 27 Member States of the European Union, which includes three of the world's top shark-fishing nations – Spain, France, and Portugal (Table 5.8), as well as landlocked countries. In addition, 22 other States have reported that they are working on their NPOAs but the status of their plans is not known. No RFMO has drafted or implemented a Regional Shark Plan. The adopted Shark Plans vary widely in scope and to the extent that they meet the objectives and recommendations of the IPOA. The recently adopted (February 2009) European Community Shark Plan, however, commits to scientifically based catch limits, a prohibition on all shark discards, marine protected areas for particularly vulnerable species and life stages and a stronger EU finning ban (European Commission 2009).

It is particularly troublesome for pelagic and highly migratory elasmobranchs that no RFMO has developed or implemented a regional Shark Plan. The closest that any RFMO has come is the adoption of resolutions requiring mandatory species-specific reporting of shark landings, banning the practice of finning, encouraging live release and calling for reductions in fishing mortality but without setting catch limits. As noted above, cooperation and follow-through on these directives has been rather poor, at best. The lack of financial resources and technical capacity may explain to some extent the slow progress of some countries (less so for RFMOs) in drafting their NPOAs. It is the continuing lack of political will and low management priority afforded sharks, however, that remain the biggest obstacles toward effective IPOA–Sharks implementation (Lack and Sant 2006; Cavanagh *et al.* 2008) and healthy populations of pelagic sharks and rays in the world's oceans.

5.5.4 The Convention on the Conservation of Migratory Species of Wild Animals

The Convention on Migratory Species of Wild Animals (CMS), adopted in 1979 and entered into force in November 1983, was formulated to protect animals (not just fish) that inhabit international waters or that migrate across national boundaries. As of November 2008, nine of the 21 major shark-fishing nations (>10,000t in landings in 2007) had ratified the Convention (Table 5.8). Migratory species that are at risk of extinction in all or part of their ranges can be listed on Appendix I and should be conferred strict protection. Migratory species with unfavourable conservation status (they need not be endangered) may be listed on Appendix II. Species can be listed on one or both appendices. All range states, whether or not they are members of CMS, are encouraged to enter into agreements for the conservation and management of Appendix II species that would benefit from international cooperation.

Because all oceanic sharks are highly migratory and 75% of the 80 migratory species evaluated are listed as Threatened or Near Threatened on the IUCN Red List (IUCN SSG 2007; IUCN 2009c), CMS is an appropriate instrument to help address their conservation needs. In 2005, in recognition of the continuing threats, CMS Parties adopted a resolution on migratory sharks (Rec. 8.16; CMS 2005) requesting that all Parties, among other things, strengthen measures to protect migratory sharks against threats such as habitat destruction, IUU fishing and fisheries bycatch.

Currently, seven elasmobranchs are listed on the CMS appendices (Table 5.5). The whale shark was listed in 1999 in Appendix II, and white and basking sharks were listed on Appendices I and II in 2002 and 2005, respectively. Shortfin and longfin mako sharks, porbeagles and northern hemisphere populations of spiny dogfish, were added to Appendix II in 2008.

In 2007, the IUCN SSG prepared a database of all migratory sharks and rays and a background paper on their conservation status, including recommended actions that could promote international cooperation in shark conservation under the CMS (IUCN SSG 2007). Following additional consultation, the Scientific Council of CMS determined that 35 sharks and rays (beyond the three listed at the time) meet the criteria for listing in the CMS appendices. The same year, CMS began a process to develop a global instrument for migratory sharks. CMS has convened two international conferences to negotiate details. It appears that the instrument will be a non-binding Memorandum of Understanding (MoU), with an Action Plan to guide the management of migratory sharks, but it remains unclear whether it will include actions for the four additional species listed in 2008. Further negotiations over the CMS global migratory shark instrument will take place in the Philippines in late 2009, and it is hoped that an MoU will open for signature before the year end.

5.5.5 The Convention on International Trade in Endangered Species of Wild Fauna and Flora

CITES, which came into force in 1975, provides a legal framework to monitor and control the international trade in species that are overexploited by such trade; it is one of the most effective agreements in regulating natural resource use (Fowler and Cavanagh 2005). Animals or plants threatened with extinction may be listed in Appendix I, essentially banning international trade in these species or their parts. Appendix II is reserved for species that could become threatened if trade is not controlled; trade in these species is closely monitored and allowed only after exporting countries provide evidence that such trade is not detrimental to populations of the species in the wild. In 2009, 175 countries were Party to CITES, including all of the major shark-fishing nations (Table 5.8).

Many pelagic sharks appear to be appropriate candidates for listing under CITES given their Threatened status and the substantial international trade in their parts – especially fins – which drives overexploitation. Indeed, at least one-third of the identified shark fins passing though the Hong Kong fin market are from pelagic sharks (Clarke *et al.* 2006a, 2006b). CITES Parties first turned their attention to sharks in 1994, when they acknowledged that existing fishery management measures were not doing enough to stem the decline of many shark populations. In Resolution Conf. 9.17, CITES Parties, RFMOs, and non-governmental organisations were asked to compile biological and trade status data for sharks involved in international trade. The SSG prepared *Sharks and Their Relatives* (Camhi *et al.* 1998) in response. This Resolution turned out to be a watershed event in global shark management. Over the next decade, it led to extensive data collection on shark landings and trade in many management arenas, stimulated the development of the FAO's International Plan of Action–Sharks; Fowler and Cavanagh 2005; Cavanagh *et al.* 2008) and laid the groundwork for the eventual listing of shark species in the CITES Appendices.

The first shark species listed under CITES – whale and basking sharks – were added to Appendix II in 2002; white sharks were listed on Appendix II in 2004. In addition to these pelagic species, all but one species of sawfish (Family Pristidae) were listed on Appendix I in 2007 (*Pristis microdon* was listed in Appendix II) (Table 5.5). Efforts to list porbeagle and spiny dogfish in Appendix II in 2007 were unsuccessful, but may resume at the next CITES Conference of the Parties in 2010.

The goal of listing sharks in CITES is to ensure that their trade is sustainable and not detrimental to the survival of the species. To that end, in addition to collecting species-specific catch, trade and status data, CITES urges its Parties, FAO and RFMOs to improve their capacity for the management of shark fisheries, such as through the development of Shark Plans in accordance with FAO's IPOA. A working group on sharks has been established by the CITES Animals Committee; it has identified a number of pelagic shark species of concern because their status is unfavourable and they enter international trade, and offers regular advice on priority management actions.

CITES Parties are required to implement the provisions of CITES in relation to listed species, unless a Party takes out a reservation for that species. International trade (including landings from the high seas) in species listed in the CITES Appendices, or their products, is only permitted when accompanied by a non-detriment finding (NDF) and declaration that the product was taken legally. NDFs define whether the export is detrimental to the survival of the species. They focus on the status of the population and, based on this, assess whether trade is likely to be promoting an undesirable level of exploitation (García Núñez 2008). Listing of commercially important pelagic shark species in Appendix II of CITES provides an important incentive for the sustainable management of listed species, because effective management by all countries exploiting a stock is one of the prerequisites for permitting international trade to take place. Under an Appendix II listing, failure to ensure the management of the whole stock will result in the inability to dispose of product on the lucrative international market and ultimately the economic failure of target fisheries for the species (Lack 2006).

Most proponents of CITES listings for sharks argue that such trade controls can complement fisheries management measures, while opponents to shark listings under CITES generally maintain that the full responsibility for international shark management lies with FAO and the RFMOs. Seldom if ever, however, do the States opposing listing sharks under CITES champion concrete shark management measures at RFMOs. Evaluation of the effectiveness of existing CITES listings for sharks is needed and would be enlightening for both sides.

6 Conclusions

This report presents the first comprehensive IUCN Red List assessments for the 64 known species of pelagic sharks and rays. Of these species, 32% are assessed as Threatened, with 6% classified as Endangered and 26% as Vulnerable on a global basis. A further 24% are considered Near Threatened. Where data allowed, the status of individual stocks was also assessed: Some stocks were deemed Critically Endangered, including Northeast Atlantic porbeagles, Mediterranean porbeagles and Mediterranean shortfin makos. As a group, the overall conservation status of the pelagic elasmobranchs is significantly worse than that for chondrichthyans as a whole, of which 17% are considered globally Threatened.

Overfishing is the primary threat to the conservation status of these sharks and rays: Tens of millions are taken each year on commercial longlines, purse seines and gillnets in all oceans of the world. Of the 21 oceanic pelagic species caught regularly in high-seas fisheries, 52% are Threatened (Dulvy *et al.* 2008). Many of these species are caught incidentally in fisheries targeting tunas and billfishes, with blue, shortfin mako, silky and oceanic whitetip sharks being the most prevalent species in such catches. With rising worldwide demand and prices paid for shark fins and meat, these same fisheries are now increasingly targeting and/or retaining pelagic sharks and rays. Other species, including porbeagle, basking and whale sharks, have been the targets of fisheries for decades. Conservation concerns have led to the closure of most basking and whale shark fisheries, but directed fisheries continue on Threatened porbeagle populations. Collectively, pelagic sharks account for about one-third of the fins entering the global shark fin trade (Clarke *et al.* 2006b). Most of this fishing and trade – which are simply outpacing the productivity of these slow-growing species – is poorly monitored and largely unregulated.

There is widespread concern over the poor quantity and quality of fisheries data for pelagic elasmobranchs. One-quarter of the 64 species lacked sufficient information to determine their status and so were assessed as Data Deficient. Yet repeated calls for improved data on landings and discards, even those from regional fisheries management organisations (RFMOs), have largely gone unheeded by fishing nations. Despite increased awareness of their vulnerability to overfishing, sharks and rays remain a low priority for fishery managers, who continue to focus their attention on more productive and highly valued bony fishes. Given the well-documented vulnerability and Threatened or unknown status of so many pelagic elasmobranchs, lack of data or population assessments must not be used as an excuse to delay the implementation of management measures. Indeed, the more we learn about pelagic sharks and rays – their life histories, mortality in fisheries and demand for their products – the more worrisome the picture of their status becomes.

Regional and international cooperation is critical to the effective management of high-seas and transboundary fisheries for these highly migratory species. To date, however, no RFMO has developed or implemented a regional Shark Plan as agreed through the IPOA–Sharks. There are no international catch limits for any pelagic shark or ray, although some limits are in place in domestic waters, especially for basking, great white and whale sharks. Shark finning bans are the only tangible management tools currently being used outside EEZs. These are important first steps, but are not sufficient to counter the illegal, unreported and unregulated (IUU) fishing that is threatening these inherently vulnerable species. CITES Appendix II listings for basking, great white and whale sharks should improve the monitoring and control of commerce in these species, while CMS offers hope for regional agreements for these and other listed species (including mako and porbeagle), as well as a global instrument for the conservation of migratory sharks. Many more elasmobranch species qualify and may soon be formally considered for listing under these and other conservation treaties.

Because fishing pressure on many already depleted shark species will likely continue to grow, it is critical that conservation efforts are accelerated. Successful management must not be measured solely by the number of Shark Action Plans or finning bans adopted, but rather by the recovery of pelagic shark and ray populations in all the world's oceans. Stricter, more enforceable shark finning bans and meaningful catch limits in all fisheries that take significant numbers of pelagic sharks and rays are immediately in order. Whereas all Threatened sharks and rays warrant measures to reduce fishing mortality, Endangered and Critically Endangered species and stocks should be fully protected throughout their ranges, as a matter of priority. Greater investment in fisheries data collection, elasmobranch life-history studies and bycatch reduction research can further fine-tune species-specific management and help ensure that pelagic shark and ray mortality is kept to sustainable levels.

7 Recommendations

Proposed management actions that would contribute to rebuilding threatened populations of oceanic pelagic elasmobranchs and sustaining associated fisheries.

Fishing nations and Regional Fisheries Management Organizations (RFMOs) are urged to:

- Implement as a matter of priority existing scientific advice for preventing overfishing, or to recover pelagic shark populations (e.g. ICES advice to prohibit the landings of Northeast Atlantic porbeagle, ICCAT Scientific Committee recommendation to reduce fishing mortality on North Atlantic shortfin mako sharks);
- Draft and implement Plans of Action pursuant to the IPOA–Sharks, which include, wherever possible, binding, science-based management measures for pelagic sharks;
- Significantly increase observer coverage, monitoring and enforcement in fisheries taking pelagic sharks;
- Require the collection and accessibility of species-specific shark fisheries data, including discards, and penalise non-compliance;
- Conduct stock assessments for pelagic elasmobranchs;
- Implement pelagic shark catch limits in accordance with scientific advice; when sustainable catch levels are uncertain, implement fishing limits based on the precautionary approach;
- Prohibit landings of pelagic shark species deemed particularly vulnerable through Ecological Risk Assessments conducted for ICCAT (e.g. bigeye threshers, longfin makos, *etc.*) and those classified as *Critically Endangered* or *Endangered* by IUCN (e.g. scalloped hammerheads);
- Strengthen finning bans through enforcement and by requiring sharks to be landed with fins attached; until then, ensure that fin-to-carcass ratios do not exceed 5% of dressed weight (or 2% of whole weight) and standardise RFMOs' finning bans to specify that ratios apply to dressed rather than whole weight;
- Promote research on gear modifications, fishing methods and habitat identification aimed at mitigating elasmobranch bycatch and discard mortality; and
- Commence programmes to reduce and eventually eliminate overcapacity and associated subsidies in pelagic fisheries.

Country governments are urged to:

- Propose and work to secure pelagic shark management at RFMOs;
- Promptly and accurately report shark landings to relevant national and international authorities;
- Take unilateral action to implement domestic management for fisheries taking pelagic elasmobranchs, including establishing precautionary catch limits and protective status where necessary, particularly for species classified by IUCN as Endangered or Critically Endangered;
- Adopt bilateral fishery management agreements for shared, pelagic elasmobranch stocks;
- Ensure active membership in CITES, CMS, RFMOs and other relevant international agreements;
- Ensure full implementation and enforcement of CITES shark listings based on solid non-detriment findings, if trade in listed species is allowed;
- Propose and support the listing of additional threatened pelagic shark species under CITES and CMS and other relevant wildlife conventions;
- Promote action for pelagic elasmobranchs based on advice of the CMS Scientific Council, the CITES Animals Committee and the scientific committees of Regional Fisheries Bodies;
- Collaborate on regional agreements and a new, global migratory shark instrument under CMS and strive for the inclusion of all CMS listed species and concrete conservation actions; and
- Strictly enforce shark fishing and protection measures and impose meaningful penalties for violations.

These recommendations are based on those of the SSG's Pelagic Shark Red List Workshop, but they have been augmented and updated by the editors and compilers of this report.

8 Red List assessments

Editors' note: This section contains a compilation of Red List assessments for pelagic sharks and rays undertaken by experts at a series of SSG regional and thematic Red List workshops over a seven-year period (2000–2007) and by SSG members outside of these workshops (see Section 3). The summaries below are taken directly from the original assessment forms (with minor edits) and therefore reflect the variability in style and content of the many contributors. The Red List assessments presented here will be updated and synthesised as new information is obtained. Readers are urged to consult the Red List web site (http://www.iucnredlist.org) for the most current assessments.

8.1 Sharks

ORDER **HEXANCHIFORMES**

FAMILY **CHLAMYDOSELACHIDAE**

Frilled Shark

Chlamydoselachus anguineus Garman, 1884

Red List assessment **Global: Near Threatened** (Paul, L. and Fowler, S. 2003)

Rationale This shark is a generally rare to uncommon deepwater species, although there are a few localities where it is taken more commonly as bycatch in several fisheries. Not an important target species, but a regular though small bycatch in many bottom trawl, midwater trawl, deep-set longline and deep-set gillnet fisheries. As bycatch, this species is variously either used for meat or fishmeal, or discarded. It is also occasionally kept in aquaria (Japan). There is some concern that expansion of deepwater fishing effort (geographically and in depth range) will increase the levels of bycatch. Although little is known of its life history, this deepwater species is likely to have very little resilience to depletion as a result of even non-targeted exploitation. It is classified as Near Threatened due to concern that it may meet the Vulnerable A2d+A3d+4d criteria.

FAMILY **HEXANCHIDAE**

Bluntnose Sixgill Shark

Hexanchus griseus (Bonnaterre, 1788)

Red List assessment **Global: Near Threatened** (Cook, S.F. and Compagno, L.J.V. 2005)

Rationale This species is wide-ranging, although patchily distributed, in boreal, temperate and tropical seas. It is a deep-benthic, littoral and semipelagic shark, not known to be epipelagic. Young are often found close inshore, adults often in deeper water, although adults and sub-adults are known to enter shallow water in bays with adjacent deepwater canyons. In tropical areas it tends not to penetrate coastal waters. Largely caught as a bycatch of other fisheries, this is also a valuable food and sports fish that appears very vulnerable to overfishing, and unable to sustain intensive, targeted fisheries for long periods. Some regional populations have been severely depleted, for example, in the Northeast Pacific. However, population and fisheries data are lacking from many regions.

ORDER **SQUALIFORMES**

FAMILY **ETMOPTERIDAE**

Broadband Lanternshark

Etmopterus gracilispinis Krefft, 1968

Red List assessment **Global: Least Concern** (Burgess, G.H., Amorim, A.F., Mancini, P. and Gonzalez, P. 2007)

Rationale *Etmopterus gracilispinis* is a small lanternshark (to at least 33cm TL) inhabiting the outer continental shelf and upper to middle slopes at depths of 100 to 1,000m. It is also epipelagic and mesopelagic at depths of 70 to 480m over waters of 2,240m off Argentina and off South Africa. It has a widespread but disjunct distribution in the Western Atlantic and off southern Africa. In the Western Atlantic, it is known from off the USA, Suriname, southern Brazil, Uruguay and Argentina. Like most other lanternsharks, its biology and ecology are poorly known. Some mortality from pelagic and deepwater fisheries is likely to occur across the species' range; for example, the species is a rare bycatch of Santos longliners off southern Brazil, and in deepwater fisheries off the USA. However, this mortality is of no immediate threat to the viability of the species given the limited catches in these fisheries, and the widespread benthic, epibenthic, epipelagic and mesopelagic occurrence of the species. As such, the species is assessed as Least Concern. As with other deepwater species though, any future expansion of deepwater fisheries within its range should be closely monitored.

Smooth Lanternshark

Etmopterus pusillus (Lowe, 1839)

Red List assessment **Global: Least Concern** (Coelho, R., Tanaka, S. and Compagno, L.J.V. 2009)

Rationale *Etmopterus pusillus* is a deepwater lanternshark that occurs in the Atlantic, Pacific and Indian Oceans, found on or near the bottom of continental and insular slopes at depths of 150–1,000m, and possibly down to almost 2,000m. The species is also oceanic in the central south Atlantic, and is found from the surface to 708m depth over deep water. Although *E. pusillus* is of little interest to global fisheries, it is a bycatch of bottom trawls operating in the Eastern Atlantic and off Japan, fixed bottom nets and line gear. It is discarded by fisheries off southern Portugal, but is probably utilised elsewhere in the Eastern Atlantic. In the Northeast Atlantic, although captures are still high and stable, very little is known about the biology and distribution of this deepwater species. More studies on this species' biology are needed, particularly considering that many deepwater squaloids have life-history characteristics that can make them especially vulnerable to depletion in fisheries. However, there is no evidence to suggest that this species has declined or faces significant threats. Furthermore, it has a widespread geographic and bathymetric distribution and is therefore considered Least Concern at present. Expanding deepwater fisheries should be monitored and bycatch levels should be quantified to ensure that this species is not significantly impacted.

Rasptooth Dogfish

Miroscyllium sheikoi (Dolganov, 1986)

Red List assessment **Global: Data Deficient** (Yano, K. 2004)

Rationale This is a rare deepsea shark with a limited distribution in southern Japan, where it is known only from the Kyushu-Palau submarine ridge at depths of 340 to 370m. It reaches at least 43cm TL, but very little information is available on its biology. Known specimens were collected by research surveys using commercial bottom trawl nets. While of no commercial value, it is possibly taken as very rare bycatch in bottom trawl nets. Future expansion of deepwater fisheries could pose a threat to this poorly known species. However, at present there is very little, if any, fishing within the species' range. At this time the species cannot be assessed beyond Data Deficient.

Viper Dogfish

Trigonognathus kabeyai Mochizuki & Ohe, 1990

Red List assessment **Global: Data Deficient** (Yano, K. 2004)

Rationale The viper dogfish is a rare deepsea shark with a limited distribution in Japan and a single record from Hawaii. Recorded on or near the bottom and in mid-water, it reaches at least 54cm TL but very little information is available on its biology. It is taken as bycatch in bottom trawl and purse-seine fisheries, but is not utilised. At this time the species cannot be assessed beyond Data Deficient. If fisheries expand in the future, catches of this species may increase and would need to be monitored.

Whitetail Dogfish

Scymnodalatias albicauda Taniuchi & Garrick, 1986

Red List assessment **Global: Data Deficient** (Duffy, C. 2003)

Rationale This species appears to be widespread in the Southern Ocean, but is known from very few specimens. It is naturally rare and there is insufficient information on its biology, distribution and exploitation to assess it beyond Data Deficient.

Azores Dogfish

Scymnodalatias garricki Kukuev & Konovalenko, 1988

Red List assessment **Global: Data Deficient** (Séret, B., McCormack, C. and Pinho, M.R.R. 2009)

Rationale This rare deepsea dogfish is known only from the holotype (37.7cm TL), found at 300m over a seamount north of the Azores in the Northeast Atlantic, and a second specimen captured south of the Azores in 2001. The biology of the species is virtually unknown. At present there is insufficient information to assess the species beyond Data Deficient, however, it occurs in an area where deepsea longline fisheries are developing and could potentially be taken as bycatch in these fisheries in the future. The species may have limiting life-history characteristics, similar to other deepwater shark species, thus will not be sufficiently fecund to withstand high levels of exploitation. Catches need to be carefully monitored and reassessment should be undertaken as further biological and fisheries data become available.

Sparsetooth Dogfish

Scymnodalatias oligodon Kukuyev & Konovalenko, 1988

Red List assessment **Global: Data Deficient** (Leandro, L. 2004)

Rationale *Scymnodalatias oligodon* is known only from the holotype, a 26cm TL immature male collected in the open ocean approximately 2,300 km WNW of Santiago, Chile. The species is apparently oceanic and was captured near the surface (at 0 to 200m) in water 2,000 to 4,000m deep. It is not known to be of any interest to fisheries, but cannot, at present, be assessed beyond Data Deficient.

Sherwood Dogfish

Scymnodalatias sherwoodi (Archey, 1921)

Red List assessment **Global: Data Deficient** (Duffy, C. 2003)

Rationale This dogfish is a very poorly known species known from a few specimens trawled off the east coast of South Island, New Zealand, between 400 and 500m depth. It may also occur off Australia. Nothing is known of the species' ecology, and there is insufficient information to assess it beyond Data Deficient.

Velvet Dogfish

Zameus squamulosus (Günther, 1877)

Red List assessment **Global: Data Deficient** (Burgess, G.H. and Chin, A. 2006)

Rationale The velvet dogfish is a widespread but sporadically distributed deepwater dogfish recorded from most regions, with the present exception of the Eastern Pacific. It is benthic on the continental and insular slopes at depths of 550 to 1,450m, and also epipelagic and oceanic off Brazil. The presently known disjunct range in many ocean regions suggests that it is more widely distributed than currently recorded. It reaches a maximum size of 69cm TL, but little is known of its biology. The shark is taken as bycatch in various deepwater fisheries, including by trawl, longline and set net, but species-specific information is not available. However, it should be recognised that deepwater squaloids are vulnerable to population collapse from overfishing (directed or bycatch) due to their limited life-history characteristics, and as such catches of this and other species require monitoring, particularly as deepwater fisheries expand worldwide. Because of a lack of information, this species cannot be assessed beyond Data Deficient at the present time.

FAMILY **DALATIIDAE**

Taillight Shark

Euprotomicroides zantedeschia Hulley & Penrith, 1966

Red List assessment **Global: Data Deficient** (Burgess, G.H. 2006)

Rationale *Euprotomicroides zantedeschia* is an extremely rare small pelagic shark. It is known from only two specimens, both from the South Atlantic: one from off South Africa and one from off Uruguay. Depths of capture were 458 to 641m from a demersal trawl and 0 to 25m near the surface. This shark is not known to enter any fishery, hence there are no apparent threats, but because it is known from only two specimens it cannot be assessed beyond Data Deficient at this time.

Pygmy Shark

Euprotomicrus bispinatus (Quoy & Gaimard, 1824)

Red List assessment **Global: Least Concern** (Burgess, G.H. 2006)

Rationale The pygmy shark is a tiny oceanic shark (one of the smallest shark species in the world, reaching 26.5cm TL). It is widespread, and recorded from numerous oceanic locations in the Pacific, Indian and Atlantic Oceans. Little is known of its biology, although it is reported to have a fecundity of eight pups/litter. Its small size and epipelagic/mesopelagic habitat preclude it from capture in most fisheries, and as such there are no apparent threats to the species. Given this, and its widespread distribution, it is assessed as Least Concern.

Longnose Pygmy Shark

Heteroscymnoides marleyi Fowler, 1934

Red List assessment **Global: Least Concern** (Burgess, G.H. 2006)

Rationale This is an extremely rare, small (to at least 36.5cm TL) pelagic shark known from only six specimens caught in the Southeast Atlantic, Western Indian and Southeast Pacific. It is possibly circumglobal in cold Sub-Antarctic waters of the Southern Hemisphere, and has been recorded from depths of 45 to 502m (in waters with bottom depths of 830 to 4,000m). Little is known of its biology, but its small size and lifestyle preclude it from entering most fisheries. It is assessed as Least Concern, because of the lack of apparent threats, its small size, and its probable widespread distribution. However, like many deeper-water species, more information on its biology, ecology and importance in fisheries is required to further assess the status and any conservation needs of this apparently rare species.

Cookiecutter Shark

Isistius brasiliensis (Quoy & Gaimard, 1824)

Red List assessment **Global: Least Concern** (Stevens, J. 2003)

Rationale *Isistius brasiliensis* is widespread but with patchy distribution records. It is too small (up to about 50cm TL) to be regularly taken by fisheries, and although it is occasionally caught by pelagic longlines, and sometimes in midwater trawls and plankton nets, there are no significant threats to this species.

South China Cookiecutter Shark

Isistius labialis Meng, Chu, & Li, 1985

Red List assessment **Global: Data Deficient** (Compagno, L.J.V. 2009)

Rationale *Isistius labialis* is a very poorly known, presumably oceanic or semi-oceanic shark. It is known from a single specimen in the South China Sea at present. If it is a valid species, *I. labialis* is possibly more wide-ranging and may be mistaken for *I. brasiliensis*, which is circumglobal in all warm seas. The lack of information on this species precludes an assessment beyond Data Deficient at this time.

Largetooth Cookiecutter Shark

Isistius plutodus Garrick & Springer, 1964

Red List assessment **Global: Least Concern** (Kyne, P.M., Gerber, L. and Sherrill-Mix, S.A. 2006)

Rationale This is a rare, epibenthic and epipelagic cookiecutter shark known from ten specimens. It is possibly circumglobal, but at present has been recorded from scattered locations in the Pacific and Atlantic, with all specimens collected close to land (in contrast to its congener *I. brasiliensis*). The largest recorded specimen was just over 42cm TL, but very little is known of the biology of this facultative ectoparasite. It is probably an irregular bycatch of trawl (benthic and pelagic) and longline fisheries (taken by hook or attached to its captured prey). Although little is known about this species, it is probably widely distributed with no significant threats apparent and is thus assessed as Least Concern.

Pocket Shark

Mollisquama parini Dolganov, 1984

Red List assessment **Global: Data Deficient** (Leandro, L. 2004)

Rationale The pocket shark is a very poorly known, deepwater shark recorded from the Nazca Submarine Ridge in the Eastern South Pacific, off northern Chile. The holotype, and only known specimen, was an adult female (40cm TL) taken at a depth of 330m. Nothing is known of its biology or threats in the area.

Smalleye Pygmy Shark

Squaliolus aliae Teng, 1959

Red List assessment **Global: Least Concern** (Heupel, M.R. 2003)

Rationale *Squaliolus aliae* has a patchy but wide distribution throughout the Indo-West Pacific. It is possibly the smallest known living shark, and its size means that it is irregularly taken in fisheries. On the basis of this and its wide range, this species is classified as Least Concern.

Spined Pygmy Shark

Squaliolus laticaudus Smith & Radcliffe, 1912

Red List assessment **Global: Least Concern** (Kyne, P.M. and Burgess, G.H. 2006)

Rationale *Squaliolus laticaudus* is one of the world's smallest sharks, reaching a maximum size of 27.5cm TL. Oceanic, with a widespread warm-temperate and tropical distribution, it occurs near landmasses generally over continental slopes and avoids central ocean basins. Little is known of its biology, but it is known to undertake diel vertical migrations from depth (~500m to ~200m), probably related to prey movements. An absence of identifiable threats (irregularly taken by fisheries because of its small size) and its widespread distribution justify an assessment of Least Concern.

ORDER **ORECTOLOBIFORMES**

FAMILY **RHINCODONTIDAE**

Whale Shark

Rhincodon typus Smith, 1828

Red List assessment **Global: Vulnerable A2bd+3d** (Norman, B. 2005)

Rationale This cosmopolitan tropical and warm-temperate species is the world's largest living chondrichthyan. Its life history is poorly understood, but it is known to be highly fecund and to migrate extremely large distances. Populations appear to have been depleted by harpoon fisheries in Southeast Asia and perhaps incidental capture in other fisheries. High value in international trade, a K-selected life history, highly migratory nature and normally low abundance make this species vulnerable to commercial fishing. Dive tourism involving this species has recently developed in a number of locations around the world, demonstrating that it is far more valuable alive than fished.

FAMILY **ODONTASPIDIDAE**

Smalltooth Sand Tiger

Odontaspis ferox (Risso, 1910)

Red List assessment **Global: Vulnerable: A2abd+4abd** (Pollard, D., Gordon, I., Williams, S., Flaherty, A., Fergusson, I.K., Dicken, M. and Graham, K. 2009)
Australia: Vulnerable A2abd+3bd+4abd
South Africa: Data Deficient
Mediterranean: Endangered A2abd+4abd

Rationale Despite its extensive, almost worldwide distribution, *O. ferox* populations and occurrences are fragmented and the species may be naturally rare. This species is morphologically very similar to *Carcharias taurus*, although it is larger and bulkier, and is presumed to have a very low reproductive capacity, similar to that of *C. taurus* (producing only two pups every two years). The presumed very low reproductive capacity of this species makes it potentially susceptible to local extirpation, even at seemingly small capture rates. Although probably not specifically targeted, there are commercial landings of the species taken in bottom trawls, set-nets and line gear in many areas, including the Mediterranean Sea, Japan and occasionally Australia (although it is now protected in New South Wales). It is generally found in deeper water (down to 880m depth), but recent observations of small aggregations in shallow water in a number of areas (Mediterranean Sea and Eastern Pacific Ocean) suggest that the species may be more vulnerable to fishing pressure than previously assumed, and potentially susceptible to coastal habitat impacts, similar to *C. taurus*. Increased demersal trawl fisheries in Australia and New Zealand are now operating in areas of possible and known occurrence. Fishery-independent surveys indicate a decline of over 50% in catches off the east coast of Australia (hence the Vulnerable assessment in those waters), probably the result of commercial fishing operations off New South Wales. Similar declines are presumed to have occurred in other parts of its range impacted by fisheries. Given the species' likely very low reproductive capacity, intensive fishing pressure throughout its bathymetric range in the Mediterranean Sea and an absence of management measures there, the decline of *O. ferox* in this region is suspected to match or even exceed that in Australia, warranting a regional assessment of Endangered. There are very few records from subequatorial Africa, where the species is currently assessed as Data Deficient. Globally, a precautionary assessment of Vulnerable is considered appropriate, as a result of documented and suspected declines, the species' apparent rarity, presumed very low fecundity and high vulnerability to exploitation, and continued bycatch in fisheries.

Bigeye Sand Tiger

Odontaspis noronhai (Maul, 1955)

Red List assessment **Global: Data Deficient** (Amorim, A.F., Arfelli, C.A. and Fagundes, L. 2005)

Rationale This rare pelagic deepwater shark is sparsely but widely distributed in tropical and warm-temperate waters, apparently an inhabitant of continental and insular slopes.

It is so infrequently recorded that its biology and population status are unknown. Its life cycle and biology are likely to be similar to that of *C. taurus*, which has been found to be particularly vulnerable to fisheries, although *O. noronhai* matures at an even larger size.

FAMILY **PSEUDOCARCHARIIDAE**

Crocodile Shark

Pseudocarcharias kamoharai (Matsubara, 1936)

Red List assessment **Global: Near Threatened** (Compagno, L.J.V. and Musick, J.A. 2005)

Rationale The crocodile shark is a small, uncommon, pelagic, oceanic shark, and is circumtropical in distribution. This species is vulnerable as bycatch in pelagic longline fisheries, which are expanding worldwide. Thus, because of its small litter size and probable demography, this species may be threatened in the near future, although there are no catch per unit effort data available to indicate trends in population size.

ORDER **LAMNIFORMES**

FAMILY **MITSUKURINIDAE**

Goblin Shark

Mitsukurina owstoni Jordan, 1898

Red List assessment **Global: Least Concern** (Duffy, C.A.J., Ebert, D.A. and Stenberg, C. 2004)

Rationale This species is assessed as Least Concern because although apparently rare, it is widespread in the Atlantic, Indian and Pacific Oceans and is only infrequently taken in deepwater fisheries. It has a sporadic distribution with most records from the Northwest Pacific (Japan, Taiwan) on the upper continental slope. It may also be mesopelagic. It is likely to be found in more locations than previously known as deepwater surveys are undertaken in other regions or as deepwater fisheries expand globally. It is taken in deep bottom-set gillnet, bottom longline and trawl fisheries, and rarely in surface driftnets. It may also be entangled in deepwater fishing gear. The goblin shark has been recorded from depths of ≤30m (occasional) to >1,000m with reported landings of adults rare, suggesting that most of the adult population is unavailable to existing deepwater fisheries.

FAMILY **MEGACHASMIDAE**

Megamouth Shark

Megachasma pelagios Taylor, Compagno & Struhsaker, 1983

Red List assessment **Global: Data Deficient** (Compagno, L.J.V. 2005)

Rationale This very large, pelagic filter-feeding shark was perhaps the most spectacular discovery of a new shark in the twentieth century. Specimens are very seldom reported, thus the shark is apparently very rare throughout its range, yet likely to be increasingly taken as bycatch in oceanic and offshore littoral fisheries. At the time of writing it was known from fewer than 20 specimens, though its distribution is thought to be circumtropical and wide-ranging. The colouration and catch records of the megamouth shark are suggestive of epipelagic rather than deepwater habitat, as is the composition of its liver oil.

FAMILY **ALOPIIDAE**

Pelagic Thresher

Alopias pelagicus (Nakamura, 1935)

Red List assessment **Global: Vulnerable A2d+A4d** (Reardon, M., Márquez, F., Trejo, T., and Clarke, S.C. 2009)

Rationale All members of the genus *Alopias*, thresher sharks, are listed as Vulnerable globally because of their declining populations. These downward trends are the result of a combination of slow life-history characteristics, hence low capacity to recover from moderate levels of exploitation, and high levels of largely unmanaged and unreported mortality in target and bycatch fisheries. *Alopias pelagicus* is a large, wide-ranging Indo-Pacific Ocean pelagic shark, apparently highly migratory, with low fecundity (two pups/litter) and a low (2–4%) annual rate of population increase. This species is especially vulnerable to fisheries exploitation (target and bycatch) because its epipelagic habitat occurs within the range of many largely unregulated and underreported gillnet and longline fisheries, in which it is readily caught. Although this species is reportedly relatively common in some coastal localities, current levels of exploitation in some areas are considered to be unsustainable. Overall, serious depletion of the global population is considered highly likely to have occurred.

Bigeye Thresher

Alopias superciliosus (Lowe, 1840)

Red List assessment **Global: Vulnerable A2bd** (Amorim, A., Baum, J., Cailliet, G.M., Clò, S., Clarke, S.C., Fergusson, I., Gonzalez, M., Macias, D., Mancini, P., Mancusi, P., Myers, R., Reardon, M., Trejo, T., Vacchi, M. and Valenti, S.V. 2009)
Northwest Atlantic and West Central Atlantic: Endangered A2bd
Mediterranean: Data Deficient
Southwest Atlantic: Near Threatened
Eastern Central Pacific: Vulnerable A2bd
Indo-West Pacific: Vulnerable A2d

Rationale Global: All members of the genus *Alopias*, thresher sharks, are listed as Vulnerable globally because of their declining populations. These downward trends are the result of a combination of slow life-history characteristics, hence low capacity to recover from moderate levels of exploitation, and high levels of largely unmanaged and unreported mortality in target and bycatch fisheries. *Alopias superciliosus* is an apparently highly migratory, oceanic and coastal species found virtually circumglobally in tropical and temperate seas. It has low fecundity (2–4 pups/litter) and an exceptionally low (0.002) potential annual rate of population increase, compared with other thresher sharks. This species is especially vulnerable to fisheries exploitation (target and bycatch) as its epipelagic habitat occurs within the range of many largely unregulated gillnet and longline fisheries in which it is readily caught, and it has been fished throughout its range. Significant reductions in thresher CPUE have been reported in pelagic longline fisheries in the Northwest Atlantic and Eastern tropical Pacific, and declines are suspected to have occurred in other areas also. Although data are lacking for many parts of its range, it is evident that this vulnerable species with such low productivity faces major threats throughout most of its range, where fishing pressure is unlikely to cease or decrease any time in the immediate future. However, this may underestimate the extent of global decline and there is an urgent need for global review of all available data throughout its range.

Northwest Atlantic and Western Central Atlantic: Estimates of trends in abundance from standardised catch rate indices of the US pelagic longline fishery suggest that this species has likely undergone a decline in abundance in this region. Thresher sharks are generally recorded by genus by observers as well as in logbooks, which includes both *A. vulpinus* and *A. superciliosus* in this region, of which the latter is the more common. The area covered by the analyses, ranging from the equator to about 50°N, encompasses the confirmed range of threshers in this region. Estimates of the decline based on logbook and observer records of combined thresher sharks from 1986–2005 range between 50–80%. Fishing pressure on thresher sharks began over two decades prior to the start of this time series, thus the estimated declines are not from virgin biomass. Bigeye thresher is more biologically vulnerable and has a lower rate of intrinsic population increase than the thresher *A. vulpinus*, with which it is grouped in the logbook and observer datasets. Given this species' intrinsic vulnerability and that fishing pressure on thresher sharks began over two decades prior to the start of these longline time series, the combined analyses may underestimate the decline in *A. superciliosus* and it is assessed as Endangered A2bd in this region.

Mediterranean: This species is a bycatch of the semi-industrial fisheries (swordfish and other pelagic fisheries) of southern Spain, Morocco, Algeria, Sicily and Malta, and of artisanal trammel and gillnet fisheries elsewhere in the Mediterranean Sea. However, *A. superciliosus* has been poorly documented in the Mediterranean and is considered scarce or rare. No data are available on catch trends in this region, although pelagic effort is high. Despite the apparent threat posed by bycatch, the lack of records and information on the population of *A. superciliosus* in the Mediterranean precludes an assessment beyond Data Deficient at this time.

Southwest Atlantic: This species is caught in tuna and swordfish longline fisheries, and to a lesser extent in gillnets, with other wide-ranging oceanic shark species in this region. Increased targeting of pelagic sharks due to the increasing demand and the commercial value of their fins has also been reported. Data are sparse in the South Atlantic and pelagic fishing pressure high. Both *A. superciliosus* and *A. vulpinus* are caught in the Brazil Santos longline fishery, with *A. superciliosus* representing the large majority of the catch. The landed catch and CPUE of *A. superciliosus* in this fishery increased from 1971 to 1989, and then gradually decreased from 1990 to 2001. This does not necessarily reflect stock abundance because changes in the depth of fishing operations also occurred, which may have affected the time series. Given the declines reported in other areas for which data are available and high fishing pressure from fleets throughout the Southwest Atlantic, the species is assessed as Near Threatened in this region based on the limited information currently available. There is a need to collect further data from throughout the South Atlantic.

Eastern Central Pacific: Pelagic fleets operating in this region are known to take *A. superciliosus*. It is a known bycatch of the purse-seine fishery operating in the Eastern Pacific Ocean. Trends in abundance and biomass of thresher sharks combined in the Eastern tropical Pacific Ocean were estimated by comparison of pelagic longline research surveys in the 1950s with recent data (1990s) collected by observers on pelagic longline fishing vessels, standardised to account for differences in depth and soak time. This analysis was not species specific, but estimated a decline in abundance of 83% and a decline in biomass to approximately 5% of virgin levels. Given the apparent decline in combined thresher abundance in this region, continued fishing pressure from pelagic fleets, and this species' vulnerable life-history characteristics, it is assessed as Vulnerable A2bd in the Eastern Central Pacific.

Indo-West Pacific: This species is taken by a variety of pelagic fisheries throughout many areas of its range in the Indo-West Pacific, including the Spanish surface longline fleet for swordfish and sharks, the Korean tuna longline fleet, South Africa's longline fisheries for tuna, and tuna fisheries in the Eastern Indian Ocean and Andaman Sea. Pelagic fisheries have operated in the Indian Ocean for more than 50 years. Pelagic fishing pressure is high and the amounts of sharks caught by longliners targeting swordfish in the Indian Ocean have been constantly increasing since the mid-1990s. Sharks are also targeted in several areas. A recent review of fisheries in the Indian Ocean reported that sharks in this region are considered fully exploited to overexploited. Most artisanal and industrial marine fisheries in the Indian Ocean are multispecies and the state of most resources is poorly documented. Catch data are incomplete and cannot be used to estimate the real magnitude of catches or trends. Although complete data are not available for evaluation from this region, this species is a known catch of many fisheries operating throughout much of its range in this region, as described above. Given that this species has high biological vulnerability and a low intrinsic rate of increase, coupled with the declines observed in other areas of its range, declines are inferred based on continuing high levels of exploitation and it is assessed as Vulnerable A2d in the Indo-West Pacific.

Thresher Shark

Alopias vulpinus (Bonnaterre, 1788)

Red List assessment

Global: Vulnerable A2bd+3bd+4bd (Goldman, K.J., Baum, J., Cailliet, G.M., Cortés, E., Kohin, S., Macías, D., Megalofonou, P., Perez, M., Soldo, A. and Trejo, T. 2009)
Eastern Central Pacific: Near Threatened
Northwest and Western Central Atlantic: Vulnerable A2bd
Mediterranean Sea: Vulnerable A3bd
Northeast Atlantic: Near Threatened
Indo-West Pacific: Data Deficient

Rationale

Global: All members of genus *Alopias*, thresher sharks, are listed as Vulnerable globally because of their declining populations. These downward trends are the result of a combination of slow life-history characteristics, hence low capacity to recover from moderate levels of exploitation, and high levels of largely unmanaged and unreported mortality in target and bycatch fisheries. *Alopias vulpinus* is virtually circumglobal, with a noted tolerance for cold waters. This species is especially vulnerable to fisheries exploitation (target and bycatch) because its epipelagic habitat occurs within the range of many largely unregulated and underreported gillnet and longline fisheries, in which it is readily caught. It is an important economic species in many areas and is valued highly for its meat and large fins. Its life-history characteristics (2–4 pups per litter; 8–14 year generation period) and high value in both target and bycatch fisheries make it vulnerable to rapid depletion. Serious declines have occurred where this species has been heavily fished, for example, in the 1980s Eastern Central Pacific drift gillnet fishery, where reported landings collapsed to 27% of peak levels between 1982 and the late 1980s. Analyses of pelagic longline CPUE data from logbook reports covering the species' entire range in the Northwest and Western Central Atlantic vary according to the time period, but suggest thresher shark stocks declined by 63–80% during 1986–2000. There is evidence that thresher sharks are being increasingly targeted by pelagic fisheries for swordfish and tuna (e.g., in the Mediterranean Sea), in attempts to sustain catches, and exploitation is increasing in these areas. The high value of the species and its exploitation by unmanaged fisheries, combined with its biological vulnerability, indicate that at least some, if not most, subpopulations in other parts of the world are likely to be equally or more seriously at risk than those for which data are available and, unlike the Californian stock, are not the subject of management, enabling stocks to rebuild.

Eastern Central Pacific: Reported landings in the drift gillnet fishery for this species that developed off the west coast of the USA in the late 1970s collapsed from a peak of 1,089.5t in 1982 to less than 300t by the late 1980s (decline of ~70%). This fishery was effectively eliminated by restrictions on the use of gill nets by 1990, and the population began to slowly recover to just below 50% of the initial subpopulation size. The species is still caught as bycatch or as a secondary target, although to a far lesser extent, of the swordfish gillnet fishery. It is clear that the species depends on adequate management measures, and would otherwise be at risk of overfishing. All this considered, the species is assessed as Near Threatened in this region based on significant population declines, which are now managed in US waters.

Northwest and Western Central Atlantic: Estimates of trends in abundance from standardised catch rate indices of the US pelagic longline fishery suggest that this species has likely undergone a decline in abundance in this region. Thresher sharks are generally recorded by genus by observers as well as in logbooks, which includes both *A. vulpinus* and *A. superciliosus* in this area, of which *A. vulpinus* is the less common. The area covered by the analyses, ranging from the equator to about 50°N, encompasses the confirmed range of threshers in this region. Estimates of the decline based on logbook and observer records of combined thresher sharks from 1986–2005 range between 50 and 80%. Fishing pressure on thresher sharks began over two decades prior to the start of this time series, thus the estimated declines are not from virgin biomass. Furthermore, the sample size in the latter observer analysis was also very small compared with the logbook analyses, which both showed declines. Given the apparent decline in abundance in this region and high fishing pressure from pelagic fleets, this species is assessed as Vulnerable A2bd in the Northwest and Western Central Atlantic.

Mediterranean Sea: Adults and juveniles of *A. vulpinus* are regularly caught as bycatch in longline, purse-seine and mid-water fisheries throughout the Mediterranean Sea, as well as in recreational fisheries. The species has some important parturition and nursery areas this region, for example, the Alboran Sea, where aggregations of pregnant females have been observed. Recent investigations show that pelagic sharks, including this species, are being increasingly targeted in the Alboran Sea by the Moroccan swordfish driftnet fleet. Data from this fishery suggest that both annual catches and mean weights of *A. vulpinus* have fallen as a result of fishing mortality. Because pelagic fishing pressure is high and ongoing throughout the Mediterranean Sea, and because of increased targeting and the decline in catches described above, *A. vulpinus* is currently assessed as Vulnerable A3bd in this region.

Northeast Atlantic: The species is taken primarily as bycatch of longline fisheries for tuna and swordfish in the Northeast Atlantic, and also in driftnets and gillnets. It is very likely that this catch is retained. Limited information is available on thresher shark catch in this region and estimated landings are still considered incomplete. Prior to 2000, estimated landings fluctuated at 17–13t, in 2000–2001 they exceeded 100t, after which they dropped to 4t in 2002, and have not exceeded 7t since. Increased targeting of pelagic sharks by Moroccan drift-netters in the Alboran Sea and Strait of Gibraltar mentioned above has also likely impacted *A. vulpinus* in the Northeast and Eastern Central Atlantic. The species is currently assessed as Near Threatened in this region and there is a need to collect further data on the status of the species in this area.

Indo-West Pacific: Little information is currently available on *A. vulpinus* in the Indo-West Pacific. While records of *A. superciliosus* and *A. pelagicus* are recorded in the catches of fisheries operating in this region, albeit very underreported, little information is available on catches of *A. vulpinus*. Although pelagic fishing effort in this region is high, with reported increases in recent years, *A. vulpinus* is more characteristic of cooler waters and further information needs to be collected on records and catches of the species in this region.

FAMILY **CETORHINIDAE**

Basking Shark

Cetorhinus maximus (Gunnerus, 1765)

Red List assessment

Global: Vulnerable A2ad+3d (Fowler, S.L. 2005)
Northeast Atlantic: Endangered A2ad
Northeast Pacific: Endangered A2ad

Rationale

This very large, filter-feeding, cold-water pelagic species is migratory and widely distributed, but only regularly seen in a few favoured coastal locations and probably never abundant. Most documented fisheries have been characterised by marked, long-lasting declines in landings after the removal of hundreds to low thousands of individuals. Its fins are among the most valuable in international trade. Basking sharks are legally protected in some territorial waters and listed in CITES Appendix II. Compagno (1984a) considers the species "to be extremely vulnerable to overfishing, perhaps more so than most sharks, … ascribed to its slow growth rate, lengthy maturation time, long gestation period, probably low fecundity and probable small size of existing populations (belied by the immense size of individuals in their small schools)."

FAMILY **LAMNIDAE**

Great White

Carcharodon carcharias (Linnaeus, 1758)

Red List assessment

Global: Vulnerable A2cd+3cd (Fergusson, I., Compagno, L.J.V. and Marks, M. 2005)

Rationale

Despite the high profile media attention this shark receives, relatively little is known about white shark biology. The white shark is relatively uncommon compared to other widely distributed shark species, and is known to have a relatively low intrinsic rebound potential. It is most frequently reported from South Africa, Australia, California and the northeast United States, but global catches of white sharks are difficult to estimate. Threats to the species include targeted commercial and sports fisheries for jaws, fins, game records and for aquarium display; protective beach meshing; campaigns to kill white sharks following shark attack events; and degradation of inshore pupping and nursery habitats.

Shortfin Mako

Isurus oxyrinchus Rafinesque, 1810

Red List assessment

Global: Vulnerable A2abd+3bd+4abd (Cailliet, G.M., Cavanagh, R.D., Kulka, D.W., Stevens, J.D., Soldo, A., Clò, S., Macias, D., Baum, J., Kohin, S., Duarte, A., Holtzhausen, J.A., Acuña, E., Amorim, A., Domingo, A. and Stevens, J.D. 2009)
Mediterranean: Critically Endangered A2acd+3cd+4acd
Eastern North Pacific: Near Threatened
Indo-west Pacific: Vulnerable A2bd + A4d
North Atlantic: Vulnerable A2bd+A3bd+A4bd
South Atlantic: Vulnerable A2bd+A3bd+A4bd

Rationale

Global: Shortfin mako is an important target species, is a bycatch in tuna and billfish longline and driftnet fisheries, particularly in high-seas fisheries, and is an important coastal recreational species. Most catches are inadequately recorded and underestimated and landings data do not reflect numbers finned and discarded at sea. Various analyses suggest that this species may have undergone significant declines in abundance over various parts of its range. A global assessment of Vulnerable is considered appropriate for this species on the basis of estimated and inferred declines, inadequate management resulting in continuing (if not increasing) fishing pressure, the high value of its meat and fins, and vulnerable life-history characteristics. Although it is difficult accurately to assess the conservation status of this shark because it is migratory and caught in numerous poorly monitored fisheries worldwide, it is reasonable to assume that decreases may be occurring in those areas for which there are limited or no data.

Atlantic: In the North Atlantic, the shortfin mako has likely undergone a decline in abundance (estimates based on logbook records range from 33% to 50%, demographic modelling suggesting a decline between 20% and 80%). In the Northeast Atlantic, landings data are not available for some countries, but the species is taken as a bycatch of the pelagic fishery. The area around the Strait of Gibraltar is thought to be a nursery area; most specimens caught there are juveniles. This area is heavily fished by the swordfish longline fleet. EU vessels fishing for small pelagic species off the west coast of Africa are also known to take unquantified elasmobranch bycatch, including shortfin mako. There is no evidence of overfishing in the South Atlantic, although data there are sparse and pelagic fishing pressure is high. In the Southwest Atlantic, shortfin mako is caught as bycatch in the pelagic longline fishery targeting mainly swordfish and tuna. Logbooks and landing data presented by, Brazil and Uruguay at ICCAT's Sharks Sub-committee meeting in July 2007 showed a decreasing trend in the CPUE values since 2003. Given the apparent decline in abundance in the North Atlantic, the trends of the CPUE values in the Southwest Atlantic and high fishing pressure from pelagic fleets throughout the Atlantic, this species is assessed as Vulnerable in the Atlantic.

Mediterranean: Recent investigations in the Mediterranean suggest that the western basin is a nursery area where bycatch of shortfin mako from the tuna and swordfish fishery consists almost exclusively of juveniles. It is possible that this nursery area corresponds to the Eastern Central Atlantic population, which is affected by the swordfish longline fishery off the western coast of Africa and the Iberian peninsula. In other areas of the Mediterranean, the shortfin mako is caught sporadically. Reports from the Ligurian Sea show a significant decline since the 1970s. In the Adriatic Sea, shortfin makos were considered common at the end of 19th/beginning of the 20th centuries, but since 1972 there have been no records of this species reported despite a large increase in fishing pressure and introduction of new fishing gear to the area. On the basis of the absence of records of this species from some localised areas, evidence of large declines in others and captures of juveniles in a probable nursery area, this species is considered Critically Endangered in the Mediterranean, warranting focused attention and immediate action in order to preserve this species in the region.

Northeast Pacific: Analysis of longline survey data of mainly juvenile individuals off southern California suggests that the shortfin mako CPUE may be declining slightly. However, recent tagging and tracking data show that it is also highly migratory, both vertically and horizontally, thus making accurate or precise population estimates difficult. There is no evidence to suggest that the Northeast Pacific population has been sufficiently depleted to warrant "Vulnerable" status at the present time, and this population is considered Near Threatened as a precautionary measure.

Indo-West Pacific: This species is taken by tuna and shark longline fisheries in Indonesia, and throughout many areas of its range in the Indo-West Pacific. Pelagic fisheries have operated in the Indian Ocean for more than 50 years. Sharks are targeted in several areas in this region, including off India, where they are captured using hook and line and in the world's largest mesh gillnets. Finning and discarding of carcasses has been reported, especially in offshore and high-seas fisheries. Most artisanal and industrial marine fisheries in the Indian Ocean are multispecies and the state of most resources is poorly documented. A recent review of fisheries in the Indian Ocean reported that sharks in this region are considered fully exploited to overexploited. Its distribution overlaps many intensive pelagic fisheries in this area. Although species-specific data are not currently available from this region for evaluation, given the declines observed where it is heavily fished in the North Atlantic, declines in this area are inferred based on continuing high levels of exploitation.

Longfin Mako

Isurus paucus Guitart Manday, 1966

Red List assessment

Global: Vulnerable A2bd+3d+4bd (Reardon, M.B., Gerber, L. and Cavanagh, R.D. 2006)

Rationale

The longfin mako *I. paucus* is a widely distributed but rarely encountered oceanic tropical shark. This species is known to be caught as bycatch in tropical pelagic longline fisheries for tuna, swordfish and sharks and in other oceanic fisheries, which operate throughout its range, but at much lower ratios than the smaller, more fecund shortfin mako *I. oxyrinchus*. Catches are inadequately monitored and underestimated due to common misidentification with shortfin makos and because landings do not reflect numbers of individuals finned and discarded at sea. The shortfin mako may have undergone significant documented declines in the North (50% or more) and South Atlantic and faces high fishing pressures throughout its epipelagic habitat from commercial longline fleets. Since longfin makos are often caught in the same fishing gear, populations are considered also likely to have declined. In addition to the inferred declines, this is a species of conservation concern due to its apparent rarity, large maximum size (>4m), low fecundity (2–8 pups/litter) and continued bycatch in intensive oceanic fisheries.

A global assessment of Vulnerable is considered appropriate for this species as a precautionary measure. A vast improvement in the collection of data is required and effective conservation of this species will require international agreements.

Salmon Shark

Lamna ditropis Hubbs & Follett, 1947

Red List assessment

Global: Least Concern (Goldman, K., Kohin, S., Cailliet, G.M., and Musick, J.A. 2009)

Rationale

The salmon shark occurs in the Eastern and Western North Pacific and its population appears to be stable and at relatively high levels of abundance. There is currently no directed fishery in the Northeast Pacific, apart from a small sport fishery for the species in Alaska. Bycatch in the Northeast and Eastern Central Pacific appears to be at low levels and is not increasing at this time. Additionally, with the current ban on commercial fishing in Alaska state waters and fairly conservative sport fishing limits, it appears the population is stable. In the Northwest Pacific, a small directed fishery still exists, but typically takes no more than ~5,000 animals per year. Bycatch in the Eastern and Western Central Pacific has been significantly reduced since the elimination of the drift gillnet fishery and the population appears to have rebounded to its former levels. In addition, the most recent demographic analysis supports the contention that salmon shark populations in the Northeast and Northwest Pacific are stable at this time and it is assessed as Least Concern. Nevertheless, there are very few data on catch in other fisheries, discards, and potential finning from the major pelagic fisheries in the North Pacific. Bycatch in US state and federal waters should be documented in order to foster responsible management, and catch records should be obtained from the Northwest and Central Pacific.

Porbeagle Shark

Lamna nasus (Bonnaterre, 1788)

Red List assessment

Global: Vulnerable A2bd+3d+4bd (Stevens, J., Fowler, S.L., Soldo, A., McCord, M., Baum, J., Acuña, E., Domingo, A. and Francis, M. 2006)
Northeast Atlantic: Critically Endangered A2bcd+3d+4bd
Northwest Atlantic: Endangered A1abd
Mediterranean Sea: Critically Endangered A2bd
Southern Hemisphere: Near Threatened

Rationale

The porbeagle is a wide-ranging, coastal and oceanic shark, but with apparently little exchange between adjacent populations. Low reproductive capacity and high commercial value (in target and incidental fisheries) of mature and immature age classes make this species highly vulnerable to overexploitation and population depletion. This depletion, despite variations in availability of data and degree of depletion between the Northern and Southern Hemispheres, is considered to meet Vulnerable criteria globally. The Eastern and Western North Atlantic populations have both been seriously overexploited by directed longline fisheries. Collapse of the Northeast Atlantic population led to intensive target fishing in the well-documented Northwest Atlantic fishery in the 1960s, with most of the virgin biomass removed in just six years. Renewed target fishing in the 1990s led to a further population decline to ~11% to 17% of virgin biomass within the three-generation period for this species. Recently improved management in the Northwest Atlantic should now help stocks to recover, however, the Northeast Atlantic population has been subject to unrestricted fishing pressure ever since its earlier crash. Data are lacking, but stock depletion is considered to be much greater than in the Northwest Atlantic. Longline tuna and swordfish fleets in the Southern Hemisphere take a significant partially utilised bycatch. Only limited trend data are available, including over 90% declines in landings by the Uruguayan longline fleet in the southwest Atlantic.

Tope Shark

Galeorhinus galeus (Linnaeus, 1758)

Red List assessment

Global: Vulnerable A2bd+3d+4bd (Carlisle, A.B., Cavanagh, R.D., Chiaramonte, G., Domingo, A., Ebert, D.A., Mancusi, C., Massa, A., McCord, M., Morey, G., Paul, L.J., Serena, F., Stevens, J.D., Vooren, C.M. and Walker, T.I. 2006)
Australia: Vulnerable A1bcd
Southwest Atlantic: Critically Endangered A2bd+A3d+4bd
South Africa: Vulnerable A2bd+3d+4bd
New Zealand: Near Threatened
Eastern North Pacific: Least Concern
Eastern South Pacific, Northeast and Eastern Central Atlantic, Mediterranean: Data Deficient

Rationale

Galeorhinus galeus is a widespread, mainly coastal- and bottom-associated shark of temperate areas, which has been fished in all parts of its distribution.

Australasia: The Australia and New Zealand assessments are based mainly on two pieces of evidence: (1) In southern Australia, the current mature biomass has been estimated from age-based model outputs to be below 20% of the level before commercial target fishing began in the 1920s; and (2) very low biological productivity; maximum age is potentially 60 years, and age at maturity in females exceeds 10 years. In New Zealand, the stock has been managed for 17 years, and landings have been stable for the past decade. However, commercial TACs introduced following some CPUE declines have been regularly exceeded. Fisheries for the species are managed by ITQs in both New Zealand and Australia, which should allow stocks to begin to rebuild, but the sustainable catch level in New Zealand remains unknown.

Southwest Atlantic: In the Southwest Atlantic, the *G. galeus* population is subject to intensive fishing throughout its distribution and, although drastic declines have occurred, the population continues to be fished without restraint. The declines have been most marked in Brazil and Uruguay, where the CPUE has declined almost to zero. The species migrates seasonally between wintering grounds in south Brazil and Uruguay and summer grounds off Argentina, where the pupping and nursery areas are situated and where intense and directed fishery of gravid females occurs. In Argentina, where the animals are generally smaller, the CPUE for the trawler fleet has declined by around 80% during the past decade, and based on current trends the population will inevitably collapse within five to ten years. The tope shark is already considered Critically Endangered and, without major and urgent management measures, the situation for this species in the Southwest Atlantic is set to become even worse.

South Africa: In South Africa, *G. galeus* has been targeted to varying degrees since the 1930s and likely prior to that by indigenous coastal communities. As the principal target species of the directed South African shark fishery, it is likely that the population has been affected. There is evidence of declines from commercial catch data and observations from shark longline fishermen. Also of concern are data from the Gansbaai longline fishery showing a high proportion of the catch to be immature females. Recent estimates based on a spawner biomass per recruit model (which therefore must be considered with caution) suggest that biomass of the South Africa population is at 43% of the pre-exploitation level. It is possible that the South African population is currently being fully exploited and any increase in fishing pressure may result in a decline of biomass to below 40% of the unexploited level. The lack of well-designed regulations governing the South African recreational and commercial shark fisheries and lack of bag limits/bycatch limits in other fisheries that take *G. galeus* mean that a hypothetically unlimited fishery exists for this species. Given its life-history characteristics (long generation time, late age at maturity, first age of reproduction) and the knowledge of the state of the fisheries for these sharks elsewhere, it is likely that the South African population of *G. galeus* is highly susceptible to overfishing, and the Vulnerable assessment is based on the fact that the current shark fishery is virtually unregulated; declines have apparently already taken place and are predicted for the future. Proposed policy for 2005 indicates that long-term rights for the shark fishery will be allocated and multispecies permits will be revoked and replaced with single-species permits. It is envisaged that demersal longline permits to target soupfin sharks will be restricted in number, as will the number of traditional handline vessels permitted to catch traditional linefish (including sharks). This will alter the characteristics of the fishery, and it is highly recommended that another stock assessment be completed within three to five years to evaluate the effect of these changes on the population. There is no fishery for this species in its range into Namibia and southern Angola waters, though they may be occasionally caught in trawl fisheries; there is no further information on these areas at this time.

Northeast Atlantic: *G. galeus* is of limited importance in commercial fisheries in the Northeast Atlantic, where it is typically a bycatch of mixed demersal and pelagic fisheries, especially by French vessels fishing in the English Channel, Western Approaches and northern Bay of Biscay. In Europe, this species is important in recreational fisheries. Data are apparently limited, as landings are often included as "dogfishes and hounds." Nevertheless, England and France have species-specific landings data, and there are also limited data from Denmark and Ireland in recent years. Tope also feature in catch statistics for Portugal and the Azores. Biological data for Northeast Atlantic stocks are limited. Because of the lack of data to form the basis of an accurate assessment, the species is considered Data Deficient in the Northeast Atlantic at this time, and further investigation into its status there is required.

Mediterranean: Although there are no target fisheries for *G. galeus* in the Mediterranean, declines are suspected to have occurred, and it is only rarely seen as bycatch. Overfishing, together with habitat degradation caused by intensive bottom trawling, are considered the main factors that have produced the suspected decline of the Mediterranean stock. Lacking data to form the basis of an accurate assessment, the species is considered Data Deficient in the Mediterranean.

Eastern North Pacific: *G. galeus* was the mainstay of the shark fishery "boom" between 1936 and 1944, when over 24 million pounds were landed. The fishery ended abruptly in 1946 with the development of synthetic vitamin A. Since 1977, the fishery has averaged between 150,000 and 250,000 pounds dressed weight landed annually. Since no studies on this species have taken place in over 50 years in this region, it is unknown whether stocks off California have attained the size of those exploited before the Second World War. However, while it appeared that the adult stock might have collapsed at that time, there would have been large stocks of juveniles to allow for a population recovery. Since the 1940s there has been no economic incentive to target it, and these sharks are now mostly taken at low levels as a bycatch to other commercial species and by recreational anglers. Although there has been no stock assessment for several decades, the fishing mortality can be expected to be low, and landings have been relatively stable; given the lack of a concentrated fishery at this time, this species is listed as Least Concern for the Eastern North Pacific. However, if fishing pressure increases, it will be necessary to re-evaluate this assessment.

Eastern Central Atlantic and Eastern Pacific (off Peru and Chile): There is currently no information from the Eastern Central Atlantic off West Africa, nor in the Eastern Pacific off Peru and Chile. However, given the evidence of decline and low recovery capacity from other parts of its range, it is imperative that the status of this species be further investigated in these and other regions for which this species is considered Data Deficient, in order to establish appropriate conservation and management measures.

FAMILY **CARCHARHINIDAE**

Silvertip Shark

Carcharhinus albimarginatus (Rüppell, 1837)

Red List assessment **Global: Near Threatened** (Pillans, R., Medina, E. and Dulvy, N.K. 2009)

Rationale *Carcharhinus albimarginatus* has a wide but fragmented distribution throughout the tropical Indian and Pacific Oceans (reports in the Western Central Atlantic are as yet unconfirmed). It is a large, slow-growing whaler shark, which appears to be relatively site-specific, possibly with limited dispersion. This species is subjected to bycatch in high-seas fisheries and in artisanal longline, gillnet and trawl fisheries throughout its range, and the number of pelagic sharks landed by fishing fleets in all oceans has become increasingly important in recent years. The meat, teeth and jaws are sold locally, and fins, skin and cartilage are exported. Few data are available, however, there is evidence to suggest that Indonesian fisheries have extirpated local populations of this species from Scott Reef in northern Australia and declines are suspected elsewhere. This species' site specificity, fragmented populations and life-history characteristics indicate that even remote populations are highly vulnerable to target shark fisheries. This information, combined with actual and potential levels of exploitation throughout its range, result in a global assessment of Near Threatened, based on suspected overall population declines approaching 30% (close to meeting the criteria Vulnerable A2bd+A4bd). More information is needed on the status of separate populations throughout its range.

Bignose Shark

Carcharhinus altimus (Springer, 1950)

Red List assessment

Global: Data Deficient (Pillans, R., Amorim, A., Mancini, P., Gonzalez, M. and Anderson, C. 2009)
Australia: Least Concern
Northwest Atlantic: Near Threatened

Rationale

Carcharhinus altimus is a deepwater, diurnally migrating (12–430m) whaler shark that probably has a circumglobal distribution on the continental shelf edge in tropical and warm seas, although records are patchy. There are no target fisheries for this species, although it is taken as bycatch in deep-set pelagic longlines, including widespread tuna longline fisheries, and occasionally in bottom trawls. Reported catches are small, but shark bycatch in longline fisheries is not reported fully throughout the species' range and cannot be used to assess mortality or population trends. It is closely related to the sandbar shark *C. plumbeus*, which it may often be mistaken for (by both fishers and biologists), and which has been heavily depleted by fishing pressure in the Northwest Atlantic. Although no specific data are available for *C. altimus*, it is suspected that this species has also been impacted by longline fisheries operating in this region, warranting an assessment of Near Threatened in the Northwest Atlantic based on a suspected decline. Fishing pressure is also high in Southeast Asia, where this species is utilised whole. Its presence is also confirmed in the Hong Kong fin trade. *C. altimus* is taken in bottom trawls in the Western Indian Ocean, probably by line or gillnet off India, and in nearshore pelagic longlines around the Maldives. Catch rates reported by fishermen in the Maldives have declined significantly in recent years. In Australia this species is not commercially fished, where it is assessed as Least Concern. At present there is insufficient information to assess this species beyond Data Deficient globally. However, given that it may have similarly vulnerable life-history characteristics as the related sandbar shark, evidence for declines in some regions, and high fishing pressure in large parts of its range, its status is of concern and data collection and precautionary adaptive collaborative management should be a priority.

Bronze Whaler

Carcharhinus brachyurus (Günther, 1870)

Red List assessment

Global: Near Threatened (Duffy, C. and Gordon, I. 2003)
East Asia: Vulnerable A2d+3d+4d

Rationale

Carcharhinus brachyurus is a large coastal shark with low productivity. Although it is widespread, regional populations appear to be discrete, and movement of individuals between them is thought to be infrequent or absent, and it does not appear to be naturally abundant anywhere. *C. brachyurus* is assessed as Vulnerable in East Asia due to intensive fisheries and the apparent widespread collapse of fisheries for large coastal sharks. Coastal multispecies fisheries in the region are likely to continue to depress the population by taking pregnant females and juveniles. Coastal nursery areas in this region are also at risk from development and pollution. Catches appear to be stable in Australia. In New Zealand, although there may have been some reduction in population size due to fishing, *C. brachyurus* is apparently still common throughout its range. Management of this species in New Zealand, Australia and South Africa is simplified by having most, if not all, of the population resident within each nation's EEZ, and the species is assessed as Least Concern in these regions. However, it is assessed as Data Deficient in the East Pacific, where there is no information and it appears to be uncommon or rare. Throughout its range, it is known to be exploited by fisheries, but landings are grouped together with other *Carcharhinus* species, meaning any population declines are likely to go unnoticed, and its coastal nursery areas are potentially vulnerable to development and pollution. This, together with life-history characteristics that make it especially vulnerable to overfishing, has led to the global assessment of *C. brachyurus* as Near Threatened. The situation must be monitored, as this species could soon qualify for a Threatened category, on the basis of population declines due to fisheries exploitation in other areas.

Spinner Shark

Carcharhinus brevipinna (Müller & Henle, 1839)

Red List assessment

Global: Near Threatened (Burgess, G.H. 2005)

Rationale

The spinner shark is a schooling active species that often leaps spinning out of the water. This common coastal-pelagic warm-temperate and tropical shark is frequently captured in recreational and commercial fisheries. It is a species that frequents nearshore waters as adults and has inshore nursery areas, making it highly vulnerable to fishing pressure and human-induced habitat alteration.

Silky Shark

Carcharhinus falciformis (Bribon, 1839)

Red List assessment

Global: Near Threatened (Bonfil, R., Amorim, A., Anderson, C., Arauz, R., Baum, J., Clarke, S.C., Graham, R.T., Gonzalez, M., Jolón, M., Kyne, P.M., Mancini, P., Márquez, F., Ruíz, C. and Smith, W. 2009)
Eastern Central and Southeast Pacific: Vulnerable A2bd+4bd
Western Central Pacific and Indian Ocean: Near Threatened
Northwest and Western Central Atlantic: Vulnerable A2bd+4bd
Southwest Atlantic: Near Threatened

Rationale

Global: This oceanic and coastal-pelagic shark is circumglobal in tropical waters, where it dominates as a target species or bycatch in certain pelagic fisheries, particularly purse seines on drifting FADs (fish aggregating devices). This species has a generation period of 11 years and is significantly less resilient to fisheries than blue shark. It is vulnerable to a wide variety of pelagic fisheries, and is taken in large numbers, but there are no population estimates and most catches are unreported. It is highly associated with seamounts and is the dominant shark in tuna purse-seine fisheries on drifting FADs, where declining catch rates have been recorded in the Eastern Pacific. Silky shark ranks among the three most important sharks in the global shark fin trade, with between half a million and one and a half million silky sharks traded annually. Estimates of trends in abundance from standardised catch-rate indices for *Carcharhinus* spp. combined in the Northwest Atlantic range from non-significant trends to a decline of 85% over 19 years. Species-specific trends for silky sharks are difficult to estimate because of difficulties distinguishing it from other carcharhinid sharks. Declines are also inferred in other areas, and silky sharks are known to be particularly important in pelagic fisheries in the Indian Ocean. Globally this species is assessed as Near Threatened, and may prove to meet the criteria for Vulnerable A2bd+A3bd+A4bd in the future.

Eastern Central and Southeast Pacific: Silky sharks are taken in pelagic commercial fisheries and also artisanal fisheries in this region, and fishing pressure from longline and purse-seine fisheries targeting tunas and swordfish is high. Silky sharks are the most commonly caught species of shark in the purse-seine fishery for tunas in the Eastern Pacific Ocean. Preliminary estimates of relative abundance trends for large silky sharks derived from purse-seine fisheries in this region show decreasing trends over the period 1993–2004 for each of three types of purse-seine sets (~65%). According to IATTC, it is not known whether these decreasing trends are due to fishing, changes in the environment, or other processes, however, these results were also consistent with a separate descriptive study of silky shark bycatch rates in dolphin sets. This descriptive analysis showed a decrease in the probability of obtaining sets with bycatches greater than or equal to each of the three threshold levels over the same period. In addition, a study of the tropical Central Pacific (which overlapped FAO Areas, but mainly included the Eastern Central Pacific) estimated a decline in abundance of ~90% and in biomass >90%. A comparison of standardised catch rates of pelagic sharks caught off Costa Rica from 1991 to 2000 (of which silky sharks made up 60–70%) also showed a decreasing trend (~60%). Given the trends described above and continued fishing pressure from pelagic fleets in this region, this species is assessed as Vulnerable A2bd+4bd there.

Northwest and Western Central Atlantic: Silky sharks are taken as a target or bycatch of both commercial and artisanal pelagic fisheries in this region, including in the US commercial shark bottom longline and the pelagic longline fishery, targeted artisanal longline fisheries off Venezuela, and recreational fisheries. This regional assessment is based on several estimates of trends in abundance of both silky shark and *Carcharhinus* spp. combined from standardised catch-rate indices, which estimate declines ranging from 91% to 46% over different areas and time periods. Given the apparent decline in abundance in the Northwest and Western Central Atlantic, and high fishing pressure from pelagic fleets throughout, this species is assessed as Vulnerable A2bd+4bd in this region.

Southwest Atlantic: Silky shark is taken in several longline fisheries in the Southwest Atlantic, including those off Santos, southern Brazil, Natal, northeastern Brazil, and Uruguay, and is retained. It is also targeted by fisheries in northeastern Brazil. Although there is a lack of catch data, the life-history characteristics of this species make it vulnerable to fisheries. Given the declines observed where this species is heavily fished in the Northwest and Western Central Atlantic, this species is considered Near Threatened as a precautionary measure.

Indian Ocean and Western Central Pacific: This species is taken as a target and bycatch of shark and tuna longline and tuna gillnet fisheries in Indonesia and throughout many areas of its range in the Indian Ocean and Western Central Pacific. Pelagic fishing pressure is high, with reports of increasing effort in recent years. Sri Lanka is one of the only countries that reports landings of silky shark to FAO. These landings rose from 5,000t in 1960 to a peak of 25,400t in 1994, after which they declined to just 1,960t in 2006 (with landings not exceeding 7,000t in the last five years of the series), suggesting possible collapse. Maldivian shark fishermen who specialise in longlining for oceanic sharks report declining catch rates of silky sharks, although specific data are not available. While Japanese assessment of data from research longline surveys in the Pacific and Indian Oceans suggests that silky shark CPUE showed no remarkable change in the 1990s when compared to levels in the 1970s, pelagic fishing effort has increased in recent years. Given the significant declines observed in other areas, including the central tropical Pacific, the large decline in reported landings off Sri Lanka, reports of declines in catch rates off the Maldives, and high and continuing fishing pressure across this region, an assessment of at least Near Threatened is considered appropriate.

Galapagos Shark

Carcharhinus galapagensis (Snodgrass & Heller, 1905)

Red List assessment

Global: Near Threatened (Bennett, M.B., Gordon, I. and Kyne, P.M. 2003)
Australia and Oceania: Data Deficient

Rationale

Carcharhinus galapagensis has a widespread, but patchy distribution, occurring at many widely separated island and some coastal sites in the Pacific, Atlantic and Indian Oceans. It is classified globally as Near Threatened (just failing to meet Vulnerable A2acd, and likely to be A3d in the near future) because populations at many of these sites may be subject to high levels of fishing pressure (tuna longline fisheries, targeted drop-line fishing and recreational/tourism-based angling). There is considerable potential to cause severe local declines in the number of mature individuals. Evidence of such reductions/extirpations exists for this species around Central America (Pacific and Atlantic Oceans). Because the species has a limited intrinsic rebound potential, and there are no data on recruitment to isolated sites, such local depletions could lead to loss of populations at specific localities. Continued fishing pressures throughout its range will result in further declines, and populations require monitoring. The species is classified as Data Deficient in Australia and Oceania; although it is not considered to be under threat off Lord Howe Island (Australia) and off the Kermadec Islands (New Zealand), where a marine reserve encompasses the species' range, there is currently no information on these populations.

Bull Shark

Carcharhinus leucas (Valenciennes, in Müller & Henle, 1839)

Red List assessment

Global: Near Threatened (Simpfendorfer, C. and Burgess, G.H. 2005)

Rationale

This common tropical and subtropical species occurs in marine, estuarine and fresh waters. It is the only species of shark that can exist for long periods in fresh water and penetrates long distances up large rivers. It is caught in fisheries throughout its range, but it is rarely a target species. Its occurrence in estuarine and freshwater areas makes it more vulnerable to human impacts and habitat modification.

Blacktip Shark

Carcharhinus limbatus (Valenciennes, in Müller & Henle, 1839)

Red List assessment

Global: Near Threatened (Burgess, G.H. and Branstetter, S. 2005)

Rationale

The blacktip shark is a modest-sized species that is frequently captured in commercial and recreational fisheries. Its meat is well-regarded and its fins are highly marketable. The blacktip is widespread in warm-temperate, subtropical and tropical waters throughout the world. It frequents inshore waters as adults and has inshore nursery areas, making it highly vulnerable to fishing pressure and human-induced habitat alteration.

Oceanic Whitetip Shark

Carcharhinus longimanus (Poey, 1861)

Red List assessment

Global: Vulnerable A2ad+3d+4ad (Baum, J., Medina, E., Musick, J.A. and Smale, M. 2006)
Northwest and Western Central Atlantic: Critically Endangered A2bd+3bd+4bd

Rationale

This formerly widespread and abundant large oceanic shark is subject to fishing pressure virtually throughout its range. It is caught in large numbers as a bycatch in pelagic fisheries, with pelagic longlines, probably pelagic gillnets, handlines and occasionally pelagic and even bottom trawls. Catches, particularly in international waters, are inadequately monitored. Its large fins are highly prized in international trade, although the carcass is often discarded. Fishery pressure is likely to persist if not increase in the future. Outside of the areas detailed below, this species is under similar fishing pressure from multiple pelagic fisheries, and there are no data to suggest that declines would have not also occurred in these areas, given that there are similar fisheries throughout the range. As such, a precautionary global assessment of Vulnerable is considered appropriate for the oceanic whitetip. Efforts are under way to improve the collection of data from some regions, and effective conservation and management of this species will require international agreements.

Northwest Atlantic and Western Central Atlantic: The oceanic whitetip shark is assessed as Critically Endangered in the Northwest and Western Central Atlantic because of the enormous declines that have been reported. Two estimates of trends in abundance from standardised catch-rate indices were made from independent datasets. An analysis of the US pelagic longline logbook data between 1992 and 2000, which covers the Northwest and Western Central Atlantic regions, estimated declines of 70%. An analysis of the Gulf of Mexico, which used data from US pelagic longline surveys in the mid-1950s and US pelagic longline observer data in the late-1990s, estimated a decline of 99.3% over this 40-year time period or 98% over three generations (30 years). However, changes in fishing gear and practices over this period were not fully taken into account in the latter analysis, and there is currently debate as to whether or not these changes may have resulted in an under- or overestimation of the magnitude of these declines.

Dusky Shark

Carcharhinus obscurus (LeSuer, 1818)

Red List assessment

Global: Vulnerable A2bd (Musick, J.A., Grubbs, R.D., Baum, J.K. and Cortés, E. 2009)

Rationale

The dusky shark is a large wide-ranging coastal and pelagic warm water species, which is among the slowest-growing, latest-maturing of known sharks, bearing small litters after a long gestation period. Its very low intrinsic rate of increase renders this species among the most vulnerable of vertebrates (including the great whales and sea turtles) to depletion by fisheries. Unfortunately the dusky shark is difficult to manage or protect because it is taken with other more productive sharks in mixed species fisheries, and has a high mortality rate when taken as bycatch. This species' fins are highly valued. Time series data are available from the Northwest and Western Central Atlantic, where catch rates have declined. Management requiring all individuals captured in the US longline fishery to be released was introduced in 2000, however, while this may have led to an increase in the numbers of juvenile sharks, adults still appear to be declining. A recent stock assessment of the fishery off southwestern Australia estimated that CPUE of this species declined by >75% from the early 1970s–2004 and was still continuing. Given the very high intrinsic vulnerability of this species' to depletion, significant estimated declines in several areas of its range and inferred declines in highly fished areas from which data are not available, *C. obscurus* is assessed as Vulnerable globally.

Sandbar Shark

Carcharhinus plumbeus (Nardo, 1827)

Red List assessment

Global: Vulnerable A2bd+4bd (Musick, J.A., Stevens, J.D., Baum, J.K., Bradai, M., Clò, S., Fergusson, I., Grubbs, R.D., Soldo, A., Vacchi, M. and Vooren, C.M. 2009)

Rationale

This large coastal species is widespread in subtropical and warm temperate waters around the world. Tagging, age and growth studies show that sandbar sharks are long-lived, with low fecundity and are consequently very vulnerable to over-fishing. This species is an important component of shark fisheries in most areas where it occurs and has been overfished in the Northwest and Western Central Atlantic and Mediterranean Sea. Population declines are suspected to have occurred off southern Brazil and in the Northeast Pacific. Off Australia, biomass has also decreased to ~35% of pre-fishery levels as a result of fishing off Western Australia, although management is in place to prevent further declines there. In Hawaiian waters, the species is common and not fished. Given the high intrinsic vulnerability of this species' to depletion, significant declines estimated and suspected in several areas of its range and inferred declines in highly fished areas from which data are not available, *C. plumbeus* is assessed as Vulnerable globally.

Night Shark

Carcharhinus signatus (Poey, 1868)

Red List assessment

Global: Vulnerable A2abd+3bd+4abd (Santana, F.M., Lessa, R. and Carlson, J. 2006)
Eastern Atlantic: Data Deficient

Rationale

Concern for the status of *C. signatus* off South America arises from uncontrolled fishing effort on the species and from its comparatively low biological productivity. Under intense fishing pressure off parts of Brazil, *C. signatus* is a target species (for fins and meat) regularly caught in commercial fisheries on seamounts off northeastern Brazil, where the species aggregates. The night shark is the most important elasmobranch species in the seamount area, where it makes up 90% of catches from over shallow banks. Estimates of age composition indicated that 89.2% of individuals were below the age at 50% maturity. Demographic analysis indicates declines due to fishing mortality rate and early recruitment to the fishery. It is likely that there are no significant natural refuges for the species and that there is little or no exchange with other populations of *C. signatus*. Formerly common in Caribbean fisheries, this species is now apparently rare. Historically, night sharks composed a significant proportion of the artisanal Cuban shark fishery, making up to 60–75% of the catch from 1937 to 1941. However, beginning in the 1970s with the development of the swordfish fishery, anecdotal evidence has indicated a substantial decline in the abundance of this species. Night sharks made up 26.1% of the shark catch in the pelagic US longline fishery from 1981 to 1983, but observer data showed this to decline to 0.3% and 3.3% of the shark catch in 1993 and 1994, respectively. Further, photographic evidence from marlin tournaments in south Florida in the 1970s shows that large night sharks were caught daily, but today they are rarely captured. However, recent trends in catch rates from the pelagic logbook data indicate that the trend has stabilised since 1992, and the Fishery Management Plan of the Atlantic tunas, swordfish and sharks currently lists the night shark as a Prohibited Species and recent time/area closures should help to reduce any further increases in bycatch. All this considered, the night shark is assessed as Vulnerable globally based on significant population declines throughout its Western Atlantic range due to target and bycatch exploitation by fisheries; although it is now managed in US waters, it is not managed elsewhere in the region. There is currently no available information from the Eastern Atlantic distribution of *C. signatus* off West Africa, and until further research and enquiries in this region, the species cannot be assessed beyond Data Deficient for this part of its range, although coastal fisheries in the region are known to be intense and its apparent disjunct distribution could easily lead to localised depletions.

Tiger Shark

Galeocerdo cuvier (Peron & Lesueur, in Lesueur, 1822)

Red List assessment **Global: Near Threatened** (Simpfendorfer, C. 2005)

Rationale This large (>550cm), omnivorous shark is common worldwide in tropical and warm-temperate coastal waters. It is a relatively fast-growing and fecund species. It is caught regularly in target and non-target fisheries. There is evidence of declines for several populations where they have been heavily fished, but in general they do not face a high risk of extinction. Continued demand, especially for fins, may result in further declines in the future.

Blue Shark

Prionace glauca (Linnaeus, 1758)

Red List assessment **Global: Near Threatened** (Stevens, J. 2005)

Rationale This abundant, highly migratory, oceanic shark is widespread in temperate and tropical waters between 50°N and 50°S. It is relatively fast-growing and fecund for a large shark, maturing in 4–6 years and producing average litters of 35 pups, with an intrinsic rate of population increase at maximum sustainable yield of 6% per annum. Because of its prevalence, it is also the shark caught in the greatest numbers worldwide, usually unintentionally. The low value of *P. glauca* meat indicates that many carcasses were discarded prior to the recent introduction of finning bans in parts of its range. Recorded and estimated catch and population declines within the past three generation period (30–45 years) or less range from 40% to 80% in 10–20 years, with other trend data fairly stable. Global maximum sustainable yield (MSY: the highest possible theoretical sustainable catch) is estimated as 7.26–12.60 million sharks per year. There are no population estimates and many (perhaps most) catches are unreported, but include large numbers of immature sharks in some regions. An estimated ~11 million (range 5–16 million) individuals enter the international fin trade annually, which exceeds the estimated range for exploitation at MSY. Furthermore, this trade-based catch estimate is likely to under-represent the actual total number of blue sharks taken by fisheries each year; total mortality is therefore likely even higher. Any trade-based estimate that approaches or exceeds an MSY reference point is of concern because it indicates that catches are unsustainable. There is also concern over the ecosystem effects of removing such large numbers of this likely keystone predator from the ocean. Blue shark catches are largely unregulated, other than through the finning bans recently adopted by RFMOs and some fishing States. Fishing effort is not declining and so these trends are likely to continue.

FAMILY **SPHYRNIDAE**

Scalloped Hammerhead

Sphyrna lewini (Griffith & Smith, 1834)

Red List assessment **Global: Endangered** A2bd+4bd (Baum, J., Clarke, S., Domingo, A., Ducrocq, M., Lamónaca, A.F., Gaibor, N., Graham, R., Jorgensen, S., Kotas, J.E., Medina, E., Martinez-Ortiz, J., Monzini Taccone di Sitizano, J., Morales, M.R., Navarro, S.S., Pérez, J.C., Ruiz, C., Smith, W., Valenti, S.V. and Vooren, C.M. 2009)
Northwest Atlantic and Western Central Atlantic: Endangered A2bd+4bd
Eastern Central and Southeast Pacific: Endangered A4bd
Southwest Atlantic: Vulnerable A4bd
Eastern Central Atlantic: Vulnerable A2bd+4bd
Western Indian Ocean: Endangered A4bd
Australia: Data Deficient

Rationale Global: This coastal and semi-oceanic hammerhead shark is circumglobal in coastal warm-temperate and tropical seas, from the surface and intertidal to at least 275m depth. Although it is wide-ranging, there is genetic evidence for multiple subpopulations. All life-stages are vulnerable to capture as both target and bycatch in fisheries: large numbers of juveniles are captured in a variety of fishing gears in near shore coastal waters, and adults are taken in gillnets and longlines along the shelf and offshore in oceanic waters. Population segregation and the species' aggregating habit make large schools highly vulnerable to fisheries and means that high CPUEs can be recorded, even when stocks are severely depleted. Hammerhead shark fins are more highly valued than other species because of their high fin ray count, leading to increased targeting of this species in some areas. Where catch data are available, significant declines have been documented: both species-specific estimates for *S. lewini* and grouped estimates for *Sphyrna* spp. combined suggest declines in abundance of 50–90% over periods of up to 32 years in several areas of its range, including South Africa, the Northwest and Western Central Atlantic and Brazil. Interviews with fishermen also suggest declining trends. Similar declines are also inferred in areas of the species' range from which specific data are not available, but fishing pressure is known to be high. Although *S. lewini* is relatively fecund compared to other large sharks (with litters of 12–38 pups), the generation period is greater than 15 years in the Gulf of Mexico and its life-history characteristics mean that its resilience to exploitation is relatively low. Given the major declines reported in many areas of this species' range, increased targeting for its high-value fins, low resilience to exploitation, and largely unregulated, continuing fishing pressure from both inshore and offshore fisheries, this species is assessed as Endangered globally.

Northwest and Western Central Atlantic: Estimates of trends in abundance are available from two long-term research surveys conducted on the US East Coast, both of which indicate this species has undergone substantial declines in this region (98% between 1972 and 2003, and an order of magnitude between 1975 and 2005). A third survey comparing catch rates between 1983/1984 with those in 1993–1995 showed a decline of two-thirds, while a survey beginning more recently showed increases in catch rates of juveniles. Standardised catch rates from the US pelagic longline fishery show declines in *Sphyrna* spp. of 89% between 1986 and 2000 (according to the logbook data) and declines of 76% between 1992 and 2005 (according to observer data). The other information for this species from this region comes from Belize, where it has been heavily fished since the 1980s and fishermen have reported dramatic declines, which led to the end of the fishery. Fishing pressure is sustained in Belize by Guatemalan fishermen.

Southwest Atlantic: This species is threatened in Brazil by two main sources of fishing mortality: 1) fishing of juveniles and neonates on the continental shelf by gillnets and trawl nets and 2) fishing of adults by gillnets (only in Brazil) and longlines on the continental shelf and oceanic waters, mostly for fins. Catches are inadequately recorded and landings data do not reflect the numbers finned and discarded at sea. The species is taken by fisheries throughout all parts of its life-cycle and greater demand for shark fins and flesh has resulted in a substantial increase in retention rates and targeting of sharks. In view of the intensive fisheries in the coastal and offshore areas where *S. lewini* occurs in this region and documented declining trends where the species has been heavily fished in other areas of its range, the species is assessed as Vulnerable in the Southwest Atlantic.

Western Indian Ocean: CPUE of *S. lewini* declined significantly from 1978 to 2003 in shark nets off the beaches of Kwa-Zulu Natal, South Africa, suggesting a 64% decline over this period. *Sphyrna lewini* is captured throughout much of its range in the Indian Ocean, including illegal targeting of the species in several areas. Landings reported to FAO in Oman, surveys of landings sites in Oman, and interviews with fishermen there also suggest that catches of *S. lewini* have declined. The species faces heavy fishing pressure in this region, and similar declines in abundance are also inferred in other areas of its range in this region. Given continued high fishing pressure and observed and inferred declines, the species is assessed as Endangered in this region.

Eastern Central and Southeast Pacific: This species is heavily exploited through its range in the Eastern Pacific. Of particular concern is increasing fishing pressure at adult aggregating sites such as Cocos Island (Costa Rica) and the Galapagos Islands (Ecuador), and along the slopes of the continental shelf where high catch rates of juveniles can be obtained. The number of adult individuals at a well-known *S. lewini* aggregation site in the Gulf of California (Espiritu Santo seamount) has declined sharply since 1980. Large hammerheads were also formerly abundant in coastal waters off Central America, but were reportedly depleted in the 1970s. A comparison of standardised catch rates of pelagic sharks (species-specific information was not available) in the EEZ of Costa Rica from 1991 to 2000 showed a decrease of 60%. In Ecuador, landings (grouped for the family Sphyrnidae) peaked in 1996 and declined until 2001. Illegal fishing for shark fins is occurring around the Galapagos. There are no species-specific data for these fisheries, but *S. lewini* is one of the most common species around the Galapagos and given the high value of its fins, it is very likely being targeted. Divers and dive guides in the Galapagos have noted a severe decrease in shark numbers and schools of hammerhead sharks. Given continued high fishing pressure and observed and inferred declines, the species is assessed as Endangered in this region.

Eastern Central Atlantic: Although there are no data on species-specific trends in abundance for *S. lewini* in this region, fishing pressure from pelagic longline fleets in this area is high and potentially comparable to that in the Northwest and Western Central Atlantic, where significant declines in abundance of *S. lewini* have been documented. The larger hammerhead shark, *S. mokarran*, is assessed as Critically Endangered in this region, from which it has apparently virtually disappeared. There is also concern for *S. lewini* in this area and, although it is still present in the catches, catches are composed entirely of juveniles in some areas. Given continued high fishing pressure throughout this species' shelf habitat off Western Africa and the declining trends observed in other areas of this species' range where it is fished, it is considered to meet the criteria for at least Vulnerable in this region.

Australia: There has been a large increase in illegal, unregulated and unreported (IUU) fishing in northern Australia recently. Hammerheads are known to feature in the catches, and are suspected targets for their large, valuable fins, although no specific data are available. Further study is urgently required to determine the status of *S. lewini* in this region.

Great Hammerhead

Sphyrna mokarran (Rüppell, 1837)

Red List assessment

Global: Endangered A2bd+4bd (Denham, J., Stevens, J., Simpfendorfer, C.A., Heupel, M.R., Cliff, G., Morgan, A., Graham, R., Ducrocq, M., Dulvy, N.D, Seisay, M., Asber, M., Valenti, S.V., Litvinov, F., Martins, P., Lemine Ould Sidi, M., Tous, P. and Bucal, D. 2007).
Southwest Indian Ocean: Endangered A2bd+A4bd
Northwest Atlantic: Endangered A2d+A4d
West Africa: Critically Endangered A2d+A4d
Australia: Data Deficient

Rationale

Sphyrna mokarran is a large, widely distributed, tropical hammerhead shark largely restricted to continental shelves. It is highly valued for its fins (in target and incidental fisheries), suffers very high bycatch mortality, and reproduces only once every two years, making it vulnerable to overexploitation and population depletion. Generally regarded as solitary, it is therefore unlikely to be abundant wherever it occurs. The species was previously observed from Mauritania to Angola, and was reportedly abundant from November to January in Senegal, and in October in Mauritania, but stocks have since collapsed and it is recognised as one of the four most threatened species by member States of the Sub Regional Fishing Commission. Although there is very little species-specific data available, the absence of recent records gives cause to suspect a decline of at least 80% in the past 25 years. Fishing proceeds unmanaged and unmonitored, resulting in an assessment of Critically Endangered in the Eastern Atlantic. Although not targeted in the Northwest Atlantic and Gulf of Mexico, it is taken as bycatch in several fisheries and suffers greater than 90% vessel mortality. Two time-series data sets (pelagic logbook, large pelagic survey) have shown a decline in the catch of *Sphyrna* spp. since 1986. Deficiencies in species identification and accurate recording make an assessment of this species very difficult, however, low survival at capture makes it highly vulnerable to fishing pressure, whether directed or incidental. It is therefore assessed as Endangered in the Northwest Atlantic and Gulf of Mexico, based on a suspected decline of at least >50% over the past 10 years. The decline is poorly documented and has not been curtailed. In the Southwest Indian Ocean, this species is assessed as Endangered based on a continued decline in catch rate of 79% reported for the period 1978 to 2003. It is uncertain whether these declines reflect highly localised stock depletion or whether they reflect a general decline in the Southwest Indian Ocean, but large numbers of longline vessels have been reported to be operating illegally in coastal waters of the Western Indian Ocean, where they are targeting primarily hammerhead sharks and giant guitarfish *Rhynchobatus djiddensis*. *Sphyrna mokarran* is also found along the northern coast of Australia. A large increase in the IUU fishing in northern Australia in the last few years points to great concern that this species is being increasingly targeted for its valuable large fins. Recent Risk Assessments of northern Australian elasmobranchs indicate that it may be "high-risk", however, due to a lack of data to form the basis of an accurate assessment, the species is considered Data Deficient in Australia at the present time. Further investigation of its status there is required. Given its vulnerability to depletion, low survival at capture, and high value for the fin trade, this species is considered to meet the criteria for Endangered globally based on the available evidence for declines of >50%. There is an urgent need for data collection in other parts of its range, but considering the high value of its fins and high fishing pressure in other parts of its range, similar declines are likely to have occurred elsewhere.

Smooth Hammerhead

Sphyrna zygaena (Linnaeus, 1758)

Red List assessment

Global: Vulnerable A2bd+3bd+4bd (Casper, B.M., Domingo, A., Gaibor, N., Heupel, M.R., Kotas, E., Lamónaca, A.F., Pérez-Jimenez, J.C., Simpfendorfer, C., Smith, W.D., Stevens, J.D., Soldo, A. and Vooren, C.M. 2009)

Rationale

Sphyrna zygaena is one of the larger hammerhead sharks, found worldwide in temperate and tropical seas, with a wider range than other members of its family. It is coastal-pelagic and semi-oceanic and occurs on the continental shelf. Although few data are available on *S. zygaena*'s life-history characteristics, it is a large hammerhead shark and presumably at least as biologically vulnerable as *S. lewini*. This species is caught with a wide variety of gears in both coastal and oceanic fisheries, as bycatch and a target. Therefore in some areas, all size classes and reproductive stages are susceptible to capture. *Sphyrna zygaena*'s large fins are highly valued for their high fin ray count and they are being increasingly targeted in some areas in response to increasing demand for the fin trade. Few species-specific data are available to assess population trends because catches of hammerhead sharks are often grouped together under a single category. This species has sometimes been confused with *S. lewini* in the tropics and these two species are probably misidentified with each other in some areas. Time-series data on population trends in hammerhead sharks, including *S. zygaena*, are available from the Northwest and Western Central Atlantic and the Mediterranean Sea. In the Northwest and Western Central Atlantic, where *S. zygaena* is outnumbered by *S. lewini* by about ten to one, analysis of US pelagic longline logbook data estimated that Sphrynidae (including *S. lewini*, *S. mokarran* and *S. zygaena*) declined in abundance by 89% since 1986. In the Mediterranean Sea, where *S. zygaena* outnumbers *S. lewini*, compilation and meta-analysis of time-series abundance indices estimated that Sphrynidae (including *S. lewini*, *S. mokarran* and *S. zygaena*) declined by >99% in abundance and biomass since the early 19th century. While very steep declines have been recorded in these areas, the species is afforded some refuge in other areas of its range, such as southern Australia, where it is abundant and fishing pressure is low. The species is currently assessed as Vulnerable globally and further investigation into threats, population trends, catches and life-history parameters throughout its range is required to determine whether it may warrant a higher category in the future.

8.2 Batoids

ORDER **RAJIFORMES**

FAMILY **TORPEDINIDAE**

Smalldisk Torpedo

Torpedo microdiscus Parin & Kotlyar, 1985

Red List assessment

Global: Data Deficient (Lamilla, J. 2006)

Rationale

This is a poorly known electric ray from the Eastern Pacific, recorded only in its original description from the junction of Nazca and Sala y Gomes Ridges in the Southeast Pacific. Of the two known specimens, one was collected by bottom trawl and the other by midwater trawl. Virtually nothing is known of its biology, and no information is available on interactions with fisheries. In the first instance further specimens are required to determine its relationship with (the probably synonymous) *T. semipelagica*. Subsequently, data are required to define accurately the species' distribution, life-history, and its capture as bycatch. Chilean orange roughy fisheries probably operate in the species' area of occurrence, and the bycatch of these need monitoring, particularly if they expand their operations. Given the potentially narrow distribution of this species, the expansion of deepwater fisheries could pose a real threat to the viability of its population. At present though, since the species is known from only two specimens, there is insufficient information to assess it beyond Data Deficient.

Atlantic Torpedo

Torpedo nobiliana (Bonaparte, 1835)

Red List assessment **Global: Data Deficient** (Notarbartolo di Sciara, G., Serena, F., Ungaro, N., Ferretti, F., Holtzhausen, H.A. and Smale, M.J. 2009)

Rationale *Torpedo nobiliana* has a relatively wide range in the Atlantic Ocean, including the Mediterranean Sea. Adults are frequently pelagic or semipelagic, from near the surface to 800m depth, whereas juveniles are mainly benthic, living on soft substrate and coral reef habitat in shallower water. Very few data are available on population or catch trends, although surveys suggest that this species is rare in the Mediterranean Sea. When caught, torpedo rays are usually discarded at sea, resulting in very few data on catches of these species. *Torpedo nobiliana* is caught with bottom trawls and line gear and further research is required to determine the impact of fishing activities on the species. Destruction and degradation of the species' shallow-water nursery grounds may threaten juveniles. At present this species is assessed as Data Deficient globally because there is very little information on catches and population trends.

FAMILY **DASYATIDAE**

Pitted Stingray

Dasyatis matsubarai Miyosi, 1939

Red List assessment **Global: Data Deficient** (Compagno, L.J.V., Ishihara, H., Tanaka, S. and Orlov, A. 2009)

Rationale This stingray appears to be endemic to the Sea of Japan and Northwest Pacific waters around Japan. It is found on the continental shelf, but one specimen captured at the surface over deepwater by gillnet suggests that the species may be semipelagic as well as benthic. The species is often taken in set-net and other fisheries, including longlines and coastal gillnets, but no information is available on catches or the impact of fisheries. Very little is known of the species' biology and it cannot be assessed beyond Data Deficient without further study. Research is required on the species' life-history parameters, distribution, capture in fisheries and population trends.

Pelagic Stingray

Pteroplatytrygon violacea (Bonaparte, 1832)

Red List assessment **Global: Least Concern** (Baum, J., Bianchi, I., Domingo, A., Ebert, D.A., Grubbs, R.D., Mancusi, C., Piercy, A., Serena, F. and Snelson, F.F. 2009)

Rationale The pelagic stingray is widespread, with an almost circumglobal distribution, throughout tropical and subtropical areas of the Pacific, Atlantic and Indian Oceans. It is perhaps the only species of stingray that occurs in pelagic, oceanic waters. The species is taken as bycatch in pelagic longline fisheries around the world. It is caught frequently by tuna and swordfish longliners and mostly discarded, but is retained and utilised in some areas (e.g., Indonesia). Post-discard survival rates are thought to be low in some areas because the fish are often discarded with serious mouth and jaw damage. Analyses of research surveys conducted with pelagic longlines in the 1950s and recent (1990s) observer data from commercial pelagic longline fisheries suggest increases in CPUE in the tropical Pacific Ocean and Northwest Atlantic. Although there is some debate as to consistency of reporting of pelagic stingrays in fisheries statistics and data are lacking from several areas of the species' range, there are no data to suggest that significant declines have occurred in this species. Increasing fishing effort in pelagic fisheries, owing to decreasing abundance of target species (swordfish and tunas), will result in an increase in catches of this species and associated high discard mortality in some areas. Careful monitoring is therefore required. However, given increasing trends observed in some regions and this species' widespread distribution, and in the absence of evidence to suggest significant declines, it is currently assessed as Least Concern globally.

Spotted Eagle Ray

Aetobatus narinari (Euphrasen, 1790)

Red List assessment

Global: Near Threatened (Kyne, P.M., Ishihara, H, Dudley, S.F.J. and White, W.T. 2006)
Southeast Asia: Vulnerable A3bd

Rationale

Aetobatus narinari is a large eagle ray with a widespread distribution across the Indo-Pacific and Eastern and Western Atlantic in tropical and warm-temperate waters. Recorded over the continental shelf from the surface to 60m depth in coastal and open ocean environments, it sometimes enters lagoons and estuaries and is often associated with coral reef ecosystems. The presently known *A. narinari* is most probably a species-complex of at least four different species. However, it is here considered as a single species as presently recognised. Taxonomic resolution of this issue is of priority as each form will have a more restricted range than the presently described wide-ranging species, which will alter the potential effects of threatening processes on each subpopulation. The 2000 Red List assessment for *A. narinari* incorrectly classified the species as "relatively fecund." Females bear a maximum of four pups/litter after a gestation period of probably a year. These limited biological parameters, the species' inshore habitat and hence availability to a wide variety of inshore fishing gear (beach seine, gillnet, purse seine, benthic longline, trawl, *etc.*), its marketability, and the generally intense and unregulated nature of inshore fisheries across large parts of the species' range warrant a global listing of Near Threatened. It is listed as Vulnerable in Southeast Asia, where fishing pressure is particularly intense and the species is a common component of landings (future declines of >30% are expected, if they have not already occurred). With further data it will likely fall into a threatened category in other regions. For example, although specific details are not available, pressure on the inshore environment through artisanal fishing activities off West Africa and eastern Africa, and throughout the Arabian Sea, the Bay of Bengal, and in large portions of the species' American range, has likely affected this species. There is nothing to suggest that pressure will decrease in these regions in the future. In a few parts of its range (e.g., South Africa, the Maldives, the USA and Australia), the species faces lower levels of threat, but overall, pressure on the species is high and likely to cause population depletions. Management and conservation measures that consider harvest and trade management need to be implemented immediately.

Ornate Eagle Ray

Aetomylaeus vespertilio (Bleeker, 1852)

Red List assessment

Global: Endangered (White, W.T. 2006)

Rationale

Aetomylaeus vespertilio is a large (to 240cm disc width), uncommon eagle ray that has not been sighted in any great numbers since its description more than 160 years ago. This species would be highly susceptible to a variety of fishing methods in regions where the level of exploitation of marine resources is very high and is increasing (e.g., India, Thailand, Taiwan and Indonesia). It is occasionally caught by the rhynchobatid gillnet fishery that operates in Southeast Asia. In Australian waters, the fishing pressure would not be very high, but it is rarely observed there. It is suspected to have limiting life-history parameters similar to other myliobatid rays (including low fecundity). This species is assessed as Endangered under the criteria of A2bd+3d+4d because of the very high (and increasing) level of fishing pressure in the inshore regions where it occurs, which is of great concern for this large, uncommon, K-selected inshore species with high susceptibility to capture.

Bat Ray

Myliobatis californicus Gill, 1865

Red List assessment

Global: Least Concern (Cailliet, G.M. and Smith, W.D. 2006)
Mexican Pacific: Data Deficient

Rationale

The bat ray was assessed as Least Concern on the 2000 Red List. It is updated here because new and better information has become available, and it remains Least Concern globally but is assessed as Data Deficient in Mexico. This abundant Eastern

Pacific coastal ray is relatively fast-growing, reaching maturity at around two to three years for males and five years for females. It produces up to 12 pups per year, although smaller litter sizes are more common. It is not a main target of any major fishery, being taken in the US primarily by recreational anglers and only secondarily by commercial fishermen. In Mexico, it is taken in directed elasmobranch fisheries and as bycatch in other fisheries. There are no reliable population estimates, catch data are unreliable because some catches are unreported or generically reported as "ray," and CPUE data do not exist. However, it does not appear that current commercial or recreational catches pose any threat to this population in US waters, which represents a sizeable portion of its range and the main centre of distribution for this species. *Myliobatis californicus* is considered to be a species of Least Concern at the time of this assessment. Improved recording and monitoring of landings in Mexican artisanal and industrial fisheries are needed. The species is assessed as Data Deficient in the Mexican Pacific.

FAMILY **MOBULIDAE**

Manta

Manta birostris (Donndorff, 1798)

Red List assessment

Global: Near Threatened (Marshall, A., Ishihara, H., Dudley, S.F.J., Clark, T.B., Jorgensen, S., Smith, W.D. and Bizzarro, J.J. 2006)

Rationale

Manta birostris is a large plankton-feeding ray that is widely distributed in tropical and subtropical shelf waters, around oceanic islands and other areas of upwelling, such as seamounts. Unfished populations are not thought to be threatened, however, it is not well understood how their use of inshore areas around inhabited coastlines might be affected by anthropogenic influences such as pollution, coastal development, and ecotourism pressures. Although only a few directed fisheries exist for manta rays, their large size, slow speed, and tendency to be found on the surface make manta rays an easy target for fishers. Target fisheries for this species do currently exist in several countries, including the Philippines, México, Mozambique, Madagascar, India, Sri Lanka, Brazil, Tanzania and Indonesia. Many manta parts are used for local and export trade and recent demand for branchial filaments, which are dried and exported for the Asian medicinal market, has resulted in dramatic increases in fishing pressure for mobulids, including mantas, throughout Southeast Asia and East Africa, causing a switch from subsistence fisheries to commercial export fisheries. Regional population declines have been recorded in areas where the species has been fished, including the South China and Sulu Seas, the Philippines, Indonesia and on the west coast of Mexico. As a result of these population declines and this species' inherent vulnerability to depletion, it is assessed as Vulnerable in waters of the Gulf of California, west coast of Mexico and Southeast Asia. Globally this species is considered Near Threatened on the basis of observed population declines in several parts of its range.

Spinetail Devilray

Mobula japanica (Müller & Henle, 1841)

Red List assessment

Global: Near Threatened (White, W.T., Clark, T.B., Smith, W.D. and Bizzarro, J.J. 2006)
Southeast Asia: Vulnerable A3d+4d

Rationale

Mobula japanica is probably circumglobal in all temperate and tropical seas, but its distribution is not completely defined. It is a large devilray (reaching 310cm disc width) of inshore, offshore, and possibly oceanic environments. The spinetail devilray is highly susceptible to gillnets and is known to be landed in Indonesia, Mexico and the Philippines, and likely elsewhere across its range. It is a common component of the inshore pelagic tuna gillnet fishery in Indonesia, where the flesh and gill rakers are utilised. The high value of gill rakers, which are dried and exported for the Asian medicinal market, has resulted in recent dramatic increases in fishing for mobulids in Indonesia, with targeting now occurring. In the Gulf of California, Mexico, the species is also landed when targeted with harpoons and as bycatch from gillnets. In the Philippines, the species was historically targeted in a mixed mobulid fishery, and while a ban on fishing for devilrays is presently in place, enforcement is insufficient and landings still occur. Information on catches is not available from other parts of its range, but it is likely being captured elsewhere, and certainly in Southeast Asia, where target fisheries for whale sharks and manta rays operate. While few species composition data are available (limiting the assessment of current fishing pressures on populations), increased targeting and catches in Indonesia, which may mirror increases elsewhere, are cause for great concern and require urgent international conservation measures as the species is unlikely to be able to tolerate present levels of exploitation. Its large size and fecundity of a single pup per litter emphasize the limited reproductive potential and low productivity of this species. *Mobula japanica* is assessed as Near Threatened globally, but Vulnerable throughout Southeast Asia, where catches and demand are increasing. Vulnerable listings may also be warranted elsewhere if future studies show declines in populations where fished.

Giant Devilray

Mobula mobular (Bonnaterre 1788)

Red List assessment **Global: Endangered A4d** (Notarbartolo di Sciara, G., Serena, F. and Mancusi, C. 2006)

Rationale This huge plankton-feeding ray is the largest of the genus *Mobula*. It has a very low reproductive capacity (giving birth to a single large pup at unknown intervals) and its geographic range is probably limited to offshore deep waters of the Mediterranean (and possibly adjoining North Atlantic waters). It is taken as bycatch on longlines and in swordfish pelagic driftnets, purse seines, trawls and fixed tuna traps, at unsustainable levels. Given this high bycatch mortality, limited reproductive capacity and range, *M. mobular* is listed as Endangered. More research is needed on its exploitation, distribution, biology and ecology. In particular, catch data are required, and stock assessments should be undertaken where the species is fished.

Sicklefin Devilray

Mobula tarapacana (Philippi, 1892)

Red List assessment **Global: Data Deficient** (Clark, T.B., Smith, W.D. and Bizzarro, J.J. 2006)
Southeast Asia: Vulnerable A3d+4d

Rationale *Mobula tarapacana* is probably circumglobal in temperate and tropical waters, but at present it is known from scattered locations in the Indian, Pacific and Atlantic Oceans. It is a large devilray (reaching 370cm disc width) of primarily oceanic occurrence, but is occasionally found in coastal waters. The threat from coastal fisheries in Mexico, Indonesia, the Philippines and elsewhere where mobulids are captured is more limited for this species given its apparent offshore habitat. However, the species is landed in Indonesia, where the catch of mobulids is increasing due to the high value of gill rakers for the Asian medicinal market. Apart from being taken as bycatch of the inshore pelagic tuna gillnet fisheries and purse-seine fisheries, mobulids are increasingly being targeted in Indonesia. Although information is lacking, it is most likely taken elsewhere in its Asian range (e.g., Taiwan). In studies of mobulid catches in the Gulf of California, Mexico and the Philippines, *M. tarapacana* represented a minor part of landings. Given its more pelagic occurrence than other mobulids and its apparent ichthyophagous diet, its capture on longlines requires investigation. The effect of the long-term use of high-seas gillnet and longline fisheries is not known for this species, but the deleterious impacts of such fishing practices on populations of other large elasmobranchs are well known. This is, however, one of the least known mobulids and the lack of population data and exploitation rates preclude a global assessment beyond Data Deficient at this time. Increasing catches of mobulids in Indonesia, which may mirror increases elsewhere, is of great concern for a species not likely to be able to tolerate high catch levels because of its low reproductive potential (fecundity of one pup/litter). As such, present catch levels in Southeast Asia, together with increasing demand in that region, warrant a Vulnerable listing there.

9 References

Aires-da-Silva, A., Ferreira, R.L. and Pereira, J.G. 2008. Case study: Blue shark catch-rate patterns from the Portuguese swordfish longline fishery in the Azores. Pp. 230–235. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Alava, M.N.R., Yaptinchay, A.A., Dolumbal, E.R.Z. and Trono, R.B. 2002. Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. Pp. 132–148. In: *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997* (eds Fowler, S.L., Reid, T. and Dipper, F.A.). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Amorim, A.F., Arfelli, C.A. and Bacilieri, S. 2002. Shark data from Santos longliners fishery off southern Brazil (1971–2000). *ICCAT Collective Volume of Scientific Papers* 54(4): 1341–1348.

Anderson, R.C. and Ahmed, H., 1993. *Shark Fisheries of the Maldives*. Ministry of Fisheries and Agriculture Maldives, and FAO, Rome, 73 pp.

Anderson, R.C. and Hafiz, A. 2002. Elasmobranch fisheries in the Maldives. Pp. 114–121. In: *Elasmobranch Biodiversity, Conservation and Management* (eds S.L. Fowler, T.M. Reed and F.A. Dipper). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Anderson, R.C. and Waheed, Z. 1999. Management of shark fisheries in the Maldives. Pp. 367–401. In: *Case Studies of the Management of Elasmobranch Fisheries* (ed. R. Shotton). FAO Fisheries Technical Paper No. 378/1. FAO, Rome, Italy.

Anonymous. 2002. Conservation et la Gestion des populations de Requins. Commission Sous-Régionale des Pêches, Secrétariat Permanent. Saly-Portuda, du 27–29 mai 2002. 14 pp.

Anonymous. 2008. Proposal for inclusion of porbeagle shark *Lamna nasus* on the appendices of the Convention on the Conservation of Migratory Species of Wild Animals (CITES). Prepared by the European Community and its Member States, Proposal II /10/ Rev.1, pp. 197–212.

Arfelli, C.A. and Amorim, A.F. 1994. Shark fishery from Santos: SP longliners off south and southeast Brazil. Pp. 173–186. In: Proceedings of Fourth Indo-Pacific Conference, Bangkok, Thailand, 28 Nov–4 Dec 1993.

Arocha, F., Arocha, O. and Marcano, L.A. 2002. Observed shark bycatch from the Venezuelan tuna and swordfish fishery from 1994 through 2000. *ICCAT Collective Volume of Scientific Papers* 54(4): 1123–1131.

Au, D.W., Smith, S.E. and Show, C. 2008. Shark productivity and reproductive protection, and a comparison with teleosts. Pp. 298–308. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Australia Department of the Environment and Natural Heritage. 2005. Whale shark (*Rhincodon typus*) Recovery Plan, 2005–2010. At www.environment.gov.au/biodiversity/threatened/publications/recovery/r-typus/ Accessed 27 April 2009.

Babcock, E.A. 2008. Recreational fishing for pelagic sharks worldwide. Pp. 193–204. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Babcock, E.A. and Nakano, H. 2008. Data collection, research, and assessment efforts for pelagic sharks by the International Commission for the Conservation of Atlantic Tunas. Pp. 472–477. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Bailey, K., Williams, P.G. and Itano, D. 1996. By-catch and discards in Western Pacific tuna fisheries: A review of SPC data holdings and literature. Technical Report 34. Oceanic Fisheries Programme, South Pacific Commission, Noumea, New Caledonia. 174 pp.

Baum, J.K. and Myers, R.A. 2004. Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico. *Ecology Letters* 7: 135–145.

Baum, J.K., Myers, R.A., Kehler, D.G., Worm, B., Harley, S.J. and Doherty, P.A. 2003. Collapse and conservation of shark populations in the Northwest Atlantic. *Science* 299: 389–392.

Beerkircher, L.R., Cortés, E. and Shivji, M. 2008. Case study: Elasmobranch bycatch in the pelagic longline fishery off the southeastern United States, 1992–1997. Pp. 242–246. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Bonfil, R. 1994. *Overview of World Elasmobranch Fisheries*. FAO Fisheries Technical Paper No. 341. FAO, Rome, Italy. 119 pp.

Bonfil, R. 2008. The biology and ecology of the silky shark, *Carcharhinus falciformis*. Pp. 114–127. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Bromhead, D., Ackerman, J., Graham, S., Wight, M., Wise, B. and Findlay, J. 2005. Byproduct: Catch, economics and co-occurrence in Australia's pelagic longline fisheries. Western and Central Pacific Fisheries Commission, WCPFC-SCI EB WP-9. 21 pp.

Buencuerpo, V., Rios, S. and Moron, J. 1998. Pelagic sharks associated with the swordfish, *Xiphias gladius,* fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin* 96: 667–685.

Burgess, G.H., Beerkircher, L.R., Cailliet, G.M., Carlson, J.K., Cortés, E., Goldman, K.J., Grubbs, R.D., Musick, J.A., Musyl, M.K. and Simpfendorfer, C.A. 2005. Is the collapse of shark populations in the Northwest Atlantic Ocean and Gulf of Mexico real? *Fisheries* 30(10): 19–26.

Camhi, M. 1999. *Sharks on the Line II: An Analysis of Pacific State Shark Fisheries.* Living Oceans Program, National Audubon Society, Islip, New York. 116 pp.

Camhi, M.D. 2008. Conservation status of pelagic elasmobranchs. Pp. 397–417. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Camhi, M., Fowler, S., Musick, J., Brautigam, A. and Fordham, S. 1998. *Sharks and their relatives – ecology and conservation*. Occasional Paper of the IUCN Species Survival Commission No. 20. IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. 39 pp.

Camhi, M.D., Fordham, S.V. and Fowler, S.L. 2008a. Domestic and international management for pelagic sharks. In: *Sharks of the Open Ocean: Biology, Fisheries* *and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Camhi, M.D., Lauck, E., Pikitch, E.K. and Babcock, E.A. 2008b. A global overview of commercial fisheries for open ocean sharks. Pp. 166–192. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Camhi, M.D., Pikitch, E.K. and Babcock, E.A. 2008c. *Sharks of the Open Ocean: Biology, Fisheries and Conservation.* Blackwell Publishing, Oxford, UK.

Campana, S.E., Joyce, W., Marks, L., Natanson, L.J., Kohler, N.E., Jensen, C.F., Mello, J.J., Pratt Jr., H.L. and Myklevoll, S. 2002. Population dynamics of the porbeagle in the Northwest Atlantic Ocean. *North American Journal of Fisheries Management* 22: 106–121.

Campana, S.E., Marks, L. and Joyce, W. 2004. Biology, fishery and stock status of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. Fisheries and Oceans Canada. Research Doc. 2004/094. 29 pp.

Campana, S.E., Marks, L., Joyce, W. and Kohler, N. 2005. Catch, by-catch and indices of population status of blue shark (*Prionace glauca*) in the Canadian Atlantic. *ICCAT Collective Volume of Scientific Papers* 58(3): 891–934.

Campana, S.E., Marks, L., Joyce, W. and Kohler, N. 2006. Effects of recreational and commercial fishing on blue sharks (*Prionace glauca*) in Atlantic Canada, with inferences on the North Atlantic population. *Canadian Journal of Fisheries and Aquatic Science* 63: 670–682.

Campana, S.E., Joyce, W., Marks, L., Hurley, P., Natanson, L.J., Kohler, N.E., Jensen, C.F., Mello, J.J., Pratt Jr., H.L., Myklevoll, S. and Harley, S. 2008. Pp. 445–461. The rise and fall (again) of the porbeagle shark population in the Northwest Atlantic. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Canada Fisheries and Oceans. 2005. *Stock assessment report on NAFO Subareas 3–6 porbeagle shark*. Science Advisory Report 2005/044. 11pp.

Castro A.L.F., Stewart B.S., Wilson S.G., Hueter RE., Meekan MG., Motta, P.J., Bowen, B.W. and Karl, S.A. 2007. Population genetic structure of Earth's largest fish, the whale shark (*Rhincodon typus*). *Molecular Ecology* 16: 5183–5192.

Cavanagh, R.D., Kyne, M., Fowler, S.L., Musick, J.A. and Bennett, M.B. 2003. *The Conservation Status of Australasian Chondrichthyans. Report of the IUCN Shark Specialist Group Australia and Oceania Regional Red List Workshop*. The University of Queensland, School of Biomedical Sciences, Brisbane, Australia. x + 170 pp.

Cavanagh, R.D. and Gibson, C. 2007. *Overview of the Conservation Status of Cartilaginous Fishes* (*Chondrichthyans*) *in the Mediterranean Sea.* IUCN, Gland, Switzerland and Malaga, Spain. 42 pp.

Cavanagh, R.D., Fowler, S.L. and Camhi, M.D. 2008. Pelagic sharks and the FAO International Plan of Action for the Conservation and Management of Sharks. Pp. 478–492. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

CCAMLR. 2006. Conservation of sharks. Conservation Measure 32–18, 2006. At www.ccamlr.org. Accessed 23 March 2009.

Chen, C.T., Liu, K.M. and Joung, S.J. 2002. Preliminary report on Taiwan's whale shark fishery. Pp. 162–167. In: *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997* (eds Fowler, S.L., Reid, T. and Dipper, F.A.). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). 2002. Proposal for the Inclusion of the Whale Shark (*Rhincodon typus*) on Appendix II of CITES. Prepared by India and the Philippines. Prop 12.35. 24 pp. Available at: www.cites.org/eng/cop/12/prop/E12-P35.pdf. Downloaded on 27 April 2009.

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). 2004. AC 20 Summary Report. Twentieth meeting of the Animals Committee Johannesburg (South Africa), 29 March–2 April 2004. Available at: http://www.cites.org/eng/com/aC/20/E20-Sum.pdf. Downloaded on 27 April 2009.

Clarke, S.C. 2004. Understanding pressures on fishery resources through trade statistics: A pilot study of four products in the Chinese dried seafood market. *Fish and Fisheries* 5: 53–74.

Clarke, S. 2008. Estimating historic shark removals in the Atlantic using shark fin trade data and Atlantic-specific area, tuna catch and effort scaling factors. ICCAT SCRS 2008/139.

Clarke, S., Burgess, G.H., Cavanagh, R.D., Crow, G., Fordham, S.V., McDavitt, M.T., Rose, D.A., Smith, M. and Simpfendorfer, C. 2005. Socio-economic importance of elasmobranchs. Pp.19–47. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler *et al*.). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Clarke, S.C., McAllister, M.K. Milner-Gulland, E.J., Kirkwood, G.P., Michielsens, C.G.J., Agnew, D.J., Pikitch, E.K., Nakano, H. and Shivji, M.S. 2006a. Global estimates of shark catches using trade records from commercial markets. *Ecology Letters* 9: 1115–1126.

Clarke, S.C., Magnussen, J.E., Abercrombie, D.L., McAllister, M.K. and Shiviji, M.S. 2006b. Identification of shark species composition and proportion in the Hong Kong shark fin market based on molecular genetics and trade records. *Conservation Biology* 20(1): 201–211.

Clarke, S., Milner-Gulland, E.J. and T. Bjorndal. 2007. Social, economic, and regulatory drivers of the shark fin trade. *Marine Resource Economics.* 22: 305–327.

Clarke, M., Guzman, D., Ellis, J., Frentzel-Beyme, B., Figueiredo, I., Helle, K., Johnston, G., Pinho, M., Séret, B., Dobby, H., Hariede, N., Heessen, H., Kulka, D. and Stenberg, C. 2008. An overview of pelagic shark fisheries in the Northeast Atlantic. *ICCAT Collective Volume of Scientific Papers* 62(5): 1483–1493.

Coello, S. 2005. La Administración de los Chondrichthyes en Ecuador. Aportes para el Plan Nacional de Tiburones. UICN, Quito, Ecuador. 42 pp.

Colman, J.G. 1997. A review of the biology and ecology of the whale shark. *Journal of Fish Biology.* 51: 1219–1234.

Compagno, L.J.V. 1984a. Sharks of the World. An annotated and illustrated catalogue of shark species to date. Part I (Hexanchiformes to

Lamniformes). *FAO Fisheries Synopsis* No. 125, Vol. 4, Part I. FAO, Rome.

Compagno, L.J.V. 1984b. *Sharks of the World. An annotated and illustrated catalogue of shark species to date. Part II (Carcharhiniformes). FAO Fisheries Synopsis* No. 125, Vol. 4, Part II. FAO, Rome.

Compagno, L.J.V. 2001. *FAO Species Catalogue for Fisheries Purposes. No. 1. Sharks of the World: An Annotated and Illustrated Catalogue of the Shark Species Known to Date. Vol. 2. Bullhead, Mackerel and Carpet Sharks* (*Heterodontiformes, Lamniformes and Orectolobiformes*). FAO, Rome, Italy. 269 pp.

Compagno, L.J.V. 2005. Appendix 1: Global Checklist of Living Chondrichthyan Fishes. Pp. 410–423. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler *et al*.). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Compagno, L.J.V. 2008. Pelagic elasmobranch diversity. Pp. 14–23. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Cook, S. 1990. Trends in shark fin markets: 1980, 1990, and beyond. *Chondros* (March):3–6.

Cortés, E. 2000. Life history patterns and correlations in sharks. *Reviews in Fisheries Science* 8: 299–344.

Cortés, E. 2008a. Comparative life history and demography of pelagic sharks. Pp. 309–322. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Cortés, E. 2008b. Catches of pelagic sharks from the western North Atlantic Ocean, including the Gulf of Mexico and Caribbean Sea. *ICCAT Collective Volume of Scientific Papers* 62(5): 1434–1446.

Cortés, E. and Neer, J.A. 2006. Preliminary reassessment of the validity of the 5% fin to carcass weight ratio for sharks. *Col. Vol. Sci. Pap. ICCAT,* 59(3): 1025–1036.

Diaz, G.A. and Serafy, J.E. 2005. Longline-caught blue shark (*Prionace glauca*): factors affecting the numbers available for live release. *Fishery Bulletin* 103: 720–724.

Denham, J., Stevens, J., Simpfendorfer, C.A., Heupel, M.R., Cliff, G., Morgan, A., Graham, R., Ducrocq, M., Dulvy, N.D, Seisay, M., Asber, M., Valenti, S.V., Litvinov, F., Martins, P., Lemine Ould Sidi, M., Tous, P. and Bucal, D. 2007. *Sphyrna mokarran.* In: IUCN 2008. 2008 IUCN Red List of Threatened Species. At www.iucnredlist.org. Accessed 10 March 2009.

Dudley, S.F.J. and Simpfendorfer, C.A. 2006. Population status of 14 shark species caught in the protective gillnets off KwaZulu-Natal beaches, South Africa, 1978–2003. *Marine and Freshwater Research* 57: 225–240.

Dulvy, N.K., Baum, J.K., Clarke, S., Compagno, L.J.V., Cortés, E., Domingo, A., Fordham, S., Fowler, S., Francis, M.P., Gibson, C., Martínez, J., Musick, J.A., Soldo, A., Stevens, J.D. and Valenti, S. 2008. You can swim but you can't hide: The global status and conservation of oceanic pelagic sharks and rays. *Aquatic Conservation: Marine and Freshwater Ecosystems* 18(5): 459–482.

European Commission. 2009. European Community Action Plan for the Conservation and Management of Sharks. At ec.europa.eu/fisheries/cfp/management_resources/conservation_measures/sharks/introduction_en.htm. Accessed 1 April 2009.

FAO Fisheries and Aquaculture Information and Statistics Service. 1999. International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks). At www.fao.org/fishery/ipoa-sharks/en. Accessed 16 March 2009.

FAO (Food and Agriculture Organization). 2009. FISHSTAT Plus (v. 2.30), Capture Production Database, 1950–2007, and Commodities Trade and Production Database 1976–2007. FAO, Rome, Italy.

Ferretti, F., Myers, R.A., Serena, F. and Lotze, H.K. 2008. Loss of large predatory sharks from the Mediterranean Sea. *Conservation Biology* 22: 952–964.

Fowler, S.L. 1996. Red List assessments for sharks and rays. *Shark News* 8:5. Newsletter of the IUCN SSC Shark Specialist Group.

Fowler, S.L. 2005. Pp. 252–256. Basking shark *Cetorhinus maximus*. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler *et al*.). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Fowler, S.L. *et al*. In preparation. Global threat status of sharks, rays and chimaeras.

Fowler, S.L. and Cavanagh, R.D. 2005. Species status reports. Pp. 213–361. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler *et al*.). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Fowler, S.L., Reed, T.M. and Dipper, F.A. (eds). 2002. *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997.* IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. xv + 258 pp.

Fowler, S.L., Cavanagh, R.D., Camhi, M., Burgess, G.H., Cailliet, G.M., Fordham, S.V., Simpfendorfer, C.A. and Musick, J.A. (comps. and eds). 2005. *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes.* IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Francis, M.P., Griggs, L.H. and Baird, S.J. 2001. Pelagic shark bycatch in the New Zealand tuna longline fishery. *Marine Freshwater Research* 52: 165–178.

Francis, M.P., Natanson, L.J. and Campana, S.E. 2008. Pp. 105–113. The biology and ecology of the porbeagle shark, *Lamna nasus*. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

François Poisson, F. and Séret, B. 2008. Pelagic sharks in the Atlantic and Mediterranean French fisheries: Analysis of catch statistics. ICCAT SCRS/2008/134.

Garcia-Cortés, B. and Mejuto, J. 2005. Scientific estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Indian Ocean: 2001–2003 period. Indian Ocean Tuna Commission, IOTC-2005WPby-14. 9 pp.

García Núñez, N.E. 2008. Sharks: Conservation, Fishing and International Trade. Bilingual edition. Dirección General para la Biodiversidad. Ministerio de Medio Ambiente, y Medio Rural y Marino, Madrid. 111 pp.

Gibson, C., Valenti, S.V., Fordham, S.V. and Fowler, S.L. 2008. *The Conservation of Northeast Atlantic Chondrichthyans: Report of the IUCN Shark Specialist Group Northeast Atlantic Red List Workshop.* IUCN Species Survival Commission Shark Specialist Group, Newbury, UK. viii + 76 pp.

Gilman, E., Clarke, S., Brothers, N., Alfaro-Shigueto, J., Mandelman, J., Mangel, J., Petersen, S., Piovano, S., Thomson, N., Dalzell, P., Donoso, M., Goren, M. and Werner, T. Shark interactions in pelagic longline fisheries. *Marine Policy* 32: 1–18.

Goldman, K.J. and Musick, J.A. 2008. Biology and ecology of the salmon shark, *Lamna ditropis*. Pp. 95–104. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Gore, M.A., Rowat, D., Hall, J., Gell, F.R. and Ormond, R.F. 2008. Transatlantic migration and deep mid-ocean diving by basking shark. *Biology Letters* 4: 395–398.

Graham, R.T. 2004. Global whale shark tourism: a "golden goose" of sustainable and lucrative income. *Shark News* 16: 8–9.

Graham, R.T., Roberts, C.M. and Smart, J.R. 2006. Diving behaviour of whale sharks in relation to a predictable food pulse. *Journal of the Royal Society Interface* 3(6): 109–116.

Hanan, D.A., Holts D.B. and Coan Jr., A.L. 1993. The California drift gill net fishery for sharks and swordfish, 1981–82 through 1990–91. *California Department of Fish and Game Fish Bulletin* 175: 95.

Hanfee, F. 1999. Management of shark fisheries in two Indian coastal states: Tamil Nadu and Kerala. Pp. 316–338. In: *Case Studies of the Management of Elasmobranch Fisheries* (ed. R. Shotton). FAO Fisheries Technical Paper No. 378/1. FAO, Rome, Italy.

Hanfee, F. 2001. *Trade in Whale Shark and its Products in the Coastal State of Gujarat, India*. TRAFFIC India.

Hareide, N.R., Carlson, J., Clarke, S., Ellis, J., Fordham, S., Pinho, M., Raymakers, C., Serena, F., Séret, B. and Polti, S. 2007. European shark fisheries: A preliminary investigation into fisheries, conversion factors, trade products, markets and management measures. European Elasmobranch Association.

Hazin, F.H.V., Hazin, H.G. and Travassos, P. 2007. CPUE and catch trends of shark species caught by Brazilian longliners in the Southwestern Atlantic Ocean. *ICCAT Collective Volume of Scientific Papers* 60(2): 636–647.

Hazin, F.H.V, Broadhurst, M.K., Amorim, A.F., Arfelli, C.A. and Domingo, A. 2008. Catches of pelagic sharks by subsurface longline fisheries in the South Atlantic Ocean during the last century: A review of available data with an emphasis on Uruguay and Brazil. Pp. 213–229. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Hoenig, J.M. and Gruber, S.H. 1990. Life history patterns in the elasmobranchs: Implications for fisheries management. *NOAA Technical Report NMFS* 90: 1–16.

Holts, D.B., Julian, A., Sosa-Nishizaki, O. and Bartoo, N.W. 1998. Pelagic shark fisheries along the west coast of the United States and Baja California, Mexico. *Fisheries Research* 39: 115–125.

Hurley, P.C.F. 1998. A review of the fishery for pelagic sharks in Atlantic Canada. *Fisheries Research* 39: 107–113.

Hurry, G.D., Hayashi, M. and Maguire, J.J. 2008. Report of the Independent Review: International Commission for the Conservation of Atlantic Tunas, PLE-106/2006. 96 pp.

IATTC. 2007. Annual report of the Inter-American Tropical Tuna Commission 2005. IATTC, La Jolla, California.

ICCAT. 2005. *Report of the 2004 Inter-sessional Meeting of the ICCAT Sub-committee on By-catches: Shark Stock Assessment*, Tokyo, Japan, 14–18 June 2004. *ICCAT Collective Volume of Scientific Papers* 58(3): 799–890.

ICCAT. 2008a. Report of the 2007 data preparatory meeting of the Shark Species Group. *ICCAT Collective Volume of Scientific Papers* 62(5): 1325–1404.

ICCAT. 2008b. Report for biennial period, 2006–2007, Part II (2007), v. 2. ICCAT, Madrid, Spain.

ICCAT. 2008c. Report of the 2008 Shark Stock Assessments Meeting. SCRS/2008/017, SHK Assessment. ICCAT, Madrid, Spain. 89 pp.

ICCAT. 2009. ICCAT Statistical Database. At www.iccat.int. Accessed 19 March 2009.

ICCAT SCRS. 2008. *Report of the Standing Committee on Research and Statistics (SCRS)*, Madrid, Spain, September 29 to October 3, 2008. ICCAT, Madrid, Spain. 241pp.

ICES. 2006. Northeast Atlantic porbeagle. ICES Advice 2006, Book 9:108–112. At www.ices.dk. Accessed 28 March 2009.

ICES. 2008. Report of the Working Group Elasmobranch Fishes (WGEF). ICES WGEF Report 2008: ICES CM 2008/ACOM: 16. 332 pp. At www.ices.dk. Accessed April 9, 2009.

IOTC. 2005. Information on shark finning fisheries. IOTC-2005-S9-08(EN). Indian Ocean Tuna Commission, Victoria, Seychelles.

IOTC. 2007. Report of the Third Session of the IOTC Working Party on Ecosystems and Bycatch, Seychelles. IOTC-2007-WPEB-R[E]/ 39 pp. At www.iotc.org. Accessed 27 April 2009.

IOTC. 2008a. Report of the Fourth Session of the IOTC Working Party on Ecosystems and Bycatch, Bangkok, Thailand. 23 pp. At www.iotc.org. Accessed 26 March 2009.

IOTC. 2008b. Report of the Eleventh Session of the Scientific Committee. Victoria, Seychelles, 1–5 December, 2008. *IOTC-2008-SC-R[E]*. 166 pp.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp.

IUCN. 2003. Shark finning. Information paper, 3 pp. At www.flmnh.ufl.edu/fish/organizations/ssg/iucnsharkfinningfinal.pdf. Accessed 20 March 2009.

IUCN. 2008a. Guidelines for Using the IUCN Red List Categories and Criteria Version 7.0 (August 2008). At www.iucnredlist.org/static/categories_criteria. Accessed 23 September 2008.

IUCN. 2008b. Global policy against shark finning. IUCN World Conservation Congress, CGR4.MOT035 Rev. 1. 2 pp.

IUCN. 2009a. About IUCN. At www.iucn.org/about/index.cfm. Accessed 23 September 2008.

IUCN. 2009b. About the Species Survival Commission. At www.iucn.org/about/work/programmes/species/about_ssc/. Accessed 20 March 2009.

IUCN. 2009c. About the IUCN Red List. At cms.iucn.org/about/work/programmes/species/red_list/about_the_red_list/. Accessed 20 March 2009.

IUCN SSG. 2007. *Review of Migratory Chondrichthyan Fishes*. CMS Technical Series No. 15. IUCN, UN Environment Programme and Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. 68 pp.

Jiao, Y., Hayes, C. and Cortés, E. 2009. Hierarchical Bayesian approach for population dynamics modeling of fish complexes without species-specific data. *ICES Journal of Marine Science*. 66(2): 367–377.

Joseph, L. 1999. Management of shark fisheries in Sri Lanka. Pp. 339–366. In: *Case Studies of the Management of Elasmobranch Fisheries* (ed. R. Shotton). FAO Fisheries Technical Paper No. 378/1. FAO, Rome, Italy.

Joseph, J. 2003. Managing fishing capacity of the world tuna fleet. *FAO Fisheries Circular*. No. 982. Rome, FAO. 67 pp.

Joung, S.J., Liu, K.M., Liao, Y.Y. and Hsu, H.H. 2005. Observed by-catch of Taiwanese tuna longline fishery in the South Atlantic Ocean. *Journal of the Fisheries Society of Taiwan* 32(1): 69–77.

Jung, A. 2008. A preliminary assessment of the French fishery targeted porbeagle shark (*Lamna nasus*) in the Northeast Atlantic Ocean: Biology and catch statistics. ICCAT SCRS/2008/152.

Kelleher, G. 1999. *Guidelines for Marine Protected Areas.* IUCN, Gland, Switzerland and Cambridge, UK. xxiv + 107 pp.

Kleiber, P., Takeuchi, Y. and Nakano, H. 2001. *Calculation of Plausible Maximum Sustainable Yield (MSY) for Blue Shark (Prionace glauca) in the North Pacific.* Administrative Report H-01-02. Southwest Fisheries Science Center, NMFS, La Jolla, California.

Kleiber, P., Clarke, S., Bigelow, K., Nakano, H., McAllister, M. and Takeuchi, Y. 2009. *North Pacific blue shark stock assessment.* US Dept. of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFS-PIFSC-17. 74 pp.

Kohler, N.E. and Turner, P.A. 2008. Stock structure of the blue shark (*Prionace glauca*) in the North Atlantic Ocean based on tagging data. Pp. 339–350. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Kreuzer R. and Ahmed, R. 1978. *Shark Utilization and Marketing.* FAO, Rome, Italy. 180 pp.

Kyne, P.M. and Simpfendorfer, C.A. 2007. A collation and summarization of available data on deepwater chondrichthyans: Biodiversity, life history and fisheries. A report prepared by the IUCN SSC Shark Specialist Group for the Marine Conservation Biology Institute. At www.iucnssg.org/tl_files/Assets/pdf/Kyne%20&%20Simpfendorfer%202007.pdf. Accessed 16 March 2009.

Lack, M. 2006. *Conservation of Spiny Dogfish* Squalus acanthias*: A Role for CITES?* TRAFFIC Oceania.

Lack, M. and Sant, G. 2006. *Confronting Shark Conservation Head On!* TRAFFIC International, Cambridge, UK. 29 pp.

Lack, M. and Sant, G. 2008. *Illegal, Unreported, and Unregulated Shark Catch: A Review of Current Knowledge and Action.* Department of the Environment, Water, Heritage and the Arts and TRAFFIC, Canberra, Australia. 57 pp.

Last, P.R. and Stevens, J.D. 1994. *Sharks and Rays of Australia.* CSIRO, Melbourne, Australia.

Maguire, J., Sissenwine, M., Csirke, J., Grainger, R. and Garcia, S. 2006. *The State of World Highly Migratory, Straddling and Other High Seas Fishery Resources and Associated Species.* FAO Fisheries Technical Paper No. 495. FAO, Rome, Italy.

Marin, Y.H., Brum, F., Barea, L.C. and Chocca, J.F. 1998. Incidental catch associated with swordfish longline fisheries in the south-west Atlantic Ocean. *Marine Freshwater Res*earch 49: 633–9.

Matsunaga, H. 2008. Estimation of catches for blue shark and shortfin mako by the Japanese tuna longline fishery in the Atlantic Ocean, 1994–2006. ICCAT SCRS/2008/150.

Matsunaga, H. and Nakano, H. 1996. CPUE trend and species composition of pelagic shark caught by Japanese research and training vessels in the Pacific Ocean. Thirteenth Meeting of the CITES Animals Committee, Pruhonice, Czech Republic, 23–27 September 1996. AC13.6.1 Annex. 8 pp.

Matsushita, Y. and Matsunaga, H. 2002. Species composition and CPUE of pelagic sharks observed by Japanese observers for tuna longline fisheries in the Atlantic Ocean. *ICCAT Collective Volume of Scientific Papers* 54(4): 1371–1380.

McKinnell, S. and Seki, M.P. 1998. Shark bycatch in the Japanese high seas squid driftnet fishery in the North Pacific Ocean. *Fisheries Research* 39(2): 127–138.

Mejuto, J., Garcia-Cortés, B. and de la Serna, J.M. 2002. Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediterranean Sea. *ICCAT Collective Volume of Scientific Papers* 54(4): 1150–1163.

Mejuto, J., Garcia-Cortés, B., de la Serna, J.M. and Ramos-Cartelle, A. 2006a. Scientific estimations of by-catch landed by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Atlantic Ocean: 2000–2004. *ICCAT Collective Volume of Scientific Papers* 59(3): 1014–1024.

Mejuto, J., Garcia-Cortés, B. and Ramos-Cartelle, A. 2006b. An overview of research activities on swordfish (*Xiphias gladius*) and the by-catch species, caught by the Spanish longline fleet in the Indian Ocean. Indian Ocean Tuna Commission, IOTC 2006-WPB-11. 23 pp.

Mejuto, J., Garcia-Cortés, B., Ramos-Cartelle, A. and Ariz, J. 2007. Preliminary overall estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Pacific Ocean and interaction with marine turtles and sea birds: Years 1990–2005. Inter-American Tropical Tuna Commission, IATTC Working Group on Bycatch, February 2007, BYC-6-INF A. 16 pp.

Miyake, P.M. 2001. ICCAT effort on research on shark incidental-catches of tuna fishing fleets. *ICCAT Collective Volume of Scientific Papers* 58(3): 1553–1557.

Moore, C.J. 2000. A review of mercury in the environment (its occurrence in marine fish). South Carolina Marine Resources Division Technical Report No. 88, Charleston, South Carolina.

Morgan, A. and Burgess, G.H. 2007. At-vessel fishing mortality for six species of sharks caught in the Northwest Atlantic and Gulf of Mexico. *Gulf and Caribbean Research* 19(2): 1–7.

Muñoz-Chapuli, R., Notarbartolo di Sciara, G., Séret, B. and Stehmann, M. 1993. The status of the elasmobranch fisheries in Europe. IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Musick, J.A. 1999. Ecology and conservation of long-lived marine animals. Pp. 1–10. In: *Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals.* American Fisheries Society, Bethesda, Maryland.

Musick, J.A. 2005. Introduction. Pp. 1–3. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler, R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer and J.A. Musick). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Musick, J.A. 2004. Shark Utilization. Chapter 14 pp. 223–236. In: *Elasmobranch Fisheries Management Techniques.* (eds J. Musick and R. Bonfil). Asia Pacific Economic Cooperation. Singapore. 370 pp. Available at www.flmnh.ufl.edu/fish/organizations/ssg/EFMT/14.pdf. Accessed on 15 April 2009.

Musick, J.A. and Ellis, J.K. 2005. Reproductive Evolution of Chondrichthyes, Pp. 45–79. In: *Reproductive Biology and Phylogeny of Chondrichthyes: Sharks, Batoids and Chimaeras.* Hamlett, W.C. (ed.) Science Publishers, Inc. Plymouth, UK. Available at: http://web.vims.edu/fish/faculty/pdfs/Repro_Evol_of_Chondrichthyans.pdf. Downloaded on 14 April 2009.

NAFO (Northwest Atlantic Fisheries Organization). 2006. *Thorny Skate (*Amblyraja radiata*) in Divisions 3L, 3N and 3O and Subdivision 3Ps.* SC, 1–15 June 2006.

Available at: /www.nafo.int/science/advice/2006/ska3lno.pdf. Accessed on 21 April 2009.
NAFO (Northwest Atlantic Fisheries Organization). 2008. Report of the Scientific Council Meeting, 5–19 June 2008. NAFO SCS Doc. 08/19. 248 pp.
Nakano, H. 1996. Historical CPUE of pelagic shark caught by Japanese longline fishery in the world. *Thirteenth Meeting of the CITES Animals Committee*, Pruhonice, Czech Republic, 23–27 September 1996. AC13.6.1 Annex, 7 pp.
Nakano, H. and Clarke, S. 2005. Standardized CPUE for blue sharks caught by the Japanese longline fishery in the Atlantic Ocean, 1971–2003. *ICCAT Collective Volume of Scientific Papers* 58(3): 1127–1134.
Nakano H. and Stevens, J.D. 2008. The biology and ecology of the blue shark, *Prionace glauca*. Pp. 140–151. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.
New Zealand Ministry of Fisheries. 2008. *New Zealand National Plan of Action for the Conservation and Management of Sharks*. October 2008. Wellington, New Zealand. 92 pp. www.fish.govt.nz/en-nz/Environmental/Sharks.htm. Accessed 10 April 2009.
Newman, H.E., Medcraft, A.J. and Colman, J.G. 2002. Whale shark tagging and ecotourism. Pp. 230–235. In: *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997* (eds S.L. Fowler, T. Reid, and F.A. Dipper). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.
Notarbartolo di Sciara, G. 2005. Giant devilray or devil ray *Mobula mobular* (Bonnaterre, 1788). Pp. 357–358. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler, R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer and J.A. Musick). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.
Pade, N.G., Queiroz, N., Humphries, N.E., Witt, M.J., Jones, S., Noble, L.R. and Sims, D.W. 2009. First results from satellite-linked archival tagging of porbeagle shark, *Lamna nasus:* Area fidelity, wider-scale movements and plasticity in diel depth changes. *Journal of Experimental Marine Biology and Ecology* 370(1–2): 64–74.
Pogonoski, J.J., Pollard, D.A. and Paxton, J.R. 2002. Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes. Environment Australia, Canberra, Australia.
Román-Verdesoto, M. and Orozco-Zöller, M. 2005. Bycatches of sharks in the tuna purse-seine fishery of the Eastern Pacific Ocean reported by observers of the Inter-American Tropical Tuna Commission, 1993–2004. Inter-American Tropical Tuna Commission, Report 11. 72 pp.
Rose, D.A. 1996. *An Overview of World Trade in Sharks and Other Cartilaginous Fishes.* TRAFFIC International, Cambridge, UK. 106 pp.
Rowat, D. 2007. Occurrence of whale shark (*Rhincodon typus*) in the Indian Ocean: A case for regional conservation. *Fisheries Research* 84: 96–101.
Rowat, D. and Engelhardt, U. 2007. Seychelles: A case study of community involvement in the development of whale shark ecotourism and its socio-economic impact. *Fisheries Research* 84: 109–113.
Santos, M.N., Garcia, A. and Pereira, J.G. 2002. A historical review of the bycatch from the Portuguese surface longline swordfish fishery: Observations on the blue shark (*Prionace glauca*) and short-fin mako (*Isurus oxyrinchus*). *ICCAT Collective Volume of Scientific Papers* 54(4): 1333–1340.
Schmidt, J.V., Schmidt, C.L., Ozer, F., Ernst, R.E., Feldheim, K.A., Ashley, M.V. and Levine, M. 2009. Low genetic differentiation across three major ocean populations of the whale shark, *Rhincodon typus*. *PloS ONE* 4(4): 1–9.
SEAFDEC. 2006. *Report on the Study on Shark Production, Utilization and Management in the ASEAN Region, 2003–2004.* SEC/SP/75. SEAFDEC, Bangkok, Thailand. 39 pp.
Semba, Y., Matsumoto, T., Okamoto, H. and Tanabe, T. 2008. Report of Japan's scientific observer program for tuna longline fishery in the Atlantic Ocean in the fishing year of 2007. ICCAT SCRS/2008/177.
Shark Alliance. 2009. Press release: European and Australian proposals to weaken Indian Ocean shark finning ban defeated. Available at: www.sharkalliance.org/content.asp?did=32622. Accessed 21 April 2009.
Simpfendorfer, C.A. 2005. Smooth hammerhead *Sphyrna zygaena.* In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler, R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer and J.A. Musick). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.
Simpfendorfer, C., Cortés, E., Heupel, M., Brooks, E., Babcock, E., Baum, J., McAuley, R., Dudley, S., Stevens, J.D., Fordham, S. and Soldo, A. 2008. An integrated approach to determining the risk of over-exploitation for data-poor pelagic Atlantic sharks. ICCAT SCRS/2008/140.
Skomal, G.B., Zeeman, S.I., Chisholm, J.H., Summers, E.L., Walsh, H.J., McMahon, K.W. and Thorrold, S.R. 2009. Transequatorial Migrations by Basking Sharks in the Western Atlantic Ocean. *Current biology* 19: 1–4.
Smale, M.J. 2008. Pelagic shark fisheries in the Indian Ocean. Pp. 247–259. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.
Smith, S.E., Au, D.W. and Show, C. 2008a. Intrinsic rates of increase in pelagic elasmobranchs. Pp. 288–297. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.
Smith, S.E., Rasmussen, R.C., Ramon, D.A. and Cailliet, G.M. 2008b. The biology and ecology of thresher sharks (Alopiidae). Pp. 60–68. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.
Sosa-Nishizaki, O., Marquez-Farias, J.F. and Villavicencio-Garayzar, C.J. 2008. Case study: Pelagic shark fisheries along the west coast of Mexico. Pp. 275–282. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.
Spanish Ministry of Fisheries. 2008. Datum released by the Spanish Ministry of Fisheries during the conference "*I Jornadas de Sostenibilidad de Pesquerías Españolas de Tiburones*" held in Madrid in February 2008.
Stevens, J.D. 2000. The population status of highly migratory oceanic sharks. In: *Getting Ahead of the Curve: Conserving the Pacific Ocean's Tunas, Swordfish, Billfishes and Sharks* (ed. K. Hinman). National Coalition for Marine Conservation, Leesburg, Virginia.

Stevens, J. 2005. Blue shark *Prionace glauca*. In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes* (eds S.L. Fowler, R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer and J.A. Musick). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Stevens, J.D. 2007. Whale shark (*Rhincodon typus*) biology and ecology: A review of the primary literature. *Fisheries Research* 84: 4–9.

Stevens, J.D. 2008. The biology and ecology of the shortfin mako shark, *Isurus oxyrinchus*. Pp. 87–94. In: *Sharks of the Open Ocean: Biology, Fisheries and Conservation* (eds M.D. Camhi, E.K. Pikitch and E.A. Babcock). Blackwell Publishing, Oxford, UK.

Tudela, S., Kai Kai, A., Maynou, F., El Andalossi, M. and Guglielmi, P. 2005. Driftnet fishing and biodiversity conservation: The case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). *Biological Conservation* 121: 65–78.

Vannuccini, S. 1999. *Shark Utilization, Marketing and Trade*. FAO Fisheries Technical Paper No. 389. FAO, Rome, Italy. 470 pp.

Vié, J.-C., Hilton-Taylor, C., Pollock, C., Ragle, J., Smart, J., Stuart, S.N. and Tong, R. 2008. The IUCN Red List: A key conservation tool. In: *The 2008 Review of IUCN Red List of Threatened Species* (eds J.-C. Vié, C. Hilton-Taylor and S.N. Stuart). IUCN, Gland, Switzerland and Cambridge, UK.

Ward, P. and Myers, R.A. 2005. Shifts in open-ocean fish communities coinciding with the commencement of commercial fishing. *Ecology* 86(4): 835–847.

Weber, M.L. and Fordham, S.V. 1997. *Managing Shark Fisheries: Opportunities for International Conservation*. TRAFFIC International and Center for Marine Conservation, Washington DC. 61 pp.

West, G., Stevens, J. and Basson, M. 2004. *Assessment of Blue Shark Population Status in the Western South Pacific*. AFMA Project R021157. CSIRO Publishing, Collingwood, Victoria, Australia.

White, W.T. and Cavanagh, R.D. 2007. Whale shark landings in Indonesian artisanal shark and ray fisheries. *Fisheries Research* 84: 128–131.

White, W.T., Last, P.R., Stevens, J.D., Yearsley, G.K., Fahmi and Dharmadi. 2006. *Economically Important Sharks and Rays of Indonesia*. ACIAR Publishing, Canberra, 329 pp.

Williams, P.G. 1999. Shark and related species catch in tuna fisheries of the tropical Western and Central Pacific Ocean. In: *Case Studies in the Management of Elasmobranch Fisheries* (ed. R. Shotton). FAO Fisheries Technical Paper 378/2. FAO, Rome, Italy.

Appendix I: Red List status of pelagic sharks and rays

Species	Common name	Red List Category (Year)	Habitat	Oceanic	Semi-pelagic	Species account page no.
Chlamydoselachus anguineus	Frilled shark	NT (2003)	Benthic and semipelagic		x	40
Hexanchus griseus	Bluntnose sixgill shark	NT (2005)	Benthic and semipelagic		x	40
Etmopterus gracilispinis	Broadband lanternshark	LC (2007)	Benthic and semipelagic		x	40
Etmopterus pusillus	Smooth lanternshark	LC (2009)	Benthic and semipelagic		x	41
Miroscyllium sheikoi	Rasptooth dogfish	DD (2004)	Benthic and possibly semipelagic		x	41
Trigonognathus kabeyai	Viper dogfish	DD (2004)	Benthic and possibly semipelagic		x	41
Scymnodalatias albicauda	Whitetail dogfish	DD (2003)	Oceanic	x		42
Scymnodalatias garricki	Azores dogfish	DD (2009)	Possibly oceanic	x		42
Scymnodalatias oligodon	Sparsetooth dogfish	DD (2004)	Possibly oceanic	x		42
Scymnodalatias sherwoodi	Sherwood dogfish	DD (2003)	Possibly oceanic	x		42
Zameus squamulosus	Velvet dogfish	DD (2006)	Benthic and semipelagic		x	42
Euprotomicroides zantedeschia	Taillight shark	DD (2006)	Oceanic and benthic	x		43
Euprotomicrus bispinatus	Pygmy shark	LC (2006)	Oceanic and benthic	x		43
Heteroscymnoides marleyi	Longnose pygmy shark	LC (2006)	Oceanic	x		43
Isistius brasiliensis	Cookiecutter shark	LC (2003)	Oceanic	x		43
Isistius labialis	South China cookiecutter shark	DD (2009)	Oceanic	x		44
Isistius plutodus	Largetooth cookiecutter shark	LC (2006)	Oceanic	x		44
Mollisquama parini	Pocket shark	DD (2004)	Possibly semipelagic		x	44
Squaliolus aliae	Smalleye pygmy shark	LC (2003)	Oceanic	x		44
Squaliolus laticaudus	Spined pygmy shark	LC (2006)	Oceanic	x		44
Torpedo microdiscus	Smalldisk torpedo	DD (2006)	Semipelagic		x	63
Torpedo nobiliana	Atlantic torpedo	DD (2009)	Benthic, littoral and semipelagic		x	64
Dasyatis matsubarai	Pitted stingray	DD (2009)	Benthic and semipelagic		x	64
Pteroplatytrygon violacea	Pelagic stingray	LC (2009)	Oceanic and littoral	x		64
Aetobatus narinari	Spotted eagle ray	NT (2006)	Benthic, littoral and semipelagic		x	65
Aetomylaeus vespertilio	Ornate eagle ray	EN (2006)	Benthic, littoral and semipelagic		x	65
Myliobatis californicus	Bat ray	LC (2006)	Benthic, littoral and semipelagic		x	65
Manta birostris	Manta	NT (2006)	Littoral and oceanic	x		66
Mobula japanica	Spinetail devilray	NT (2006)	Littoral and semipelagic or oceanic	x		66
Mobula mobular	Giant devilray	EN (2006)	Littoral and semipelagic or oceanic	x		67
Mobula tarapacana	Sicklefin devilray	DD (2006)	Littoral and semipelagic or oceanic	x		67
Rhincodon typus	Whale shark	VU (2005)	Oceanic, semipelagic and littoral	x		45
Odontaspis ferox	Smalltooth sand tiger	VU (2009)	Littoral, benthic and semi-pelagic, on ridge systems and seamounts far from land		x	45
Odontaspis noronhai	Bigeye sand tiger	DD (2005)	Oceanic and rarely littoral	x		45
Pseudocarcharias kamoharai	Crocodile shark	NT (2005)	Oceanic and semipelagic	x		46
Mitsukurina owstoni	Goblin shark	LC (2004)	Semipelagic, benthic on continental slopes		x	46
Megachasma pelagios	Megamouth shark	DD (2005)	Oceanic and semipelagic	x		46
Alopias pelagicus	Pelagic thresher	VU (2009)	Oceanic and occasionally littoral	x		46
Alopias superciliosus	Bigeye thresher	VU (2009)	Oceanic, semipelagic and occasionally littoral and benthic on continental slopes	x		47
Alopias vulpinus	Thresher shark	VU (2009)	Oceanic, semipelagic and littoral	x		48
Cetorhinus maximus	Basking shark	VU (2005)	Littoral, semipelagic and occasionally oceanic		x	50

Appendix I *cont'd*. Red List status of pelagic sharks and rays.

Species	Common name	Red List Category (Year)	Habitat	Oceanic	Semi-pelagic	Species account page no.
Carcharodon carcharias	Great white	VU (2005)	Oceanic, semipelagic, littoral and occasionally benthic on continental slopes	x		50
Isurus oxyrinchus	Shortfin mako	VU (2009)	Oceanic, semipelagic and littoral where continental shelves are narrow	x		50
Isurus paucus	Longfin mako	VU (2006)	Oceanic, rarely littoral where continental shelves are narrow	x		51
Lamna ditropis	Salmon shark	LC (2009)	Oceanic, semipelagic and littoral where continental shelves are narrow	x		52
Lamna nasus	Porbeagle shark	VU (2006)	Oceanic, semipelagic and littoral	x		52
Galeorhinus galeus	Tope shark	VU (2006)	Littoral and semipelagic		x	53
Carcharhinus albimarginatus	Silvertip shark	NT (2009)	Littoral and semipelagic		x	54
Carcharhinus altimus	Bignose shark	DD (2009)	Semipelagic and benthic on the upper continental slopes		x	55
Carcharhinus brachyurus	Bronze whaler	NT (2003)	Littoral and semipelagic		x	55
Carcharhinus brevipinna	Spinner shark	NT (2005)	Littoral and semipelagic		x	56
Carcharhinus falciformis	Silky shark	NT (2009)	Oceanic and semipelagic	x		56
Carcharhinus galapagensis	Galapagos shark	NT (2003)	Littoral and semipelagic		x	57
Carcharhinus leucas	Bull shark	NT (2005)	Littoral and freshwater, occasionally semipelagic		x	57
Carcharhinus limbatus	Blacktip shark	NT (2005)	Littoral and semipelagic		x	58
Carcharhinus longimanus	Oceanic whitetip shark	VU (2006)	Oceanic and semipelagic	x		58
Carcharhinus obscurus	Dusky shark	VU (2009)	Littoral and semipelagic		x	58
Carcharhinus plumbeus	Sandbar shark	VU (2009)	Littoral and semipelagic		x	58
Carcharhinus signatus	Night shark	VU (2006)	Semipelagic		x	59
Galeocerdo cuvier	Tiger shark	NT (2005)	Littoral and semipelagic		x	60
Prionace glauca	Blue shark	NT (2005)	Oceanic, semipelagic and littoral where continental shelves are narrow	x		60
Sphyrna lewini	Scalloped hammerhead	EN (2009)	Littoral and semipelagic		x	60
Sphyrna mokarran	Great hammerhead	EN (2007)	Littoral and semipelagic		x	62
Sphyrna zygaena	Smooth hammerhead	VU (2009)	Littoral and semipelagic		x	63

Appendix II: Summary of the IUCN's Red List Categories and Criteria Version 3.1

Summary of the five criteria (A–E) used to evaluate if a species belongs in a category of threat (Critically Endangered, Endangered or Vulnerable)

Use any of the criteria A–E	Critically Endangered	Endangered	Vulnerable
A. Population reduction	Declines measured over the longer of 10 years or 3 generations		
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%
A1. Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible **AND** understood **AND** have ceased, based on and specifying any of the following: **(a)** direct observation **(b)** an index of abundance appropriate to the taxon **(c)** a decline in AOO, EOO and/or habitat quality **(d)** actual or potential levels of exploitation. **(e)** effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.			
A2. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased **OR** may not be understood **OR** may not be reversible, based on (a) to (e) under A1.			
A3. Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under A1.			
A4. An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased **OR** may not be understood **OR** may not be reversible, based on (a) to (e) under A1.			
B. Geographic range in the form of either B1 (extent or occurrence) AND/OR B2 (area or occupancy)			
B1. Extent of occurrence	< 100 km^2	< 5,000 km^2	< 20,000 km^2
B2. Area of occupancy	< 10 km^2	< 500 km^2	< 2,000 km^2
AND at least 2 of the following:			
(a) Severely fragmented, **OR** number of locations.	= 1	≤ 5	≤ 10
(b) Continuing decline in any of: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** area, extent and/or quality of habitat; **(iv)** number of locations or subpopulations; **(v)** number of mature individuals			
(c) Extreme fluctuations in any of: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** number of locations or subpopulations; **(iv)** number of mature individuals.			
C. Small population size and decline			
Number of mature individuals	< 250	< 2,500	< 10,000
AND either C1 or C2:			
C1. An estimated continuing decline of at least: (up to a max. of 100 years in future)	25% in 3 years or 1 generation	20% in 5 years or 2 generations	10% in 10 years or 3 generations
C2. A continuing decline AND (a) and/or (b):			
(a) (i) # mature individuals in each subpopulation.	< 50	< 250	< 1,000
(a) (ii) or % individuals in one sub-population at least.	90%	95%	100%
(b) extreme fluctuations in the number of mature individuals.			
D. Very small or restricted population			
Either:			
Number of mature individuals	≤ 50	≤ 250	**D1.** ≤ 1,000 AND/OR
	Restricted area of occupancy		**D2.** AOO < 20 km^2 or # locations ≤ 5
E. Quantitative Analysis			
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations (100 years max)	≥ 20% in 20 years or 5 generations (100 years max)	≥ 10% in 100 years

[1] Where generation length varies under threat, the more natural, i.e. pre-disturbance, generation length should be used.
Source: Standards and Petitions Working Group of the IUCN SSC Biodiversity Assessments Sub-Committee 2008; http://www.iucnredlist.org/documents/redlist_guidelines_v1223290226.pdf

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Key
ANWP = Asia and Northwest Pacific
AO = Australia and Oceania
MED = Mediterranean Region
NWA = Northwest Atlantic Region
NEP = Northeast Pacific Region
SEA = Subequatorial Africa
SAM = South America Region

The Conservation Status of Pelagic Sharks and Rays

Report of the IUCN Shark Specialist Group
Pelagic Shark Red List Workshop
Tubney House, University of Oxford, UK, 19–23 February 2007

Compiled and edited by
Merry D. Camhi, Sarah V. Valenti, Sonja V. Fordham, Sarah L. Fowler and Claudine Gibson

Executive Summary

This report describes the results of a thematic Red List Workshop held at the University of Oxford's Wildlife Conservation Research Unit, UK, in 2007, and incorporates seven years (2000–2007) of effort by a large group of Shark Specialist Group members and other experts to evaluate the conservation status of the world's pelagic sharks and rays. It is a contribution towards the IUCN Species Survival Commission's Shark Specialist Group's "Global Shark Red List Assessment." The Red List assessments of 64 pelagic elasmobranch species are presented, along with an overview of the fisheries, use, trade, and management affecting their conservation.

Pelagic sharks and rays are a relatively small group, representing only about 6% (64 species) of the world's total chondrichthyan fish species. These include both oceanic and semipelagic species of sharks and rays in all major oceans of the world. No chimaeras are known to be pelagic.

Experts at the workshop used established criteria and all available information to update and complete global and regional species-specific Red List assessments following IUCN protocols. These assessments were agreed upon by consensus throughout the SSG network prior to submission to the IUCN Red List of Threatened Species™. Overall, 32% of the world's pelagic sharks and rays (20 species) are threatened, which includes 6% that are Endangered and 26% that are Vulnerable. A further 24% are Near Threatened, 19% are assessed as Least Concern, and 25% are Data Deficient. As a group, pelagic elasmobranchs suffer significantly greater threats than do chondrichthyans as a whole. In addition, oceanic shark and ray species taken regularly in high-seas fisheries are more likely to be threatened (52%) than are pelagic elasmobranchs in general.

Brief summaries of the Red List assessments, including the global and/or regional IUCN Red List Category, are presented for all known pelagic sharks and rays. Fishing, often driven by the demand for shark fins and meat, is the single most important threat to these species wherever they occur. Sharks are increasingly targeted by fisheries that once discarded them. National management, where it exists, is undermined because there are no catch limits on the high seas. Where regional management is in place, it is generic (not species specific), indirect (operating through controls on finning, rather than controls on catch or mortality), generally poorly enforced and inadequate to reverse population declines or rebuild stocks. Such illegal, unreported and unregulated (IUU) fishing contributes significantly to unsustainable catches of these inherently vulnerable species. The report's recommendations are intended to complement and enhance existing scientific advice regarding the conservation and management of pelagic sharks and rays. The information contained within this report can facilitate the further development and implementation of research, conservation, and management priorities for this group of vulnerable species.

The IUCN Species Survival Commission's Shark Specialist Group (SSG) was established in 1991 to promote the sustainable use, wise management, and conservation of the world's chondrichthyan fishes. There are 180 SSG members from 90 countries distributed among 12 ocean-region subgroups, all of whom are actively involved in chondrichthyan research and fisheries management, marine conservation, or policy development and implementation. The SSG has recently concluded its 10-year Global Shark Red List Assessment programme by completing Red List assessments for every chondrichthyan species described in the scientific literature before the end of 2007. This is the first complete assessment of all members of a major marine taxonomic group, and will provide an important baseline for monitoring the global health of marine species and ecosystems.