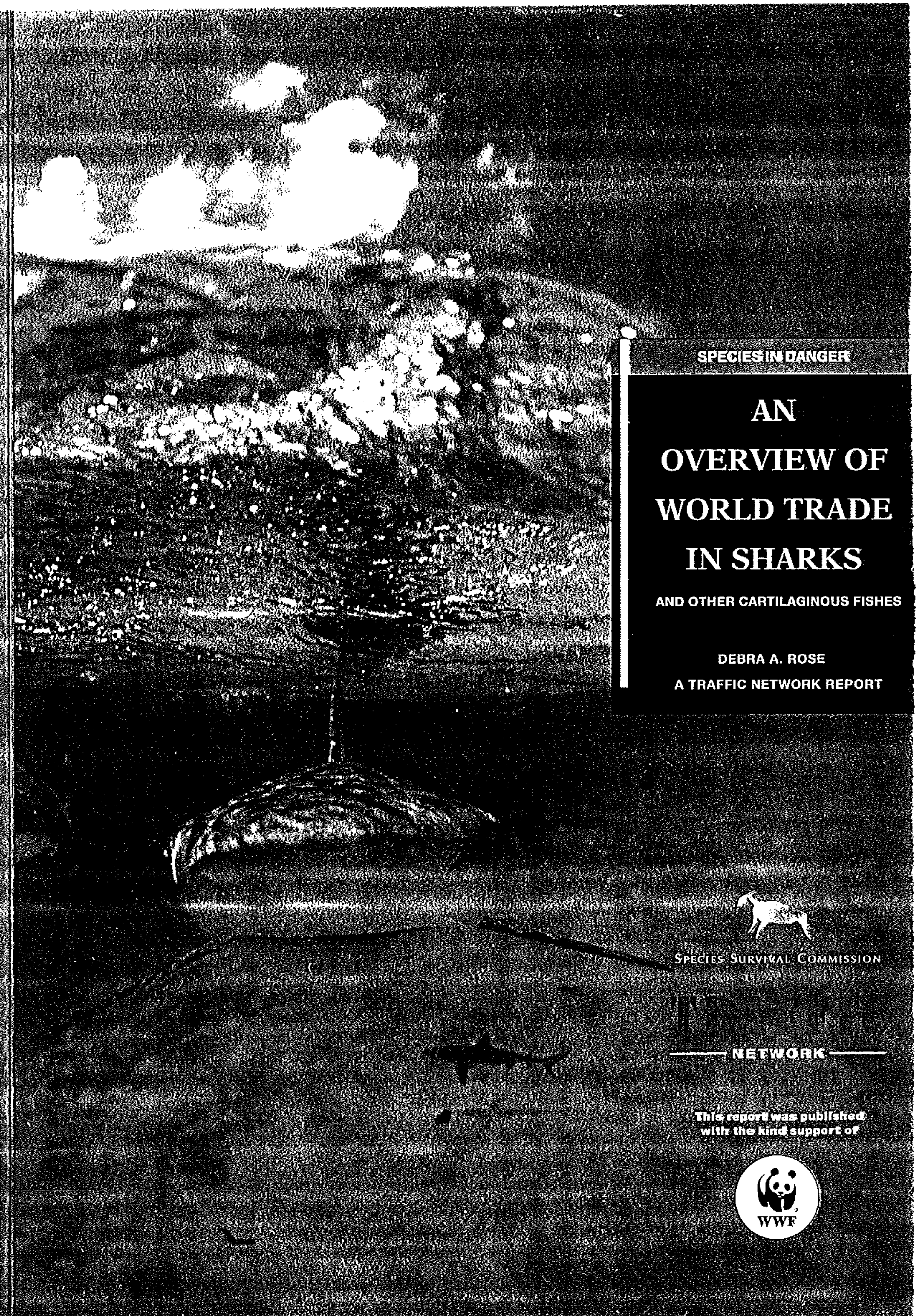

SPECIES IN DANGER

AN OVERVIEW OF WORLD TRADE IN SHARKS

AND OTHER CARTILAGINOUS FISHES

DEBRA A. ROSE

A TRAFFIC NETWORK REPORT

SPECIES SURVIVAL COMMISSION

NETWORK

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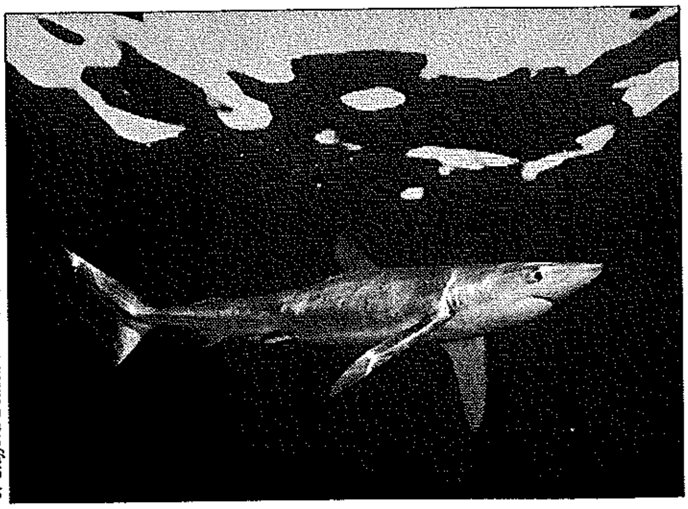

J. Stafford-Deitsch / WWF UK

Blue Shark *Prionace glauca*.

TRAFFIC's research for this project has been carried out in collaboration with the Center for Marine Conservation and the Shark Specialist Group of the Species Survival Commission of IUCN – The World Conservation Union.

CENTER FOR MARINE CONSERVATION

SHARK Specialist Group

CONTENTS

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The TRAFFIC Network project *International Trade in Sharks and Shark Products* was initiated in early 1994, culminating at the end of 1996 with the publication of several in-depth regional reports and the present overview. Much of this report is based on the work of the TRAFFIC regional offices, which would not have been possible without the generous financial support of the Rufford Foundation; the Center for Marine Conservation; WWF National Organizations and the WWF Endangered Seas Campaign; AusAID; the European Commission; and the Wray Trust. The author would like to thank the authors of the regional TRAFFIC shark reports, in particular Rob Parry-Jones, Marcus J. Phipps, and Hisako Kiyono of TRAFFIC East Asia, Chen Hin Keong of TRAFFIC Southeast Asia, Glenn Sant of TRAFFIC Oceania, Nina T. Marshall of TRAFFIC East/Southern Africa, Fahmeeda Hanfee of TRAFFIC India, and Elizabeth H. Fleming and Philippe Papageorgiou of TRAFFIC Europe for their contributions to this research and for their assistance in the development of this report.

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BACKGROUND

Sharks, skates, rays, and chimaeras, the cartilaginous fishes – or chondrichthyans[1] – are a versatile fisheries resource. Not only the meat and fins, but even the skin and internal organs are used for human consumption. The skins may be tanned to produce a high-quality leather, or used as an abrasive, while the liver oil is used in the textile and tanning industries and in the manufacture of lubricants, cosmetics, vitamins, and pharmaceutical products. The cartilage may be used in the manufacture of fishmeal and is increasingly marketed as a treatment for cancer, with additional research underway to test its efficacy in treating a wide variety of additional ailments. Shark teeth and jaws, by-products of growing commercial fisheries, are widely offered for sale as tourist curios. Live specimens increasingly appear in both public and private aquaria, and sharks and rays have become an important attraction to scuba divers and recreational fishers.

Chondrichthyans are also a valuable fisheries resource. Shark fins, highly appreciated in Chinese cuisine, are among the world's most expensive fisheries commodities, and their value has risen sharply in the last decade. Long considered inferior, or entirely unpalatable in many regions, the meat of sharks, skates, rays, and chimaeras is increasingly popular in many markets around the world. New markets for shark cartilage offer the opportunity to utilize a fisheries by-product that would otherwise be discarded or used in low-value fishmeal production. The social and economic importance of these species is increased by the fact that fisheries for sharks and related species are seldom regulated, and therefore readily available when other species are depleted, restricted, or seasonally unavailable. As many of the world's important traditional fisheries decline, chondrichthyans therefore increasingly appear on the list of "underexploited species" that are considered to offer new opportunities for fisheries development.

Many chondrichthyans are also extremely vulnerable to overexploitation (Compagno, 1990; Bonfil, 1994). Long life cycles, delayed sexual maturation, and low fecundity rates severely limit the rate of sustainable harvest for many of these fishes. For most species, little is known of stock structure, abundance, life history, or reproductive rate, hindering effective management. Many shark species are highly migratory, further complicating the task of fisheries managers. Moreover, shark fisheries have historically represented only a minor and relatively low value contribution to the overall fisheries production of most nations, and are often a minor and/or seasonal component of multispecies fisheries that include high-profile species such as tuna and swordfish. As a consequence, information on both the volume and species composition of catches and landings, as well as on the species themselves, is sparse or non-existent. Difficulties in species identification for the approximately 380 described species of sharks and more than 470 species of rays (McEachran, 1990) further limit the quality of information available for status assessments.

In 1994, the TRAFFIC Network began to address these information deficiencies by initiating a global study of chondrichthyan fisheries and trade. It is hoped that by enhancing available information on international trade in these species, this work will assist a number of efforts currently underway at the national and international levels to improve the management and conservation of these valuable and fascinating fishes.

INTRODUCTION

Before leading into its main findings, this report offers a brief description and analysis of available data and information reviewed during the course of the TRAFFIC Network study. These sources include national fisheries statistics; data collated by the Food and Agriculture Organization of the United Nations (FAO) and other international and inter-governmental bodies; and biological and status assessments. Thereafter, those shark fisheries covered by this study are described briefly, followed by a summary of the various shark products in trade, their processing and preparation, their use in domestic and international markets, and of the species from which they are derived. The final sections of the report discuss the management and conservation implications of these chondrichthyan fisheries and resultant trade, and subsequent conclusions and recommendations for the future management of chondrichthyan stocks.

METHODS

TRAFFIC offices in Europe, India, East and southern Africa, Southeast Asia, East Asia, Oceania and the USA undertook in-depth research on the exploitation of chondrichthyans on a regional basis, examining available information on fisheries, utilization of products, domestic markets and trade, and management and conservation measures, in many cases conducting original research on fisheries, markets, and trade. These investigations focused on sharks, with incidental information on skates, rays, and chimaeras collected and reported as available. Each TRAFFIC regional report may be published separately by the TRAFFIC office concerned. For a full list of these reports, see **Appendix 1**.

The present overview summarizes and analyses the findings of these regional studies, and information from a variety of additional sources, to give a global overview of world markets for, and trade in, sharks and other chondrichthyan species and analysis of the implications for their management and conservation.

SOURCES OF INFORMATION ON CHONDRICHTHYAN FISHERIES AND TRADE

National fisheries data

As previously mentioned, because chondrichthyan fisheries have historically made a relatively minor contribution to the overall fisheries production of nations, little emphasis has been placed on gathering data on these species or their exploitation. Data on the volume and species composition of chondrichthyan catches is often sparse or does not exist. Those national agencies which do report chondrichthyan catches at all, may report them all within a single category, or may report shark catches, but not those of related species. National reporting by species is rare and generally occurs only in the few cases where chondrichthyans are included in existing management plans. Similarly, although national fisheries agencies often report production of processed products - such as fillets, or frozen or canned fish - for high-value species, such as tunas, this type of reporting is rare for chondrichthyan species.

National trade data

National trade data are similarly incomplete. Standard six-digit Customs tariff headings adopted under the Harmonized System of classification are not specific for meat, categories used being "dogfish" and "other sharks", which, even then, are often combined into a single category. Many countries use a sub-heading for "shark fin" in trade, but Customs records of trade in shark leather and oil are virtually non-existent, and completely so in the case of cartilage. Further, in many cases, imports of chondrichthyan products may be reported but not exports, or *vice versa*. For example, the USA reports its shark fin imports, but despite its importance as an exporter and re-exporter of shark fins, does not report outgoing trade.

FAO data - catches and landings

Limitations of national trade data are not only reflected in international data sources, but are often compounded by additional reporting problems. The FAO, by means of its *Yearbook of Fisheries Statistics: Catches and Landings* and *Yearbook of Fisheries Statistics: Production*, provides the most comprehensive data available on world fisheries production, and the only published sources of such data on a global scale. However, because FAO data are based on reports from the fisheries agencies of individual nations, they are affected by the same limitations in reporting capabilities, including problems of species identification and lack of species-specific reporting.

Of the total chondrichthyan fish landings reported by FAO in 1994, approximately 182 000t (t = metric tonnes) were identified as sharks, 197 000t as skates and rays, 5000t as chimaeras, and 347 000t as unidentified chondrichthyan species (Anon., 1996). Approximately half of all catches and landings, and the largest increases in landings in recent years, are reported in the category of "unidentified chondrichthyans" (Anon., 1994a).

In addition to the classification for unidentified chondrichthyans, the FAO reports world catches and landings for 37 distinct species classifications, ranging from individual species to orders (Table 1). Of FAO-reported catches of identified sharks, the classifications with the largest reported volumes are the Carcharhinidae, or requiem sharks, particularly the Silky Shark *Carcharhinus falciformis*; smooth-hounds, most notably *Mustelus* spp.; and dogfishes, particularly the Piked or Spiny Dogfish *Squalus acanthias*. (A list of all common species names used in this report is provided in Table 2). Reported species classifications are, however, highly misleading as an indicator of overall species composition of catches or landings. For example, data for nominal catches of Shortfin Mako Sharks *Isurus oxyrinchus* include only catches reported by the USA and Portugal, despite the fact that the species is widely distributed and appears in the landings of several other nations and regions. Similarly, catches of Silky Sharks are reported exclusively for Sri Lanka, but this species is caught and landed by numerous offshore and distant-water fleets. Species identification is even more problematic for skates and rays, as indicated by the more than 136 000t reported merely as Rajiformes in 1994.

Several additional caveats are in order in interpreting the catch and landing data reported by FAO. Although they are generally consistent with data available through national sources, national agencies often provide summary information only to FAO, so that reported FAO statistics may be less detailed than national data. Data reported by FAO may also differ from those reported by national agencies owing to differences in reporting years or conversions from landed weight to live weight, or nominal catches. Moreover, in the event that a country ceases to report national data to the FAO, the FAO may extrapolate from previous years; such extrapolations may involve merely repeating the volume for the last year reported, and may therefore be misleading. In some cases, for example, that of China, national data sources are not available at all or are not provided to FAO, and are therefore lacking entirely from FAO compilations.

Furthermore, although described as "nominal catches", the volume of catches reported by FAO is actually based only on landings. These landings may include semi-processed carcasses, belly flaps, fillets, fins, livers, or a combination of the above. These landed weights must be converted to estimated weights of whole fish using standard conversion factors, resulting in an unknown level of estimation error. In addition, reported volumes do not include catches that are not landed but instead are discarded at sea; such discards include not only bycatch from fisheries targeting non-chondrichthyan species, but also discards of unmarketable specimens from directed chondrichthyan fisheries. Bonfil (1994) estimates that the volume of elasmobranchs captured incidentally in fisheries targeting other species is approximately equal to reported commercial landings. Such incidental catch, or bycatch, occurs in most of the world's fisheries and gears, including shrimp trawls and other trawl fisheries, tuna purse seine and hook and line fisheries, tuna and swordfish longline fisheries, and drift gillnet fisheries.

Table 1

World nominal chondrichthyan catches by FAO species classification (t), 1994

Species	FAO common names	Nominal catches (t)
Lamna nasus	Porbeagle	1049
Isurus oxyrinchus	Shortfin Mako Shark	97
Isurus paucus	Longfin Mako Shark	5
Lamnidae	mackerel sharks	49
Cetorhinus maximus	Basking Shark	1763
Scyliorhinus spp.	catsharks, nursehounds	24
Prionace glauca	Blue Shark	656
Carcharhinus falciformis	Silky Shark	25 400
Carcharhinidae	requiem sharks	51 037
Mustelus schmitti	Narrownose Smooth-hound	11 450
Mustelus spp.	smooth-hounds	20 497
Galeorhinus spp.	liveroil sharks	6964
Somniosus microcephalus	Greenland Shark	43
Squalus acanthias	Piked Dogfish	20 589
Squalidae	dogfish sharks, (nei)	27 357
Squalidae, Scyliorhinidae	dogfishes and hounds	6542
Squatina squatina	Angelshark	18
Squatinidae	angelsharks, sand devils	120
Squaliformes	large sharks, (nei)	2690
Rhinobatos percellens	Chola Guitarfish	1110
Rhinobatos planiceps	Pacific Guitarfish	30
Rhinobatidae	guitarfishes	1559
Pristidae	sawfishes	718
Raja batis	Blue Skate	209
Raja clavata	Thornback Ray	1298
Raja montagui	Spotted Ray	827
Raja fullonica	Shagreen Ray	62
Raja naevus	Cuckoo Ray	2822
Raja oxyrinchus	Longnosed Skate	293
Raja spp.	skates	47 492
Dasyatis akajei	Whip Stingray	4041
Myliobatidae	eagle rays	3
Rajiformes	skates and rays (nei)	136 287
Torpedo spp.	torpedo rays	75
Callorhinchus capensis	Cape Elephantfish	262
Callorhinchus spp.	elephantfishes	4760
Selachimorpha (Pleurotremata)	various sharks (nei)	5418
Elasmobranchii	sharks, rays, skates, etc.	347 168
Total	**Total sharks, rays, skates, etc.**	**730 784**

nei = not elsewhere indicated

Source: Anon., 1996.

Table 2

Guide to chondrichthyan species and their common names

Species	FAO common names
HEXANCHIDAE	cowsharks, sixgill sharks, sevengill sharks
Hexanchus griseus	Bluntnose Sixgill Shark
Notorynchus cepedianus	Broadnose Sevengill Shark
ECHINORHINIDAE	bramble sharks
Echinorinus brucus	Bramble Shark
SQUALIDAE	dogfish sharks
Centrophorus spp.	gulper sharks
Centrophorus acus	Needle Dogfish
Centrophorus granulosus	Gulper Shark
Centrophorus harrissoni	Dumb Gulper Shark
Centrophorus lusitanicus	Lowfin Gulper Shark
Centrophorus moluccensis	Endeavour Dogfish
Centrophorus niaukang	Taiwan Gulper Shark
Centrophorus squamosus	Leafscale Gulper Shark
Centrophorus uyato	Little Gulper Shark
Centroscyllium kamoharai	Bareskin Dogfish
Centroscymnus coelolepis	Portuguese Dogfish
Centroscymnus crepidater	Longnose Velvet Dogfish
Centroscymnus owstoni	Roughskin Shark
Centroscymnus plunketi	Plunket's Shark
Cirrhigaleus barbifer	Mandarin Dogfish
Euprotomicrus bispinatus	Pygmy Shark
Dalatias licha	Kitefin Shark
Deania calcea	Birdbeak Dogfish
Heteroscymnoides marleyi	Longnose Pygmy Shark
Isistius brasiliensis	Cookiecutter Shark
Isistius labialis	Cookiecutter Shark
Isistius plutodus	Largetooth Cookiecutter Shark
Scymnodon ringens	Knifetooth Dogfish
Somniosus microcephalus	Greenland Shark
Squaliolus aliae	Pygmy Shark
Squaliolus laticaudus	Spined Pygmy Shark
Squalus acanthias	Piked Dogfish
Squalus cubensis	Cuban Dogfish
Squalus megalops	Shortnose Spurdog
Squalus mitsukurii	Shortspine Spurdog
PRISTIOPHORIDAE	sawsharks
Pristiophorus cirratus	Longnose Sawshark
Pristiophorus japonicus	Japanese Sawshark
Pristiphorus nudipinnis	Shortnose Sawshark

Table 2 continued

Species	FAO common names
SQUATINIDAE	
Squatina aculeata	Sawback Angelshark
Squatina argentina	Argentine Angelshark
Squatina australis	Australian Angel Shark
Squatina californica	Pacific Angel Shark
Squatina nebulosa	Clouded Angelshark
Squatina oculata	Smooth Angelshark
Squatina squatina	Angel Shark
Squatina tergocellata	Ornate Angel Shark
HETERODONTIDAE	bullhead sharks, horn sharks
Heterodontus japonicus	Japanese Bullhead Shark
Heterodontus portusjacksoni	Port Jackson Shark
Heterodontus zebra	Zebra Bullhead Shark
BRACHAELURIDAE	blind sharks
Brachaelurus waddi	Blind Shark
Heteroscyllium colcloughi	Bluegray Carpetshark
OROLECTOBIDAE	wobbegongs
Eucrossorhinus dasypogon	Tasselled Wobbegong
Orectolobus maculatus	Spotted Wobbegong
Orectolobus ornatus	Ornate Wobbegong
HEMISCYLLIDAE	bamboo sharks
Chiloscyllium griseum	Grey Bamboo Shark
Chiloscyllium indicum	Slender Bamboo Shark
Chiloscyllium plagiosum	Whitespotted Bamboo Shark
Chiloscyllium punctatum	Brownbanded Bamboo Shark
Hemiscyllium ocellatum	Epaulette Shark
STEGOSTOMATIDAE	zebra sharks
Stegostoma fasciatum	Zebra Shark
GINGLYMOSTOMATIDAE	nurse sharks
Ginglymostoma brevicaudatum	Short-tail Nurse Shark
Ginglymostoma cirratum	Nurse Shark
Nebrius ferrugineus	Tawny Nurse Shark
RHINIODONTIDAE	whale sharks
Rhiniodon typus	Whale Shark
ODONTASPIDAE	sand tiger sharks
Odontaspis ferox	Smalltooth Sand Tiger
PSEUDOCARCHARIIDAE	crocodile sharks
Pseudocarcharias kamoharai	Crocodile Shark
ALOPIIDAE	thresher sharks
Alopias pelagicus	Pelagic Thresher
Alopias superciliosus	Bigeye Thresher
Alopias vulpinus	Thresher Shark

Table 2 continued

Species	FAO common names
CETORHINIDAE	basking sharks
Cetorhinus maximus	Basking Shark
LAMNIDAE	Mackerel sharks, porbeagles, white sharks
Carcharodon carcharias	Great White Shark
Isurus oxyrinchus	Shortfin Mako Shark
Isurus paucus	Longfin Mako Shark
Lamna ditropis	Salmon Shark
Lamna nasus	Porbeagle
SCYLIORHINIDAE	catsharks
Atelomycterus marmoratus	Coral Catshark
Cephaloscyllium isabellum	Draughtboard Shark
Galeus melastomus	Blackmouth Catshark
Galeus sauteri	Blacktip Sawtail Catshark
Halaeurus buergeri	Blackspotted Catshark
Scyliorhinus canicula	Small-spotted Catshark
Scyliorhinus stellaris	Nursehound
Scyliorhinus torazame	Cloudy Catshark
TRIAKIDAE	houndsharks
Furgaleus macki	Whiskery Shark
Galeorhinus galeus	Tope Shark
Hemitriakis japanica	Japanese Topeshark
Hemitriakis leucoperiptera	Whitefin Topeshark
Hypogaleus hyugaensis	Blacktip Tope
Mustelus antarcticus	Gummy Shark
Mustelus asterias	Starry Smooth-hound
Mustelus canis	Dusky Smooth-hound
Mustelus fasciatus	Striped Smooth-hound
Mustelus griseus	Spotless Smooth-hound
Mustelus lenticulatus	Spotted Estuary Smooth-hound
Mustelus manazo	Starspotted Smooth-hound
Mustelus mustelus	Smooth-hound
Mustelus schmitti	Narrownose Smooth-hound
Triakis scyllium	Banded Houndshark
Triakis semifasciata	Leopard Shark
HEMIGALEIDAE	weasel sharks
Hemipristis elongatus	Snaggletooth Shark
CARCHARHINIDAE	requiem sharks
Carcharhinus acronotus	Blacknose Shark
Carcharhinus albimarginatus	Silvertip Shark
Carcharhinus altimus	Bignose Shark
Carcharhinus amblyrhynchoides	Graceful Shark
Carcharhinus amblyrhynchos	Gray Reef Shark

Table 2 continued

Species	FAO common names
Carcharhinus amboinensis	Pigeye Shark
Carcharhinus brachyurus	Copper Shark
Carcharhinus brevipinna	Spinner Shark
Carcharhinus dussumieri	Whitecheek Shark
Carcharhinus falciformis	Silky Shark
Carcharhinus hemiodon	Pondicherry Shark
Carcharhinus isodon	Finetooth Shark
Carcharhinus leucas	Bull Shark
Carcharhinus limbatus	Blacktip Shark
Carcharhinus longimanus	Oceanic Whitetip Shark
Carcharhinus macloti	Hardnose Shark
Carcharhinus melanopterus	Blacktip Reef Shark
Carcharhinus obscurus	Dusky Shark
Carcharhinus plumbeus	Sandbar Shark
Carcharhinus porosus	Smalltail Shark
Carcharhinus sealei	Blackspot Shark
Carcharhinus signatus	Night Shark
Carcharhinus sorrah	Spot-tail Shark
Carcharhinus (=Eugomphodus) taurus	Sand Tiger Shark
Carcharhinus tilstoni	Australian Blacktip
Carcharhinus wheeleri	Blacktail Reef Shark
Galeocerdo cuvier	Tiger Shark
Loxodon macrorhinus	Sliteye Shark
Negaprion acutidens	Sicklefin Lemon Shark
Negaprion brevirostris	Lemon Shark
Prionace glauca	Blue Shark
Rhizoprionodon acutus	Milk Shark
Rhizoprionodon oligolinx	Grey Sharpnose Shark
Rhizoprionodon taylori	Australian Sharpnose
Rhizoprionodon terraenovae	Atlantic Sharpnose
Scoliodon laticaudus	Spadenose Shark
Triaenodon obesus	Whitetip Reef Shark
SPHYRNIDAE	bonnethead sharks, hammerhead sharks, scoophead sharks
Eusphyra blochii	Winghead Shark
Sphyrna lewini	Scalloped Hammerhead
Sphyrna mokarran	Great Hammerhead
Sphyrna tiburo	Bonnethead Shark
Sphyrna zygaena	Smooth Hammerhead
RHINOBATIDAE	shovelnose rays
Rhinobatos blochi	Shovelnose Ray
Rhinobatus granulatus	Shovelnose Ray
Trygonorrhina spp.	fiddler rays

Table 2 continued

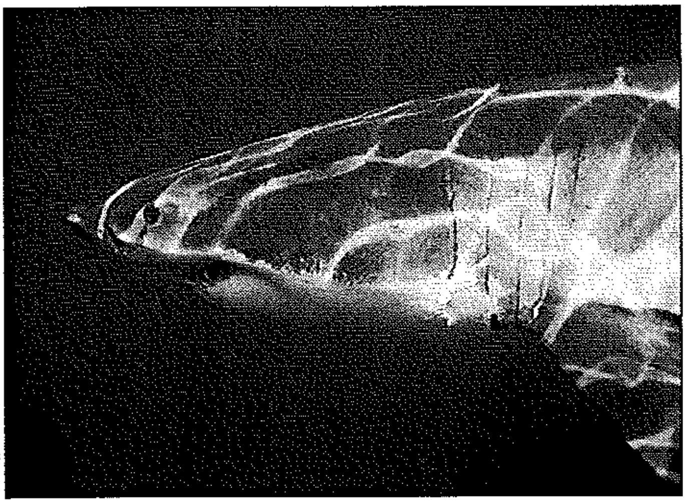
Species	FAO common names
RHYNCHOBATIDAE	guitarfishes
Rhynchobatus djiddensis	Giant Guitarfish
Rhina anclyostoma	Shark Ray
RAJIDAE	skates
Raja alba	
Raja batis	Common or Blue skate
Raja binoculata	Big Skate
Raja brachyura	Blonde Ray
Raja circularis	Sandy Ray
Raja clavata	Thornback Ray
Raja fullonica	Shagreen Ray
Raja innoninata	Smooth Skate
Raja montagui	Spotted Ray
Raja naevus	Cuckoo Ray
Raja nasuta	Rough Skate
Raja oxyrhynchus	Longnosed Skate
PRISTIDAE	sawfishes
Anoxpristis cuspidata	Narrow Sawfish
Pristis pectinata	Wide Sawfish
TORPEDINIDAE	torpedo rays
Torpedo spp.	torpedo rays
DASYATIDIDAE	stingrays
Dasyatis akajei	Whip Stingray
Dasyatis jenkinsii	
Dasyatis kuhlii	Bluespotted Maskray
Dasyatis pastinacea	
Dasyatis sephen	
Himantura bleekeri	
Himantura undulata	Leopard Whipray
Himantura uarnak	Reticulate Whipray
Potamotrygon laticeps	
Taeniura lymna	Blue Spotted Fantail Ray
GYMNURIDAE	butterfly rays
Gymnura spp.	butterfly rays
Gymnura natalensis	Diamond Ray
MYLIOBATIDIDAE	eagle rays
Aetobatus narinari	White-spotted Eagle Ray
Aetobatus flagellum	
Aetomylus nichofii	Banded Eagle Ray
Myliobatis aguila	Common Eagle Ray

Table 2 continued

Species	FAO common names
MOBULIDAE	devilrays
Manta birostris	Manta rays
Mobula diabolus	
Mobula eregoodootenkee	Pygmy Devil Ray
Mobula mobular	Devil Ray
CALLORHINCHIDAE	elephantfishes
Callorhynchus callorhynchus	Elephantfish
Callorhinchus capensis	Cape Elephantfish
Callorhinchus milii	Elephantfish
CHIMAERIDAE	shortnose chimaeras
Hydrolagus novaezelandiae	Dark Ghost Shark
Hydrolagus sp.	Pale Ghost Shark

Sources: Compagno, 1983 and Last and Stevens, 1993.

FAO catch data are usually only from commercial and subsistance fisheries, and subsistance catches are likely to be substantially under-reported. However, in some areas, for example in the USA (Rose, 1996d), recreational fishers contribute a significant percentage of total national catches and landings of chondrichthyans. The International Game Fishing Association recognizes nine types of shark which are caught recreationally, which are also taken in large numbers in commercial fisheries throughout the world. (These are the Blue Shark *Prionace glauca*, hammerhead sharks *Sphyrna* spp., the Shortfin Mako Shark, Porbeagle *Lamna nasus*, Tope or School Shark *Galeorhinus galeus*, thresher sharks *Alopias* spp., Tiger Shark *Galeocerdo cuvier*, Copper Shark *Carcharhinus brachyurus*, and Great White Shark *Carcharodon carcharias*.) (Anon., 1990).



J. Stafford-Deitsch / WWF

Great White Shark *Carcharodon carcharias*.

FAO trade data

Limitations in production and trade data are also reflected in FAO statistics, which often differ significantly from national Customs statistics, mirroring frequent discrepancies in reports by national fisheries and Customs agencies. Furthermore, many of the countries that do include chondrichthyan products in multiple tariff classifications do not appear in published FAO statistics. To cite merely two examples, world production of shark liver oil as reported by FAO totalled only 412t from 1984 to 1993, production of other shark oil, 227t (Anon., 1995a). However, South Korea alone reports imports averaging 327t of shark liver oil annually. Similarly, FAO reports shark fin exports from a total of 15 countries, while Hong Kong Customs data detail imports from a total of 125 countries during 1980-1995.

Other data sources

Data from some regional and inter-governmental bodies which have recently begun to collect information on shark catches and landings are available in addition to those from FAO. The International Council for the Exploration of the Seas (ICES) compiles catch and landing data for sharks, skates, and rays, and the ICES Study Group on Elasmobranch Fishes has recently begun an assessment of data and management needs for these species in the Northern Atlantic (Anon, 1995b). The International Commission for the Conservation of Atlantic Tunas (ICCAT) has also recently begun to request information from member nations on incidental catch of sharks in Atlantic tuna and billfish fisheries (Anon., 1995c). However, information and assessment from these sources remain limited to date.

THE CHONDRICHTHYAN FISHERIES

Introduction

According to published data of the FAO, world nominal catches of sharks and related species have been rising steadily since the 1940s (Compagno, 1984; Bonfil, 1994). Total reported world catches averaged 678 249t per year in the decade 1985-1994, with an upward trend from 622 908t in 1985 to 730 784t in 1994 (Table 3) (Anon., 1995d; Anon., 1996). The most notable increases in nominal catches during this period occur in FAO Fishing Areas of the Northwest Atlantic, the Indian Ocean, and the Western Central Pacific, with declining trends notable in the Mediterranean and Black Sea and the Northeast and Southeast Pacific (see map on page 13). In 1994, the Western Indian Ocean (FAO Area 51), Eastern Indian Ocean (FAO Area 57), Northwest Pacific (FAO Area 61), and Western Central Pacific (FAO Area 71) reported the highest nominal catches of chondrichthyans, together accounting for nearly 57% of world nominal catches (Table 3) (Anon., 1995d; Anon., 1996). In that year, major chondrichthyan fishing territories of the world – those reporting nominal catches of 10 000t or more annually – included Argentina, Brazil, France, India, Indonesia, Italy, Japan, Malaysia, Maldives, Mexico, New Zealand, Pakistan, Portugal, South Korea, Spain, Sri Lanka, Taiwan, the United Kingdom (UK) and the USA. Other important chondrichthyan-fishing nations included Australia, Canada, Nigeria, Norway, Philippines, Thailand, and Venezuela (Anon., 1996).

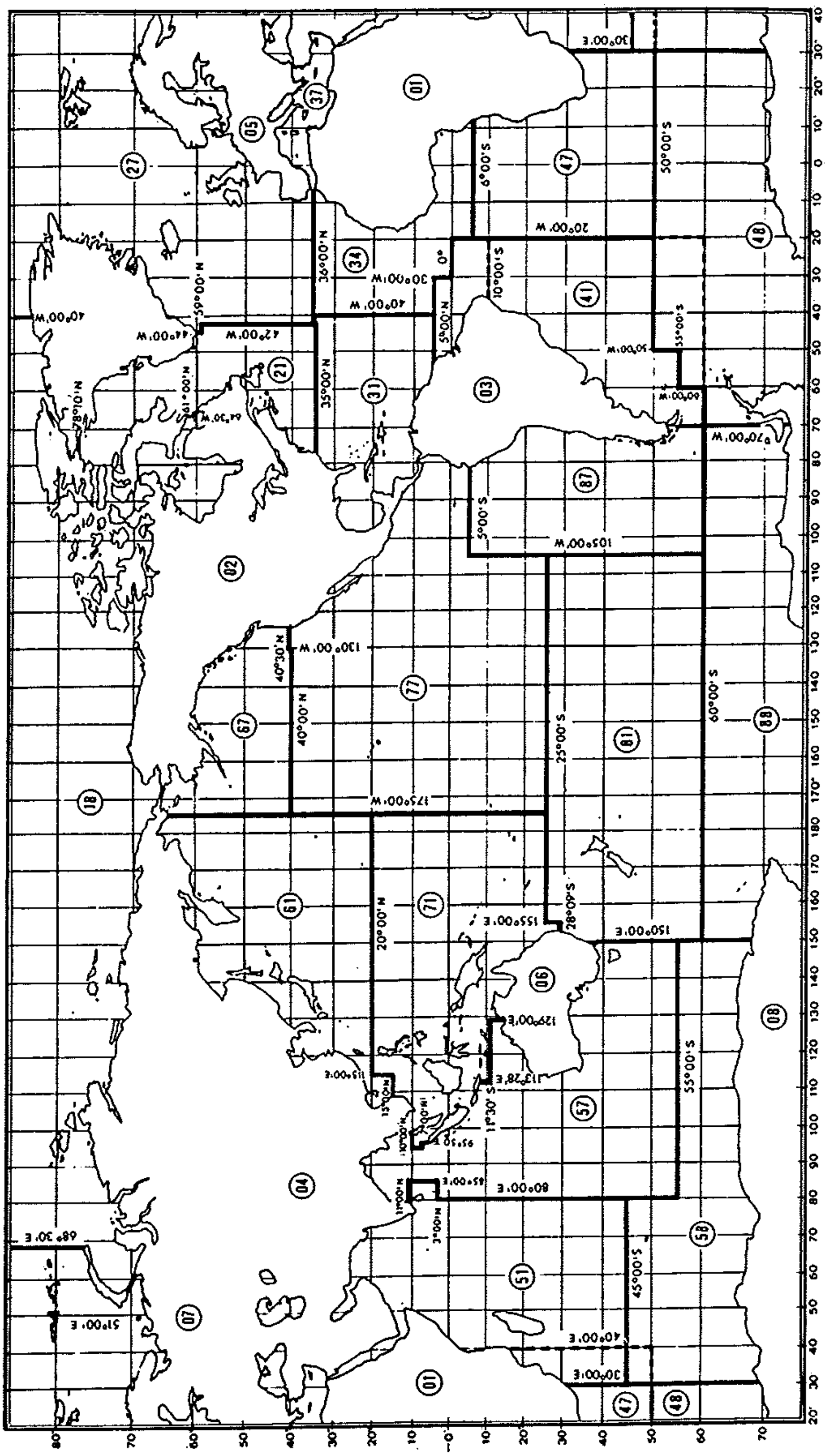
The following sections of this chapter provide brief overviews of chondrichthyan fisheries in the producer nations and territories which were included within the TRAFFIC studies. Emphasis is placed on commercial and subsistence rather than recreational fisheries, although information on recreational fisheries is also briefly reported when available. In most cases, the overviews are taken from the TRAFFIC Network regional reports (see Methods). The summaries included here are not intended to be comprehensive, but rather to provide an overview of diverse regional and local fisheries and to indicate information availability and needs.

Regional Overviews

East Asia

Japan has historically ranked among the world's most important shark fishing nations, although reported landings have declined from 90 000 to 100 000t annually during the 1950s to an average of some 30 000t annually during the 1980s and early 1990s. Landings declined further during the latter period, from 35 533t in 1983 to 25 673t in 1993. In 1993, some 77% of the total catch was by tuna longline; 42% was caught by offshore tuna longline, 27% by distant-water tuna longline vessels, and the remainder in the coastal tuna longline fishery. Much of the shark landed in Japan is taken incidentally, but in northern Japan, a targeted shark fishery occurs by tuna longline vessels. Coastal longline vessels land primarily Starspotted Smooth-hounds

Major Fishing Areas for statistical purposes, as designated by FAO

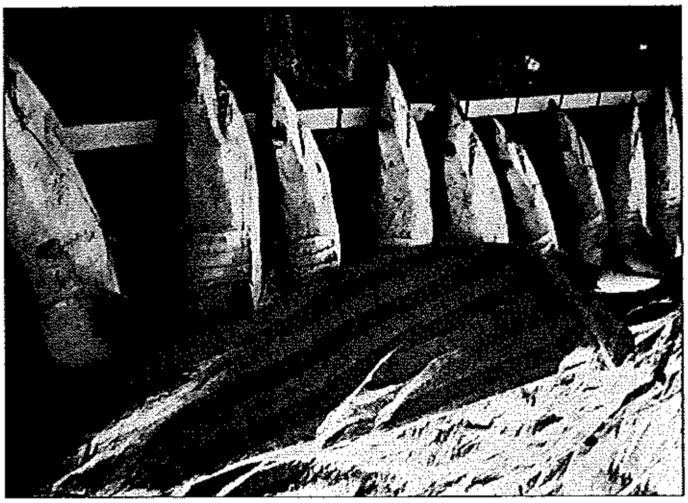


Source: Anon., 1995a.

Mustelus manazo, hammerhead sharks, dogfishes, and Draughtsboard Sharks *Cephaloscyllium isabellum*, while a coastal trawl fishery targets Piked Dogfish (Kiyono, 1996).

Landings by Japanese offshore tuna longline vessels consist predominantly of Blue Sharks, Salmon Sharks *Lamna ditropis*, Thresher Sharks *Alopias vulpinus*, and Shortfin Mako Sharks. Offshore vessels frequently retain only the fins, landing only those shark carcasses caught during the last part of the voyage. Fins are typically divided among the vessel members, who individually supply them fins directly to dealers. Distant-water tuna longline vessels catch Blue, Salmon, Thresher and Shortfin Mako Sharks, Longfin Mako Sharks *Isurus paucus*, Oceanic Whitetip Sharks *Carcharhinus longimanus*, and hammerhead sharks, but only Shortfin Mako Sharks are landed; other species are finned and discarded in order to save cargo space. Offshore swordfish gillnet fisheries in the East China Sea land only Blue Shark and Shortfin Mako Shark meat and fins (Kiyono, 1996).

Over the last 10 years, **Taiwan**'s combined coastal and distant-water shark landings have averaged between 39 000 and 74 000t annually, accounting for roughly 7.25% of world shark landings in 1993. Eighty-five per cent of Taiwan's shark landings are caught on the high seas or in other countries' exclusive economic zones (EEZs). Despite the large volumes of sharks landed in Taiwan, the relatively low price of shark meat means that shark catches continue to be predominantly incidental. Nonetheless, a wide variety of products are retained for use, including fins, meat, skins, intestines, oil, and cartilage (Chen *et al.*, 1996).



A.L. Gaski / TRAFFIC

Sharks on display before auction, Taiwan.

A directed fishery for sharks takes place in Taiwanese coastal and offshore waters. Few vessels fish sharks all year round; the majority target tunas and billfishes during part of the year and sharks when the other species are unavailable. Predominant shark species caught by these fisheries include the Bigeye Thresher Shark *Alopias superciliosus*, Pelagic Thresher Shark *Alopias pelagicus*, Shortfin Mako Shark, Smooth Hammerhead *Sphyrna zygaena*, Scalloped Hammerhead *Sphyrna lewini*, Sandbar Shark *Carcharhinus plumbeus*, Silky Shark, Oceanic Whitetip Shark, Spinner Shark *C. brevipinna*, Dusky Shark *C. obscurus*, and Tiger Shark (Chen *et al.*, 1996).

Taiwan has a significant distant-water, directed, longline shark fishery, concentrated in three major fishing grounds, those off Papua New Guinea, Indonesia, and Mozambique. The Papua New Guinea fishery consists of 40 directed shark fishing vessels and several tuna longliners that catch sharks incidentally. The vessels range from 50 to 100t and the catch consists predominantly of Silky (60%) and Oceanic Whitetip (30%) Sharks. The fishery off Indonesia consists of eight directed shark-fishing vessels; the catch consists primarily of Silky Sharks (90%). The fishery off Mozambique consists of four directed shark-fishing vessels of 300t. Species most commonly caught in this fishery are the Silvertip Shark *Carcharhinus albimarginatus*, hammerheads, Blue and Oceanic Whitetip Sharks, and thresher sharks (Chen *et al.*, 1996).

As the unit price of shark meat is lower than that of tunas and billfishes, Taiwanese distant-water fishing vessels conduct primary processing of sharks immediately in order to save cargo space for the higher value species and maximize the economic value of the fishery by increasing the unit price of shark products retained on board. Shark fins, stomachs, intestines, and gutted carcasses are retained, with two categories of exception: sharks under 20kg, and Blue Shark carcasses apart from the belly flaps, are discarded (Chen *et al.*, 1996).

South Korean chondrichthyan landings averaged 19 182t annually, peaking in 1985 at 22 888t and declining by 1992 to 12 221t. Rays and skates make up nearly 75% of landings of chondrichthyans from adjacent waters, and more than 50% of landings from distant-water fisheries. Directed fisheries for sharks occur in both adjacent and distant waters, with shark gillnets apparently the only gear type used. Total shark landings averaged 3314t annually during 1990-1994, with landings by the distant-water fleet accounting for 53% of total shark landings. The most important species in landings from the adjacent-water directed fisheries are the Broadnose Sevengill Shark *Notorynchus cepedianus*, Smooth Hammerhead, Common Thresher, Longfin Mako Shark, and Salmon Shark. Shark landings by the directed distant-water fleet declined from a peak of 4387t in 1985, to 1461t in 1994, while directed fisheries in adjacent waters fell from a peak of 4567t in 1982, to 1512t in 1994. The decline in landings from adjacent waters is believed to be owing to increasing costs of labour, rising fuel costs, uncertainty over the future of the fishery, and depletion of the resource, although there is no scientific evidence confirming the perceived decline in shark stocks (Parry-Jones, 1996b).

South Korea's distant-water fleet consisted of 642 vessels in 1995, with 387 operating in the Pacific, 189 in the Atlantic, and 66 in the Indian Ocean. The majority of the fleet is composed of tuna longline vessels, trawlers, purse seiners, and squid jiggers. The volume of shark bycatch discarded by the fleet is not known, and the species composition of catches and landings by this fleet are not available (Parry-Jones, 1996b).

China's directed and incidental fisheries for sharks and related species are virtually unknown, as the volume and species composition of catches and landings have not been reported. Official estimates of total annual shark landings range from 4000 to 7000t annually (Parry-Jones *et al.*, 1996). Bonfil (1994), estimating shark catches based on shark fin exports, suggests that China's landings grew from less than 1000t in 1981, to between 17 000 and 28 000t in 1991. However, exports of shark fins from China should not be taken as representative of domestic catches or landings, owing to constraints on China's external trade in former years and the fact that a significant proportion of China's shark fin exports consists of fins shipped from Hong Kong for processing and then re-exported to Hong Kong (see **Shark fin**, ***Markets and trade***) (Parry-Jones *et al.*, 1996).

In general, however, China's fishing industry has expanded rapidly since 1987. Industry growth includes the rapid development of China's distant-water fleet, which is extremely competitive, owing to low labour costs, and which grew from one vessel of capacity greater than 500 GRT (gross registered tonnes) in 1975, to 26 vessels in 1992. By 1996, the Shanghai fisheries industry was reported to have 64 vessels operating in the North Pacific, Atlantic, and Indian Oceans. The development of distant-water tuna longline fisheries is expected to increase greatly the nation's incidental catch, and possibly landings, of sharks and other species (Parry-Jones *et al.*, 1996). Information on the volume and species composition of sharks caught by distant-water vessels is not available.

A recent survey of China's coastal and offshore fisheries (Parry-Jones *et al.*, 1996) reported that common species in landings included the Spadenose Shark *Scoliodon laticaudus*, Whitespotted Bamboo Shark *Chiloscyllium plagiosum*, Japanese Topeshark *Hemitriakis japanica*, Scalloped Hammerhead, Spot-tail Shark *Carcharhinus sorrah*, Banded Houndshark *Triakis scyllium*, and Spotless Smooth-hound *Mustelus griseus*. Other species appearing in commercial landings included the Broadnose Sevengill Shark, Zebra Bullhead Shark *Heterodontus zebra*, Japanese Bullhead Shark *H. japonicus*, Grey Bamboo Shark *Chiloscyllium griseum*, Brownbanded Bamboo Shark *C. punctatum*, Zebra Shark *Stegostoma fasciatum*, Thresher Shark, Pelagic Thresher Shark, Shortfin Mako Shark, Great White Shark, Basking Shark *Cetorhinus maximus*, Draughtboard Shark, Blackspotted Catshark *Halaeurus buergeri*, Coral Catshark *Atelomycterus marmoratus*, Blacktip Sawtail Catshark *Galeus sauteri*, Starspotted Smooth-hound, Whitetip Reef Shark *Triaenodon obesus*, Whitecheek Shark *Carcharhinus dussumieri*, Blacktip Reef Shark *C. melanopterus*, Graceful Shark *C. amblyrhynchoides*, Sandbar Shark, Copper Shark, Hardnose Shark *C. macloti*, Tiger Shark, Blue Shark, Great Hammerhead *Sphyrna mokarron*, Piked Dogfish, Shortspine Spurdog *Squalus mitsukurii*, Clouded Angelshark *Squatina nebulosa*, and Japanese Sawshark *Pristiophorus japonicus*.

Southeast Asia

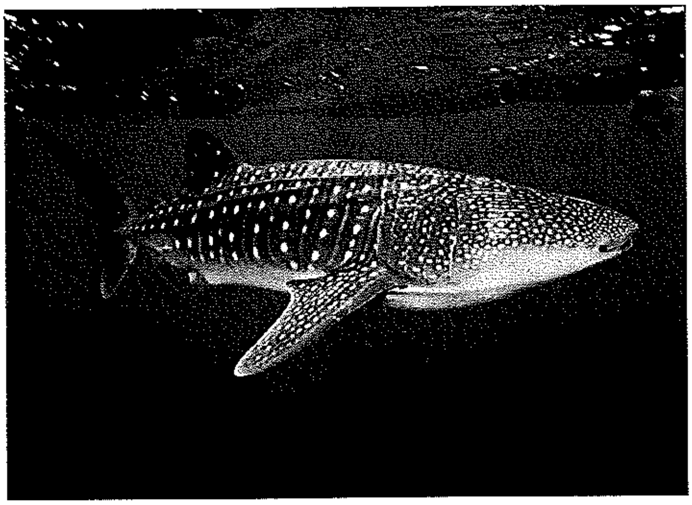
Indonesia is currently the world's leading nation in terms of reported annual chondrichthyan landings, which rose sharply from 42 900t in 1980, to 79 800t in 1991, and 92 990t in 1994 (Bonfil, 1994; Anon., 1996). Indonesia is also unusual in that some 65% of the chondrichthyan catch consists of sharks. Both shark and batoid (skate and ray) fisheries are concentrated in the western provinces, namely Java, Sumatra, and Kalimantan, and a large-scale, industrial, longline fishery targets pelagic sharks in northern Sulawesi. Anecdotal information suggests that gillnet vessels fishing around the Aru Islands target Giant Guitarfish *Rhynchobatus djiddensis*. This species yields the highest value fins in the world, and fishermen receive some US$90 per kg for the dorsal fins and discard the carcasses. In addition, fishing effort by Indonesian vessels targeting sharks in Australian waters has increased since the late 1980s, and a growing number of Indonesian vessels fishing illegally for sharks, primarily Blacktip Sharks *Carcharhinus limbatus* and Spot-tail Sharks, are apprehended in Australian waters each year (Bentley, 1996b).

Malaysian shark fisheries have developed more slowly, with a gradual increase from 12 200t in 1976, to some 17 000t per year in 1988-1991, and more than 20 000t in 1993. Most chondrichthyans are caught by trawls, although drift gillnet and hook-and-line fisheries are increasing in importance in recent years. Rays represent some 60% of total chondrichthyan catches, with catches of these having increased during the period 1976-1991. Shark catches, by contrast, show a declining trend until 1991-1992. Although species-specific landings data are not available, the species most commonly landed are reported as the Giant Guitarfish, butterfly rays *Gymnura* spp., the Spadenose Shark, Slender Bamboo Shark *Chiloscyllium indicum*, hammerhead sharks, and stingrays *Dasyatis* spp. Sharks, skates, and rays are caught throughout Malaysia, but overall catches are higher on the west coast of Peninsular Malaysia compared with those in the South China Sea, reflecting the greater importance of skates and rays in Peninsular Malaysia and sharks in the South China Sea. In addition, Indonesian and Vietnamese trawlers occasionally fish for sharks in Malaysian waters off Sarawak (Chen, 1996).

Fishing fleets in **Thailand** have harvested sharks at least since the 1960s, with catches fluctuating around 11 000t during the period 1988-1991. Nearly two-thirds of annual landings consist of rays (mainly *Dasyatis* spp.), while the shark catch is predominantly composed of small specimens of under 1.5m in length, mainly of requiem sharks, with smaller catches of bamboo sharks *Chiloscyllium* spp. Sharks are primarily a bycatch of other fisheries, and both sharks and rays are landed from vessels fishing in Indonesian waters around northern Sumatra, in the South China Sea and Arafura Sea, off Irian Jaya, as well as in the waters off Myanmar and Bangladesh. The majority of sharks and rays caught in Thailand are from the waters of the Gulf of Thailand, where they are taken chiefly by trawling, and gillnetting. Smaller catches are made in the Indian Ocean by trawler or drift gillnet, but nearly all the sharks taken in these waters are trawled (Chen, 1996).

The **Philippines** is another significant chondrichthyan-fishing nation, with landings rising from 10 900t in 1985, to an average of 18 100t during the period 1986-1991. Rays represent roughly half of chondrichthyan landings. Landings are predominantly from inshore artisanal fisheries, which accounted for 93.5% of shark landings and 95% of ray and skate landings during 1988-1991. Although species-specific landings data are not available, a partial list includes the following species: Thresher Shark, Coral Catshark, Gray Reef Shark *Carcharhinus amblyrhynchos*, Blacktip Reef Shark, Blacktip Shark, gulper sharks *Centrophorus* spp., Bareskin Dogfish *Centroscyllium kamoharai*, Tiger Shark, Whitefin Topeshark *Hemitriakis leucoperiptera*, Bluntnose Sixgill Shark *Hexanchus griseus*, Shortfin Mako Shark, Spotless Smooth-hound, Tawny Nurse Shark *Nebrius ferrugineus*, sawshark *Pristiophorus* sp., Whale Shark *Rhiniodon typus*, Cloudy Catshark *Scyliorhinus torazame*, hammerhead sharks, Piked Dogfish, Whitetip Reef Shark, Bluespotted Maskray *Dasyatis kuhlii*, whiprays *Himantura uarnak* and *H. undulata*, and guitarfishes Rhinobatidae (Chen, 1996).

Oceania


J. Stafford-Deitsch

Whale Shark *Rhiniodon typus*.

In absolute terms, Australia's chondrichthyan catches are relatively low, peaking in the late 1980s at just over 10 000t annually. However, chondrichthyan catches represented 4.8% of Australia's total fish catch during the period 1987-1991, making this one of the world's most important chondrichthyan fisheries in terms of proportional contribution to national fishery production. The Southern Shark Fishery is the largest directed fishery in Australia and, using gillnets and longlines, targets primarily Gummy Sharks *Mustelus antarcticus* and Tope Sharks, with smaller catches of sawsharks *Pristiophorus* spp., Elephantfish *Callorhinchus milii*, Whiskery Sharks *Furgaleus macki*, Dusky Sharks, Broadnose Sevengill Sharks, Blue Sharks, Copper Sharks, Shortfin Mako Sharks and angelsharks, while Port Jackson Sharks *Heterodontus portusjacksoni* and swell sharks *Cephaloscyllium* spp. are discarded alive. Little Gulper Sharks *Centrophorus uyato* and Shortspine Spurdogs, and to a lesser extent Endeavour Dogfish *Centrophorus moluccensis* and Dumb Gulper Sharks *Centrophorus harrissoni*, have recently begun to be exploited for liver oil (Bentley, 1996a).

In Western Australia, three separate fisheries use gillnets, longlines, and droplines to target sharks. The South Coast shark fishery consists of gillnet and longline fisheries for Dusky and Whiskery Sharks, wobbegongs Orectolobidae, Gummy Sharks, hammerheads, Sandbar Sharks, Spinner Sharks, Tope Sharks, Blacktip Topes or Pencil Sharks *Hypogaleus hyugaensis*, dogfishes *Squalus* spp., Tiger and Sand Tiger Sharks *Carcharhinus taurus*. The Northern Shark Fishery was initiated by the Taiwanese gillnet fleet in the early 1970s, shifting after 1986 to domestic vessels. Gillnet and longline vessels target Australian Blacktips *Carcharhinus tilstoni*, Spot-tail Sharks, Hardnose Sharks, Graceful Sharks, Pigeye Sharks *C. amboinensis*, Whitecheek Sharks, Milk Sharks *Rhizoprionodon acutus*, Australian Sharpnose Sharks *R. taylori*, Tiger Sharks and Scalloped Hammerheads. In addition, a small fishery targets wobbegongs with demersal longlines off the coast of New South Wales, and net fisheries and prawn trawlers in Queensland account for minor landings of sharks. Catch volumes and species composition in Queensland are not known, but landings are reported to consist mainly of small sharks of the genera *Carcharhinus*, *Rhizoprionodon*, and *Hemipristis* (Bentley, 1996a).

Bycatch of sharks and other cartilaginous fishes in Australian fisheries is significant and has increased rapidly since the 1960s and 1970s, in large part as a result of the development of trawl fisheries for other target species.

Domestic tuna longline vessels reportedly catch primarily mako and requiem sharks and hammerheads, with smaller bycatches of Tiger and Thresher Sharks. In some cases, vessels target sharks where no tunas are available, and may retain fins, meat, and skin from target or incidental shark catches. In the Southern Bluefin Tuna *Thunnus maccoyi* fishery, dogfishes, angelsharks, and Tope and Gummy Sharks dominate the retained catch of chondrichthyans, while Birdbeak Sharks *Deania calcea*, sawsharks and fiddler rays *Trygonorrhina* spp. are also caught. In the Northern prawn fishery, sharks and rays may account for up to 15% by weight of bycatch, dominated by Giant Guitarfish and Shark Rays *Rhina anclyostoma*.

The catch of sharks from Taiwanese gillnet vessels operating in Australian waters from the early 1970s to 1986 was larger than that of any domestic fishery, and consisted primarily of Blacktip and Spot-tail Sharks, with smaller numbers of hammerheads. Japanese tuna longline vessels continue to operate in Australian waters, their catches dominated by Blue Sharks and mako sharks, with smaller numbers of Porbeagles, Copper Sharks, and Crocodile Sharks *Pseudocarcharias kamoharai*. The bycatch of Blue Sharks, mako sharks, Porbeagles, and Copper Sharks from this fishery is often landed in Australia (Bentley, 1996a).

Protective beach meshing in New South Wales ensnares some 160 sharks annually, mainly hammerheads, requiem sharks, angelsharks, and Tiger Sharks, while some 80 rays (Rajidae, Dasyatidae, Urolophidae, Mobulidae, Myliobatidae, Rhinobatidae, Rhinopteridae, and Rhynchobatidae) are also caught in beach meshing in New South Wales each year. All sharks so caught in the New South Wales fishery are required to be dumped at sea to prevent conflict of interest. Some 970 sharks are taken each year in the Queensland beach meshing programme, consisting predominantly of Tiger Sharks, hammerheads, Blacktip Sharks, and other *Carcharhinus* species, with rays and sawfishes Pristidae taken as bycatch.

Liz Hayes

Shark fishing in the South Pacific.

Recreational anglers and game fishers take sharks and rays, but this has been little researched. Tiger Sharks, Blue Sharks, mako sharks, and Giant Guitarfish are sought by recreational fishers (Last and Stevens, 1994), while small numbers of requiem sharks, wobbegongs, blind sharks Brachaeluridae, and other species are also taken (Bentley, 1996a).

New Zealand has three targeted fisheries for sharks, for Tope Sharks, Spotted Estuary Smooth-hounds (or Rigs) *Mustelus lenticulatus*, and Elephantfish. Some 40% of the total shark catch and a rising volume of skate are taken as incidental catch in various trawl fisheries, including those for Orange Roughy *Hoplostethus atlanticus* Hoki *Macruronus novaezelandiae*, Jack mackerel *Trachurus* spp. and Barracuda *Sphyraena barracuda* (Hayes, 1996a). Inshore bottom trawlers take a bycatch of Piked Dogfish, Rough Skates *Raja nasuta* and Smooth Skates *R. innoninata*, Tope Sharks, Spotted Estuary Smooth-hounds and Elephantfish, while chimaeras *Hydrolagus* spp. are taken as target and bycatch species by bottom trawlers operating over the continental slope (Francis, 1996).

Foreign vessels no longer participate to a substantial extent in fisheries in New Zealand waters, with the exception of the Japanese tuna fishery, which takes a large but unreported bycatch of pelagic sharks, primarily Blue and Shortfin Mako Sharks (Hayes, 1996a). Foreign tuna longliners were estimated to take more than

100 000 Blue Sharks and 2000 to 5000 mako sharks annually in the mid-1980s, with actual catches likely to be significantly higher owing to under-reporting, although current catches have declined as a result of a fall in the number of foreign longline vessels participating in the fishery (Francis, 1996). In addition, foreign vessels operating on behalf of New Zealand companies take Tope Sharks, Spotted Estuary Smooth-hounds, Elephantfish, Piked Dogfish, other chimaeras, and skates. Recreational fishers in New Zealand catch Spotted Estuary Smooth-hounds and Tope Sharks, while a recreational fishery for game fish both targets sharks and catches them incidentally, primarily Blue Sharks and mako sharks (Hayes, 1996a).

Many subsistence and small-scale commercial fisheries for sharks occur elsewhere in the **South Pacific region**. Subsistence fishing is carried out by Polynesian, Micronesian and, to a lesser extent, Melanesian people. Typically, meat is used for domestic consumption and the teeth and jaws sold as curios to the tourist industry. Although sharks form an important part of island culture in many countries, catches are poorly documented. The transition from subsistence to cash-based economies in many of the Pacific island nations may increase the pressure on shark resources as deep-sea fishing is encouraged to take the pressure off inshore resources. In many countries, fish catches have been enhanced by the development and placement of fish-aggregating devices (FADs), which attract large numbers of sharks, particularly mako sharks, Ocean Whitetip Sharks, and other requiem sharks, which are then exploited for their meat and fins. Sharks are also commonly taken in the region as a bycatch of commercial tuna fisheries, mainly by Japanese, South Korean, and Taiwanese longline and purse seine vessels, which retain primarily shark fins and occasionally carcasses (Hayes, 1996b; Nichols, 1993).

Although shark is not consumed in many areas of Fiji owing to traditional taboos, there is an international trade in dried and frozen shark fin taken mostly as bycatch of pelagic longline fisheries. Longline fishing takes a substantial volume of Blue Shark, which totalled 15.84t, or 0.4% of total longline catch of all species in Fiji, in 1994. Some shark carcasses, primarily of mako sharks, are retained for export to Japan. Dropline fisheries also take Oceanic Whitetip Sharks, Grey Reef Sharks *Carcharhinus amblyrhynchos*, Blacktip Sharks, Bull Sharks *Carcharhinus leucas*, Whitetip Reef Sharks, Sicklefin Lemon Sharks *Negaprion acutidens*, and Tiger Sharks. During 1985-1987, an experimental fishery for squalene-rich deep water sharks was conducted in Fijian waters under the direction of the Fiji Fisheries Division (Hayes, 1996b).

South Asia

India is one of the world's leading chondrichthyan fisheries, landing an average of 55 460t annually during 1982-1991 (Bonfil, 1994). On India's east coast, a directed bottom longline and drift longline fishery for sharks has developed in recent years in response to declining shrimp catches; as of 1992, some 500 small craft participated in the fishery. In addition, a number of Sri Lankan vessels participate illegally in the fishery. The most common species caught are Silky Shark, Scalloped Hammerhead, Bull Shark, and Tiger Shark (Dahlgren, 1992). Shrimp trawls in the region are also reported to catch significant numbers of sharks, a small proportion of which are landed (Sivasubramaniam, 1990). Although catch data are not reported by species, other species commonly caught in India's longline, gillnet, and trawl fisheries include the Milk Shark, Grey Sharpnose Shark *Rhizoprionodon oligolinx*, Blacktip Shark, Spot-tail Shark, Pondicherry Shark *Carcharhinus hemiodon*, Winghead Shark *Eusphyra blochii*, Blacktip Reef Shark, and Spadenose Shark. Important batoid species include Pygmy Devil Ray *Mobula eregoodootenkee*, Shovelnose Ray *Rhinobatus granulatus*, Reticulate Whipray *Himantura uarnak*, *H. bleekeri*, *Dasyatis sephen*, *D. jenkinsii*, White-spotted Eagle Ray *Aetobatus narinari*, *A. flagellum*, Banded Eagle Ray *Aetomylus nichofii* and *Mobula diabolus* (Bonfil, 1994).

Pakistan's chondrichthyan landings consist primarily of Carcharhinidae and batoids. Landings have declined from a peak of nearly 75 000t in 1979 to an average of 33 640t annually during the period 1982-1991; a sharp decline in landings of batoids accounts for much of this decrease, but other causes are unknown. Detailed information on shark fisheries is available only for tuna gillnet vessels in Sind Province. In the late 1980s and early 1990s, nearly all of the shark landings from this fishery were accounted for by pelagic driftnet vessels, with the highest catches registered in Somali waters (Bonfil, 1994).

Sri Lankan shark landings averaged 16 800t during the period 1982-1991. There are few directed chondrichthyan fisheries, although an offshore directed shark longline fishery occurs in the EEZ. Most of the chondrichthyan catch is bycatch from gillnet and other fisheries, and pelagic tuna fisheries off Sri Lanka are believed to catch high numbers of sharks (Bonfil, 1994). Although detailed catch information is lacking, available data suggest that Silky Sharks make up the bulk of shark catches (Sivasubramaniam, 1992; Bonfil, 1994), with the remainder including Oceanic Whitetip Sharks, Spot-tail Sharks, Scalloped Hammerheads, Pelagic Thresher Sharks, and Shortfin Mako Sharks. Pelagic shark bycatch specifically in the tuna fishery is composed mostly of Carcharhinidae, with smaller numbers of hammerheads, thresher sharks, mackerel, and other sharks (Bonfil, 1994).

Shark fisheries in the **Maldives** traditionally targeted Tiger Sharks, Whale Sharks, and Bluntnose Sixgill Sharks for their oil. The development of tuna longlining, a reef fish gillnet fishery, and commercial markets for liver oil led to the diversification of directed shark fisheries, now including longlining for pelagic species, gillnetting for reef sharks, and a multiple hook longlining fishery for Gulper Sharks. Commonly caught species also include the Tawny Nurse Shark, Smalltooth Sand Tiger *Odontaspis ferox*, Silvertip Shark, Bignose Shark *Carcharhinus altimus*, Grey Reef Shark, Silky Shark, Oceanic Whitetip Shark, Blacktip Reef Shark, Spot-tail Shark, Blue Shark, Whitetip Reef Shark, and Scalloped Hammerhead (Anderson and Ahmed, 1993).

Africa

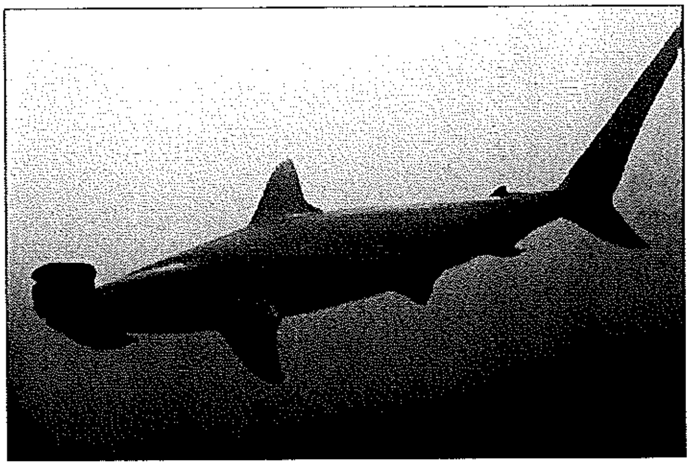
Reported chondrichthyan landings in most African nations remain small. Only Algeria, Egypt, Ghana, Morocco, Mozambique, Nigeria, Senegal, Sierra Leone, South Africa, Tanzania, and Tunisia have reported chondrichthyan catches of more than 100t annually in recent years (Barnett, 1996a; Anon., 1996). TRAFFIC reviews of shark fisheries and trade in Eritrea, Somalia, Kenya, Tanzania, Seychelles, Madagascar, Mozambique, South Africa, and Namibia suggest, however, that recorded catches and landings in much of the region are under-reported because the management frameworks in place for many of the countries are insuficient to enable the compilation of complete data sets on shark and ray catches. The most recent available chondrichthyan landings data for the countries reviewed are 125t in 1994 for Seychelles; 152t in 1993 for Kenya; 3300t in 1990 for Mozambique; 350t in 1993 for South Africa; and 1810t in 1994 for Tanzania. Available data show a declining trend in landings for Madagascar and Kenya in recent years, while South Africa, Seychelles, and Tanzania show a gradual rising trend in landings (Barnett, 1996a).

In much of the region, chondrichthyan catches are taken primarily in artisanal fisheries. In **Eritrea**, an artisanal directed fishery for sharks in the Red Sea uses gillnets and longlines to exploit sharks for domestic and export markets. A pelagic offshore fishery for snapper Lutjanidae, grouper Serranidae, and spanish mackerel *Scomberomorus* spp. takes shark bycatch that is generally finned and discarded. Many of the craft involved in this fishery are foreign fishing vessels operating illegally in Eritrean waters. At present, information is unavailable on the volume of shark production. However, owing to many years of war, the volume is well below previous levels; for the period 1965 to 1970, average annual production was 2260t (Marshall, 1996a).

Sharks form an important proportion of total landings in **Somalia**. The directed artisanal fishery uses baited longlines, driftnets, and gillnets, and the catch is used primarily for the production of dried salted meat, fins, and liver oil for maintenance of *dhows*. Although data are minimal on the volume and species composition of artisanal catches, it has been reported that 90% of the catch in the north-east region consists of Blacktip Reef Sharks, thresher sharks, hammerheads and mako sharks. Bignose Sharks and stingrays Dasyatididae form part of the incidental catch, and the Whale Shark is occasionally caught incidentally. There is no large-scale, directed, commercial fishery for sharks, but vessels targeting squid, crustaceans, and demersal fish take an incidental catch of sharks, of which fins, and occasionally meat, are retained. Foreign offshore trawlers operating illegally in Somali waters are also believed to take a significant annual shark bycatch (Marshall, 1996b).

Kenyan fisheries are similarly dominated by the artisanal sector, although landings by sector and species are not reported. The prawn and tuna fisheries catch sharks incidentally, and although the volume of shark bycatch is unrecorded, it is landed and included in national catch statistics. Shark bycatch from Spanish tuna vessels operating offshore is also landed in Kenya, the fins exported to Hong Kong and the meat sold locally. In addition, sharks are occasionally targeted or caught incidentally in recreational fisheries (Marshall, 1996c).

In **Tanzania**, more than 96% of total marine production is contributed by small-scale artisanal fishermen in coastal waters. A substantial, artisanal, directed shark fishery using drift gillnets, demersal gillnets, and longlines contributes an estimated catch of 1103t annually. The seasonal nature of the shark fishery in Tanzania affects the type and overall number of fishing gears, as artisanal fishermen invest limited resources into efficient fishing gears if the shark season is short, as is the case in Zanzibar island, off the coast of Tanzania. A directed fishery has existed for centuries, but output is limited by the small size of the fishing vessels. Catches consist primarily of Silky, Silvertip, Hardnose, Blacktip Reef and Sandbar Sharks, Blackspot Sharks *Carcharhinus sealei*, Blacktail Reef Sharks *C. wheeleri*, Milk and Whitetip Reef Sharks, Scalloped Hammerheads, and Great Hammerheads and Giant Guitarfish (Barnett, 1996b).



Charles Hood / WWF UK

Scalloped Hammerhead *Sphyrna lewini*.

A small commercial prawn fishery takes an annual shark bycatch of some 24t, of which nearly half is constituted of Giant Guitarfish. In this fishery, the meat is consumed directly by the fishers and the fins sold when in port. The presence of foreign longline fishing vessels in Tanzania's EEZ is reported, but owing to the lack of any government regulatory management of offshore waters, the extent of foreign fishing effort and shark catch is unknown. A small recreational fishery rarely targets sharks, but some incidental catch is reported, particularly of Whitetip Reef Sharks in the Dar-es-Salaam area (Barnett, 1996b).

In **Mozambique**, directed artisanal shark gillnet fisheries catch an estimated 1800t annually, while semi-industrial and industrial prawn fisheries take a utilized bycatch of sharks and rays estimated at 1500t annually. During the 1980s, several development projects were initiated to assist in the industrialization of shark fishing by training artisanal communities in fishing methods and processing of meat, cartilage, liver oil, leather, fins, and trunks, but it was noted that preparation of shark fins for export was the main activity of the shark fishing industry in Mozambique. At present, commercial shark fisheries exist in Maputo Bay and Inhamane Bay, but species composition of catches is not known. In addition, sharks, rays, and skates are caught in growing recreational fisheries. In one popular site on Bazaruto Island, common species in recreational catches are the Snaggletooth Shark *Hemipristis elongatus* and Spinner Shark, while Great Hammerheads and Sandbar Sharks are caught occasionally and Great White Sharks rarely (Sousa *et al.*, 1996).

The artisanal fishery of **South Africa** is limited, but South Africa maintains the largest offshore commercial fishery in the region, which is believed to account for a significant volume of chondrichthyan bycatch. Bottom trawl hake *Merluccius* spp. and sole *Austroglossus* spp. fisheries recorded shark landings of 164t in 1993, which do not include a substantial volume of discards. More than 45 chondrichthyan species have been recorded in trawls on the Agulhas Bank, but the predominant species recorded is the Shortnose Spurdog *Squalus megalops*. The species retained include the Tope Shark, Smooth-hound *Mustelus mustelus* and *Carcharhinus* spp. The Cape Elephantfish *Callorhinchus capensis* and Thornback Ray *Raja clavata* are also retained. Landings appear to include only shark trunks and skate wings. In the KwaZulu-Natal demersal prawn trawl fishery, chondrichthyans are generally discarded and therefore not included in landings data (Smale, 1996).

Purse seine vessels and mid-water trawls off the south and west coasts of the Cape take small numbers of chondrichthyans, but catch data is unavailable. A commercial line fishery increasingly targets sharks as catches of bony fishes decline, and reported a 1994 chondrichthyan catch of 518t. In addition, 31 domestic longline vessels were licensed to take sharks from 1995. South African shark longliners initially targeted Shortfin Mako Sharks, with a bycatch of Blue Sharks. With growing demand for shark meat, Tope Sharks and smooth-hounds are also targeted for export to Australia and Europe. In addition, from 1994, 90 Japanese and 30 Taiwanese vessels have held licences for tuna longlining in South African waters. Bycatch of these vessels is mostly discarded and unreported, although finning is known to occur. Domestic and foreign longliners reported total landings of 233t in 1994 (Smale, 1996).

Several additional South African fisheries take chondrichthyans directly or incidentally. Beach seining and gillnetting recorded an additional 346t of landings in 1993. Beach seining takes some 40 chondrichthyan species as bycatch, of which only Cape Elephantfish, skates, and Diamond Rays *Gymnura natalensis* are usually retained, while set nets target Cape Elephantfish as well as mullets. A targeted recreational fishery for sharks reported landings of 73t in 1994, with identified species including the Diamond Ray, Giant Guitarfish, Dusky Shark, and Milk Shark. Protective beach meshing by the Natal Parks Board catches some 1470 sharks, of roughly 14 species, annually, with average annual catches of 90t during 1978-1990. Live captures are released, while dead specimens are landed, and various products marketed to raise funds for the beach meshing program (Smale, 1996).

In the Seychelles, an artisanal fishery for groupers, snappers, emperors Lethrinidae, and rabbit fish *Siganus* spp. also takes sharks, although sharks are not specifically targeted. Generally, only the fins are valued and commercially traded, although a small volume of dried, salted meat is produced for local consumption and export. Reported landings are low, with a peak of 116.5t in 1994. Common species in Seychelles waters are the Silvertip Shark, Grey Reef Shark, Copper Shark, Spinner Shark, Blacktip Reef Shark, Sandbar Shark, Oceanic Whitetip Shark, Tiger Shark, Sliteye Shark *Loxodon macrorhinus*, Whitetip Reef Shark, Sand Tiger Shark, Great Hammerhead, Smooth Hammerhead, Short-tail Nurse Shark *Ginglymostoma brevicaudatum*, Tawny Nurse Shark, Giant Guitarfish, and Shovelnose Ray *Rhinobatos blochi*. Domestic commercial tuna and swordfish fisheries take an unknown volume of shark bycatch in the Seychelles EEZ, as do foreign tuna longline vessels, including several from the European Union (EU). The Oceanic Whitetip Shark is reported as the most frequently caught species by tuna vessels. Foreign vessels often land shark bycatch in Seychelles; in 1994, landings from these vessels totalled 8.3t (Marshall, 1996d).

In Madagascar, the artisanal fishery uses small, sail-powered vessels and launches with outboard or inboard motors. Small vessels use handlines, large mesh gillnets, and small mesh gillnets, while larger vessels use longlines and drift gillnets. Shark landings were minor until the mid-1980s, when markets expanded for shark fins and for dried shark meat for consumption in the Comoros. In some areas, fisheries development projects have been initiated with foreign assistance, including an artisanal fishery project in Nosy Be, supported by the *Deutsche Gezellschaft für Technische Zusammenarbeit* (GTZ), which acts primarily to distribute shark nets to local fishermen. In addition, the Catholic mission in Maroansetra has provided small vessels with outboard motors for shark fishing. A large-scale commercial fishery directed at sharks operated in Madagascar during 1991-1992 but has since ceased, and there are currently no large commercial directed fisheries for sharks or other chondrichthyans. A substantial coastal prawn fishery contributes an estimated shark bycatch of tens of thousands of sharks annually. In addition, a licensed European fleet of 60 pelagic tuna purse seine, and at least 40 licensed and several unlicensed Taiwanese, South Korean, and Chinese tuna longline vessels, are believed to take a substantial, but unreported, number of sharks as bycatch. Although information is not available on other products retained, shark fins from these vessels are landed in large volumes in Madagascar. Recreational catches are considered to be negligible (Cooke, 1996).

Official data on the volume and species composition of Malagasy landings are not available, but TRAFFIC fisheries surveys conducted during 1995 reported that important species in small-scale coastal fisheries include the Blacktip Reef Shark, Grey Reef Shark, Silky Shark, Oceanic Whitetip Shark, Spot-tail Shark, Pigeye Shark, Tiger Shark, Scalloped Hammerhead, Smalltooth Sand Tiger Shark, Grey Bamboo Shark, and Zebra Shark. Sawfish are also widely exploited, as are a number of other chondrichthyan species, including the White-spotted Eagle Ray, Blue Spotted Fantail Ray *Taeniura lymna*, Giant Guitarfish, and Thornback Ray (Cooke, 1996).

Europe

France has long been considered Europe's leading chondrichthyan fishing nation in terms of volumes produced, and one of the most important worldwide, although few chondrichthyan species are specifically targeted. French vessels operate mainly in the Atlantic and Indian Oceans and in the Mediterranean Sea. Reported commercial landings include only those into French ports in the Atlantic and Mediterranean, and no data are available for landings in the Indian Ocean. Reported landings since the 1960s were high and variable at some 35 000t annually until 1988, since when they have declined to an average of 23 500t annually. Some 85% of chondrichthyan landings are taken by trawl fisheries: skates and rays account for the majority of chondrichthyan landings. Skate and ray landings ranged around 11 000t per year during 1988-1992, declining to just under 9000t in 1994. The Small-Spotted Catshark or Lesser Spotted Dogfish *Scyliorhinus canicula* is currently the most frequently landed shark species, with landings averaging 5423t annually during 1988-1994. The Piked Dogfish is the object of one of the few directed commercial shark fisheries and the second-most common shark species in landings; however, landings have fallen rapidly from nearly 8000t in 1988, to 1600t in 1994. Other important species occurring in trawl fisheries are the Nursehound or Greater Spotted Dogfish *Scyliorhinus stellaris*, Tope Shark, Smooth-hound, and Starry Smooth-hound *Mustelus asterias* (Fleming and Papageorgiou, 1996).

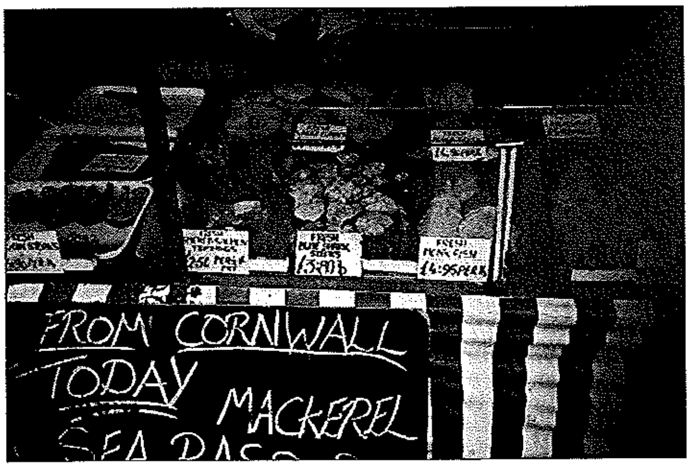
Since the early 1990s, French trawlers operating down the slope of continental shelf west of the British Isles have caught some 15 deep-water chondrichthyan species, of which the Leafscale Gulper Shark *Centrophorus squamosus* and Portuguese Dogfish *Centroscymnus coelolepis* are commercially important. The latter is one species landed for its liver oil and squalene. Overall landing statistics for France are not available for this species, but the port of Boulogne-sur-Mer records landings of 322t in 1990 and 1400t in 1992 of Portuguese

Dogfish. Bycatch of a recently developed fishery on the Mediterranean continental slope also includes several species of deep-dwelling sharks. Landings of these species are reported collectively as *siki*, but species composition is not known (Fleming and Papageorgiou, 1996).

Regarding pelagic sharks, the Porbeagle is the only species directly targeted. Shortfin Mako and Common Thresher Sharks are caught incidentally in the Porbeagle longline fishery, while Blue Sharks are caught incidentally by the pelagic tuna gillnet fleet, longliners, and coastal trawlers. Discards of Blue Sharks by the tuna gillnet fishery appear to be significant, accounting for an estimated 400t in 1993. French purse seine and longline vessels fishing tuna in the Indian Ocean are believed to catch large numbers of sharks incidentally, but quantitative and species information are not available (Fleming and Papageorgiou, 1996).

Landings by the UK averaged 20 400t during 1987-1993. In 1990, the UK was ranked second in chondrichthyan landings in the Northeast Atlantic fishing area, with landings accounting for almost 25% of the area total. Directed chondrichthyan fisheries occur only for Piked Dogfish and skates. While UK chondrichthyan fisheries have been very stable overall, an analysis of individual sets of landing data from the 18 Sea Fisheries Committees (SFCs) in England, Wales, Scotland, and Northern Ireland reveals fluctuations in Piked Dogfish landings that are not apparent in the FAO landings data for all the regions combined. Landings data for 1972-1993 from the 18 SFCs indicate that landings in only three Piked Dogfish fisheries are currently increasing, and that all others have declined at some point within this time period. Skates and rays are primarily caught as bycatch, but localized directed fisheries operate in different areas of the UK, and these species are increasingly targeted as traditionally fished species are regulated by quotas. During the past 30 years, this fishery has experienced two peaks in catches followed by declining returns. A number of skate and ray species are believed to have declined in number in the Irish and Celtic Seas and Bristol Channel, including the Common or Blue Skate *Raja batis*, *R. alba*, Shagreen Ray *R. fullonica*, and Longnosed Skate *R. oxyrinchus* (Fleming and Papageorgiou, 1996).

Other dogfish species, including the Small-spotted Catshark and Nursehound, also appear in reported UK landings. Pelagic species such as the Blue Shark, Porbeagle, and Tope Shark are captured usually incidentally, although a limited directed fishery for Blue Sharks developed in southern Cornwall in 1991, with four longline vessels targeting this species by 1993. Scottish directed fisheries for Porbeagle have occasionally operated, and a small-scale directed line fishery developed off the Shetland Isles in 1987-1988. This fishery landed more than 300 individuals within a period of a few weeks, after which landings rapidly declined. Basking Sharks have also been periodically and locally targeted, and small local catches are currently reported. In addition, a number of Anglo-Spanish convenience flag vessels licensed from the UK are involved in directed shark longline fishing, targeting mainly pelagic species, and French vessels annually land several hundred tonnes of deep-water sharks, mainly Kitefin Sharks *Dalatias licha* at Scottish ports. Blue Sharks, Porbeagles, and Tope Sharks are targeted by recreational fishers in the UK, and Piked Dogfish are also commonly caught in recreational fisheries (Fleming and Papageorgiou, 1996).



C. Allan

Blue Shark *Prionace glauca* on sale at Cambridge market, UK.

Ireland's chondrichthyan landings increased rapidly during the 1980s, from an average of 1700t during the 1960s and 1970s to a peak of over 11 000t in 1985 and 1987. Landings dropped to just under 4000t by 1991, rising in 1994 to more than 5000t. Piked Dogfish are caught primarily by trawlers and gillnetters, and account for most of the recorded dogfish landings, although small numbers of Small-spotted Catsharks and Nursehounds also appear in landings records. A sharp reduction in Piked Dogfish catches was observed off the northwestern coast in 1986, followed by a similar decline in catches from the south-west the following year. By the late 1980s, fishing effort for this species had shifted from the north to the south, and the Department of the Marine had expressed concern over the disappearance of large mature females from catches (Fleming and Papageorgiou, 1996).

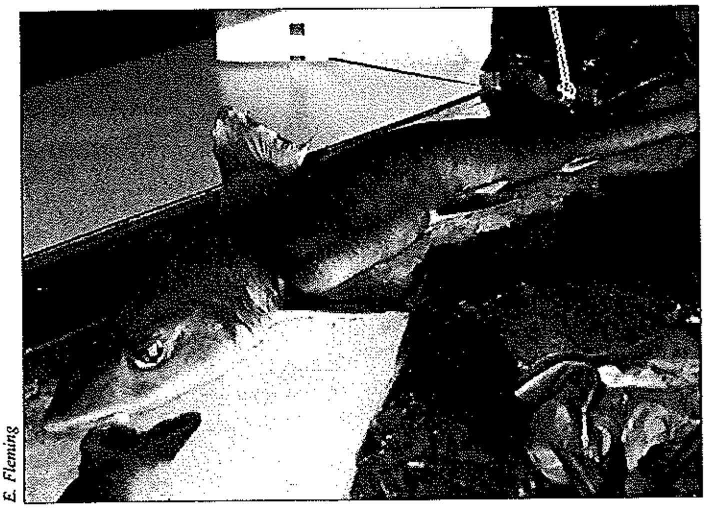
A seasonally directed trawl fishery also occurs in Ireland for Spotted Rays *Raja montagui*, Blonde Rays *R. brachyura*, Thornback Rays and Cuckoo Rays *R. naevus* off the east and south-east coasts. Fishing pressure has contributed to the depletion of ray fauna in the Irish Sea, and the decline of the Common or Blue Skate owing to overfishing was documented in 1981. Other shark species, such as the Shortfin Mako Shark and Porbeagle, are caught incidentally and landed for sale to the UK or continental Europe. Trials to develop a commercial longline fishery for Blue Sharks were conducted in 1990 but proved uneconomical owing to low catch per unit of effort and the low value of the fish. As in the UK, Blue Sharks, Porbeagles, and Tope Sharks are also targeted by recreational fishers and Piked Dogfish appear commonly in recreational catches. In addition, Ireland is unique in terms of the importance of skates and rays in recreational fisheries (Fleming and Papageorgiou, 1996).

Spain's chondrichthyan landings increased rapidly from 5700t in 1984 to an annual average of 17 200t during the period 1985-1991. Spanish vessels operate in both the Atlantic Ocean and the Mediterranean Sea, as well as in the Indian Ocean, although information on the volume and species composition of sharks caught by distant-water vessels is not available. Generally speaking, shark landings are primarily considered incidental catches of swordfish fisheries, although sharks are often targeted on a seasonal basis, and incidental catches are significant.

In the Atlantic Ocean, principal fishing methods employed by Spanish vessels include drift longlines, drift gillnets, bottom trawls, bottom gillnets, and bottom longlines. Blue and Shortfin Mako Sharks represent most of the catch by Atlantic longliners and gillnetters; Shortfin Mako Sharks (known in Spain as *marrajos*), are caught by surface drift longlines (known as *marrajeras*). Coastal shark species such as the Tope Shark (known locally as *cazon*) and Small-spotted Catshark are the most commonly landed species from gillnets, or *cazonales*, and bottom trawls. Deep-dwelling sharks such as Kitefin Sharks, Birdbeak Dogfish, Portuguese Dogfish, Knifetooth Dogfish *Scymnodon ringens*, and gulper sharks are the most commonly landed species in the bottom longline fishery.

In the Mediterranean, Shortfin Mako Sharks, Tope Sharks, Blue Sharks, thresher sharks, and Sandbar Sharks are landed as targeted or bycatch species by the Spanish swordfish fleet. Blue Sharks and other species are frequently finned at sea and the carcass discarded. Landings of coastal species include Piked Dogfish, Small-spotted Catsharks, gulper sharks, smooth-hounds, Blackmouth Catsharks *Galeus melastomus* and rays and skates, most notably Thornback Rays and *R. asterias* (Fleming and Papageorgiou, 1996).

Italy is the most important fishing nation operating in the Mediterranean Sea in terms of tonnages of chondrichthyans caught there, although landings from distant waters are increasing. Total chondrichthyan landings averaged 11 960t a year during the period 1988-1994, of which 73% was attributed to the Mediterranean fleet, 19% to that of the East Central Atlantic, and the remaining eight per cent to that of the rest of the Atlantic



E. Fleming

Piked Dogfish *Squalus acanthias* and skate Rajidae on sale in Europe.

and the Indian Ocean (see map of fishing areas). Chondrichthyan species are mostly taken incidentally by longliners, trawlers, and driftnetters. The driftnet fishery targeting swordfish *Xiphias gladius* and albacore *Thunnus alalunga* takes a significant bycatch of Thresher Sharks, Blue Sharks, Porbeagles, Devil Rays *Mobula mobular*, and Common Eagle Rays *Myliobatis aguila*, with a lesser bycatch of Basking Sharks, Shortfin Mako Sharks, and Smooth Hammerheads. Trawlers catch mainly coastal/demersal species such as dogfishes, smooth-hounds, rays and skates *(Raja* spp., *Torpedo* spp.).

Small incidental catches of chondrichthyan species are also landed in the Mediterranean by **Malta**, **Greece**, **Turkey**, and **Cyprus** (Fleming and Papageorgiou, 1996).

In **Norway**, Piked Dogfish have supported traditional fisheries and the species is considered commercially important. Landings reached a high of roughly 34 000t in 1963, and a size limit of 70cm per fish was imposed in 1964 to conserve the stocks. Landings declined sharply during the 1970s, stabilizing at an annual average of approximately 5000t in the 1980s. Landings increased in the later years of that decade, owing to the development of a local coastal-water gillnet fishery, reaching 9634t in 1991, before decreasing again to under 5000t in 1994. In addition to this fishery, directed fisheries for Basking Sharks have existed from as early as the sixteenth century but today's fishery involves only a small number of vessels. Porbeagles are caught in small volumes in purse-seine, trawl, and gillnet fisheries. Landings of skates and rays are low, at an annual average of 964t during the period 1970-1994. A commercial fishery for Greenland Sharks *Somniosus microcephalus*, for their liver oil, existed from the beginning of the century until 1960 (Fleming and Papageorgiou, 1996). In recent years, the species has reportedly become increasingly popular in recreational fisheries (Anon., 1995b).

The Americas

In the **USA**, chondrichthyan landings are dominated by Piked Dogfish and skates. Piked Dogfish landings have risen rapidly from 8812t in 1982, to 21 242t in 1994, while landings of skates also increased after 1983 to more than 10 000t annually during the early 1990s. After 1985, directed commercial fisheries for sharks off the Atlantic coast developed in response to rising prices for shark fins, growing popularity of shark fillets and steaks for domestic consumption, and declining stocks of tunas and swordfish. Total landings of sharks other than dogfish rose from 2554t in 1985, to 7436t in 1994. Recreational shark fisheries are also popular in the USA and landings from such fisheries in the Atlantic Ocean and Gulf of Mexico averaged 2.5 million sharks per year during the period 1978-1988. Rising concern over the status of shark stocks as a result of the rapid increase in landings led to the establishment of catch quotas and other regulatory measures through the federal *Fishery Management Plan for Sharks of the Atlantic Ocean*, implemented in 1993, and to increased state regulation in the Pacific (Rose, 1996d).

On the Atlantic coast of the USA, common shark species in landings, other than Piked Dogfish, include the Blacktip Shark, Sandbar Shark, Bull Shark, Spinner Shark, Blacknose Shark *Carcharhinus acronotus*, Finetooth Shark *C. isodon*, Copper Shark, Smalltail Shark *C. porosus*, Oceanic Whitetip Shark, Silky Shark, Lemon Shark *Negaprion brevirostris*, Sand Tiger Shark, hammerheads, Bonnethead Shark *Sphyrna tiburo*, Tiger

Shark, Nurse Shark *Ginglymostoma cirratum*, Atlantic Sharpnose Shark *Rhizoprionodon terraenovae*, Longfin Mako Shark, Shortfin Mako Shark, Porbeagle, Thresher Shark, Pelagic Thresher Shark and Blue Shark (Rose, 1996d).

Volumes of chondrichthyans landed on the Pacific coast are smaller than on the Atlantic and fluctuated around 5000t annually during the late 1980s and early 1990s. Landings again consisted largely of Piked Dogfish. Other principal species in Pacific landings include thresher sharks, the Pacific Angelshark *Squatina californica*, Tope Shark and Shortfin Mako Shark, with minor landings of Salmon Sharks, Broadnose Sevengill Sharks, and Leopard Sharks *Triakis semifasciata*. Reported shark landings in Hawaii and American territories in the Western Pacific (Guam, American Samoa, and the Northern Marianas) were minimal until 1993, when shark landings of 1180t were registered by Hawaii, apparently consisting almost entirely of pelagic sharks (Blue Sharks, thresher sharks, and Shortfin Mako Sharks), caught as bycatch by tuna- and swordfish-fishing vessels relocating from the Atlantic (Rose, 1996d).

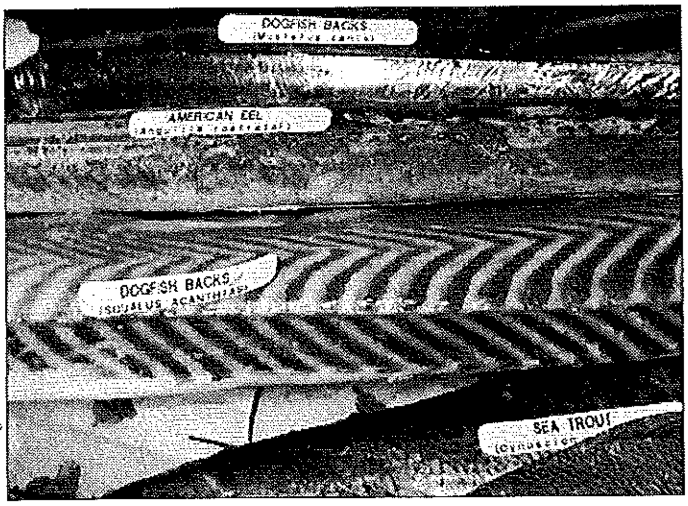
Canada has historically been a minor shark fishing nation. Total commercial shark landings averaged only slightly over 3000t per year during the 1980s, with most commercial landings consisting of Piked Dogfish. Landings of sharks other than dogfish take place mostly on the Atlantic coast, and amounts caught stayed below 100t per year until the beginning of the 1990s. A directed fishery emerged off the Atlantic coast in 1991, targeting primarily Porbeagles, Shortfin Mako Sharks and Blue Sharks, and landings of sharks other than dogfish here reached 1890t in 1994. In that year, a federal management plan for Atlantic sharks established a number of precautionary management measures, including species-specific landing quotas, reporting requirements, and a prohibition of finning (Rose, 1996b).

Sharks have long served as an important resource for artisanal fisheries in Mexico, and reported shark catches have remained relatively constant over the past several years, averaging some 33 000t annually during the period 1982-1993. Approximately two-thirds of reported landings are from the Pacific Ocean, the remainder from the Gulf of Mexico and the Caribbean Sea. Directed shark fisheries in the Gulf and Caribbean Sea take Nurse, Shortfin Mako, Silky, Bull, Dusky, Blacktip, Blacknose, Sandbar Sharks and Caribbean Reef Sharks *Carcharhinus perezi*, Night Sharks *C. signatus*, Tiger and Lemon Sharks, and Atlantic Sharpnoses, Bonnetheads, Scalloped Hammerheads, Great Hammerheads, and smooth-hounds. Rays are also frequently landed for human consumption, but no data are available on the volume or species composition of landings. The small Gulf of Mexico longline fleet targeting tunas, groupers and snappers takes a utilized bycatch of sharks, including Blacktip, Oceanic Whitetip, Bull, Tiger, Blue, Shortfin Mako, Longfin Mako, Thresher and Bigeye Thresher Sharks, Scalloped Hammerheads, Great Hammerheads, and other requiem sharks. Shark bycatch by tuna vessels operating in the Pacific Ocean is reported to include many of the same species, but excluding Longfin Mako Sharks and including Pelagic Thresher Sharks (Rose, 1996c).

In **Uruguay**, artisanal fisheries target Tope Sharks, primarily for domestic consumption of their meat, with a utilized bycatch of other shark species, including the Argentine Angelshark *Squatina argentina*, Sand Tiger Shark, Sandbar Shark, Broadnose Sevengill Shark, and hammerheads. Uruguayan longline vessels targeting tunas and swordfish also take sharks incidentally, including Shortfin Mako Sharks, Porbeagles, Blue Sharks, hammerheads, thresher and requiem sharks, and other species. Beginning in 1992, the Uruguayan fleet began to replace Japanese-built longline vessels with vessels constructed in the USA and Spain, a change resulting in shorter periods at sea and correspondingly higher landings of sharks. By 1994, sharks represented 35% of the landings by the longline tuna fleet, up from four per cent in 1985. Incidental catch also occurs in trawl fisheries, which take Blue Sharks, Shortfin Mako Sharks, hammerheads, and Sand Tiger Sharks. Total landings averaged 1062t annually during 1990-1994, with landings identified by species dominated by smooth-hounds, Piked Dogfish, Argentine Angelsharks, and Sand Tiger Sharks (Villalba-Macías, 1996).

Chondrichthyan landings in **Argentina** have risen significantly since the early 1980s, increasing from 9440t in 1980, to 15 566t in 1985, 20 907t in 1992, and 27 299t in 1995. Targeted fisheries exist only for three species: the Narrownose Smooth-hound *Mustelus schmitti*, Tope Shark and Copper Shark, with the majority of landings accounted for by coastal vessels. Directed fisheries for Tope Sharks emerged in the 1940s, principally for salted meat and liver oil, and the species became an important target of seasonal artisanal gillnet fisheries during the 1980s and 1990s. Smoothound landings in artisanal gillnet and bottom trawl fisheries account for much of the increase in Argentina's total chondrichthyan landings; in 1995, the species accounted for 83% of total shark landings and 41% of total chondrichthyan landings. Copper Sharks are rare in Argentine waters, but highly prized when captured by commercial fishermen (Chiaramonte, 1996).

Incidental catches account for a significant and rising volume of landings in Argentina. Argentine Angelsharks are taken as bycatch in the Tope Shark fishery, but are the second-most important component of landings, reaching more than 3000t annually since 1987. Piked Dogfish are also taken as bycatch in coastal gillnet fisheries, but are typically discarded. Other species taken incidentally in coastal fisheries are the Broadnose Sevengill Shark, Dusky Smooth-hound *Mustelus canis*, Striped Smooth-hound *Mustelus fasciatus*, Sand Tiger Shark, and occasionally the Great White and Bluntnose Sixgill Sharks. In addition, a large foreign fleet consisting of more than 100 factory and freezer trawlers takes a significant bycatch of skates and rays, with reported catches increasing from 459t in 1990, when they were first reported, to 7191t in 1995. Elephantfish *Callorhynchus callorhynchus* are taken incidentally, both in coastal fisheries and by large trawlers. Offshore longlines also take a small and unreported bycatch of Porbeagles and Shortfin Mako Sharks, while recreational fishers target Broadnose Sevengill Sharks and take unknown numbers of Copper and Sand Tiger Sharks (Chiaramonte, 1996).



E. Fleming

Backs of Dusky Smooth-hound *Mustelus canis* and Piked Dogfish *Squalus acanthias*, imported from the USA, on sale in Europe.

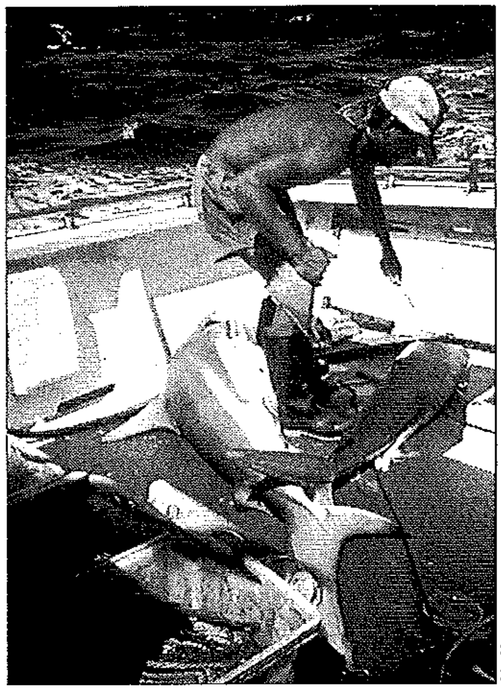
Fisheries management and conservation measures

Oceania

Relatively few nations have implemented management measures for sharks or other chondrichthyan species. **Australia** for several years provided the only examples of managed shark fisheries, the most noteworthy being the Southern Shark Fishery, now under joint state and Commonwealth management authority. The fishery is subject to a licensing requirement, with limited entry for longline vessels catching Gummy and Tope Sharks; landing of bycatch of these species by other vessels is subject to trip limits. In addition, gear and effort restrictions, fish size limits, and seasonal and area closures are in place. The Western Australia South Coast shark fishery is also managed under joint authority, as it potentially exploits the same stocks as the Southern Shark Fishery. Management measures include limited entry and gear and effort restrictions achieved through the establishment of the time-gear units. (These are regulatory units used to restrict total fishing effort by manipulating both types of gear allowable and the length of time allowed for their use. The two are interrelated, so that, for example, if a vessel has more hooks than others, it must spend a shorter time fishing.) In other

Western Australian shark fisheries, management is by licence requirements only; in the North Coast fishery, droplines and longlines are the only permitted gears. The Northern Shark fishery is managed by the Commonwealth in waters of the EEZ; regulatory measures include licensing limitations and gear restrictions (Bentley, 1996a).

Incidental shark catch by the Northern Prawn Fishery is also regulated, trip limits of 100 trunks/bodies or the equivalent, and 100 sets of fins having been established. Logbook reporting of both target fishes and chondrichthyan bycatch is required in a number of other fisheries, but under-reporting is at a significant level. Foreign tuna vessels are also required to submit logbooks, but misidentification and under-reporting are believed to be a considerable problem. According to trilateral agreements among Australia, Japan, and New Zealand for Southern Bluefin Tuna and other species, a 1994 subsidiary agreement between Japan and Australia specifies that all sharks caught by Japanese vessels in the fishery within the Australian EEZ will either be released alive and undamaged or retained whole. Sharks retained must be killed before they are processed, and where fins are retained, trunks must also be retained (Bentley, 1996a).


Liz Hayes

A fisherman processes freshly caught shark in the South Pacific.

New Zealand manages fisheries for Tope Sharks, Spotted Estuary Smooth-hounds and Elephantfish under quota management systems that include restrictions on seasons, methods, gear and area, and number of vessels participating in the fisheries. In addition, quotas are established for Piked Dogfish and skates. Mandatory reporting provides data on catches and landings, but applies only to the top five species caught by a given fisher, and so is thought to substantially under-represent catch of chondrichthyans, which are usually taken as bycatch. Recreational fishing is limited by a daily bag limit of 20 fish from a list of preferred species that includes the Tope Shark, Spotted Estuary Smooth-hound and Elephantfish. Also relevant to sharks is a minimum mesh size of 150mm for nets used in recreational fishing (Hayes, 1996a).

Most **South Pacific island nations**, including the Cook Islands, Fiji, Marshall Islands, Federated States of Micronesia, Palau, Papua New Guinea, Tonga, and Vanuatu, have no domestic legislation in place for the management or protection of shark stocks. Furthermore, there are no restrictions or reporting requirements governing the operations of distant-water fleets in international waters in this region. Although foreign vessels operate in national EEZs under bilateral agreement, shark bycatch by such vessels is generally unrestricted and unreported (Hayes, 1996b).

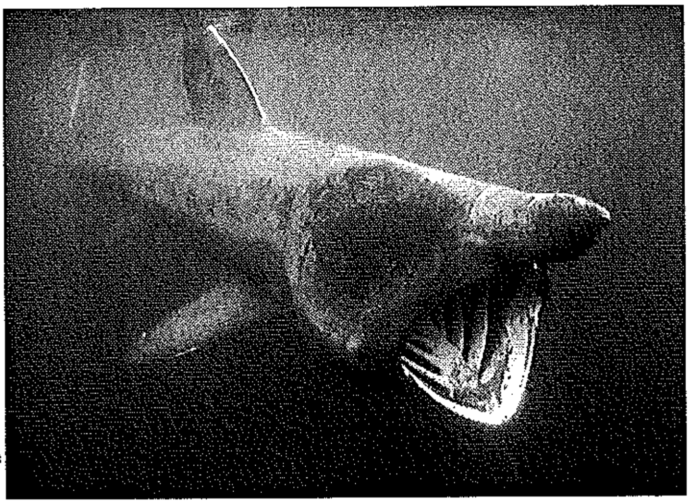
Africa

In **South Africa**, Great White Sharks have been granted complete protection since 11 April 1991 and their intentional killing or sale thereby prohibited. In addition, recreational fisheries are limited to a catch and possession limit of 10 fish per day of listed species, which include all chondrichthyans except the Great White Shark. Although a permit is required for directed shark fishing using longlines, there are no additional permit requirements, and no restrictions or reporting requirements are in place for other vessel or gear types (Smale, 1996).

None of the other nations of eastern and southern Africa surveyed by TRAFFIC have in place management or conservation measures specifically for sharks or other chondrichthyan species. Exceptionally, Madagascar has considerable monitoring capability for domestic fisheries production at the regional level and has recently instituted a fisheries production monitoring programme that will include sharks and related species (Marshall and Barnett, 1996). In most countries in the region, however, fisheries management and monitoring mechanisms are limited in general, and available catch and landing statistics are likely to under-report chondrichthyans significantly. Species composition is generally unknown, as it is not reported officially and few research programmes are in place in the region. Furthermore, although marginal landings by foreign vessels are often reported, these may originate outside the EEZ or even the region, and there are no specific reporting requirements for catches that are discarded.

Europe

There are few restrictions on chondrichthyan fisheries in **Europe**. In the UK, three Sea Fisheries Committees have introduced regional legislation establishing minimum size limits for skates and rays caught. In addition, the Basking Shark is protected within a three-mile zone off the Isle of Man, and is currently being considered by the UK Department of Environment for inclusion in Schedule 5 of the *Wildlife and Countryside Act* of 1981. The Act prohibits the killing, injuring, taking, disturbing, possession, selling, offering or exposing for sale of listed species throughout Great Britain and within adjacent territorial waters up to 12 miles from the shore. If accepted, the proposed listing would be implemented in 1997. Elsewhere in Europe, Norway has imposed a minimum size limit of 70cm on Piked Dogfish caught, and Portugal has established gear restrictions (total net length per vessel) for the Kitefin Shark fishery (Fleming and Papageorgiou, 1996).



J. Stafford-Deitsch / WWF

Basking Shark *Cetorhinus maximus* feeding off the Isle of Man.

Chondrichthyan fisheries are currently unregulated by the EU under its *Common Fisheries Policy*, with the exception of the establishment of annual quotas for sharks included in EU-Norway and EU-Faroe Island fisheries agreements. According to limits first established in 1982, Norway is subject to an annual Porbeagle quota of 200t and Basking Shark quota of 100t in EU waters. The Faroe Islands are permitted to take Porbeagles in EU waters, with a current quota of 125t a year (Fleming and Papageorgiou, 1996).

From late 1996, a proposal to require recording of several chondrichthyan species and species groups in fisheries logbooks, and of landings for the Northeast Atlantic and the Mediterranean fishing areas, has been under consideration within the EU. Under the proposal, the list of species to be included in reporting requirements would include those subject to EU catch restrictions or quotas, those subject to technical conservation measures provided for in EU legislation, those subject to international conservation measures, and those of particular scientific or commercial interest. Chondrichthyans currently proposed for listing include the Basking Shark, Shortfin Mako Shark, Porbeagle, Piked Dogfish, other dogfish sharks, smooth-hounds, rays and skates (Fleming and Papageorgiou, 1996).

The Americas

In the Americas, the USA implemented in 1993 a *Fishery Management Plan for Sharks of the Atlantic Ocean* (FMP) that applies to 73 species of shark, although only 39 species are actively managed through the establishment of quotas. The FMP established annual permit requirements for vessels wishing to sell shark, and set commercial quotas for species included in large coastal and pelagic species management units. In addition, the FMP prohibits the practice of finning, and stipulates that total fin landings may not exceed five per cent of landed carcass weights. Finally, mandatory vessel logbook reporting requires not only reporting of catch, but also of destination of catch (whether retained, discarded dead, or discarded alive). Despite mandatory reporting of shark catches, some 68% of these are not indentified to species level (Rose, 1996d).

A similar management plan was implemented in Canada in 1994 for Atlantic sharks, but applies only to Porbeagles, Blue and Shortfin Mako Sharks. The management plan establishes precautionary quotas for an experimental fishery for these species, and prohibits the practice of finning. Reporting of catches comprising managed species is required.

Neither the USA nor the Canadian management plans apply to Piked Dogfish, by far the most important species by weight in Atlantic landings in North America (Rose, 1996b).

In Mexico, the Ministry of Fisheries has reportedly suspended the issuance of new fishing permits for sharks, and in 1992 initiated a national shark programme for improving biological and fisheries research as a basis for developing further management measures for shark fisheries (Rose, 1996c).

Management measures specifically for sharks and related species have not been implemented in Argentina or Uruguay (Chiaramonte, 1996; Villalba-Maciás, 1996).

CHONDRICHTHYAN PRODUCTS IN TRADE

Knowledge regarding utilization of chondrichthyans is often limited, as national fisheries statistics frequently do not report production of skins and leather, jaws, fishmeal and fertilizer, liver oil, cartilage, or even fins. Artisanal fisheries producing salted meat and other products for local consumption may also be under-reported in national data. Furthermore, as discussed above, production data available at the national level are often not included in published FAO reports and may therefore not be widely accessible.

Chondrichthyan fisheries, directed as well as incidental, are often described as being characterized by a great deal of waste, owing to the low commercial value of chondrichthyan meat and the difficulty or economic infeasibility of obtaining all potential products from a single animal (Kreuzer and Ahmed, 1978; Nichols, 1993; Anon., 1993). Drying and salting of sharks and rays has traditionally been practised in rural areas worldwide, and allows systematic removal of skins, cartilage, and other byproducts. However, drying is time-consuming and dried meat commands low prices, with limited possibilities for export. Shark tissue contains high levels of urea, so that production of fresh, chilled, or frozen meat requires immediate processing to prevent spoilage and therefore requires the installation of costly refrigeration or freezing facilities on board processing vessels. Smaller sharks are more easily marketed for human consumption, owing to lower concentrations of mercury, as well as of urea, in their flesh, and to relative ease of processing because of their size, while larger sharks are more likely to be used for dried fins and leather. Markets for skins are limited by the small number of facilities available for tanning shark leather, which requires a special chemical process for the removal of denticles from the skin. It is also difficult to process sharks for meat and skins simultaneously, as skins must be processed immediately to preserve their quality.

As a result of these various difficulties, shark fisheries have been historically undervalued or ignored, except during boom-and-bust cycles for export products such as liver oil and fins. In the 1930s and 1940s, the use of shark liver oil as a lubricant and source of vitamin A prompted an increase in fishing for Tope Sharks (also known as Liveroil Shark) and Piked Dogfish. The development of synthetic substitutes soon caused the shark liver oil market to collapse, although the oil continues to be used in small volumes in the manufacture of cosmetic and pharmaceutical products. Commercial production of shark meat on a significant scale began in the 1950s and 1960s, and fresh or frozen shark steaks and fillets are increasingly popular in urban markets. In many regions, skates and rays have also become important to human consumption. The rapid rise of world prices for shark fin in the mid-1980s, and again in the early 1990s, stimulated trade in this luxury product, in some areas stimulating shark fisheries as well as trade. Shark cartilage, obtained as a by-product from commercial and artisanal fisheries, is increasingly marketed as a health supplement worldwide.

Total world production of chondrichthyan products as reported by the FAO (Table 4) gives some indication of chondrichthyan exploitation, but is highly incomplete and may therefore be misleading if used to deduce the relative importance of, or trends for, various products. For example, reported production of shark liver oil totalled only 412t for the period 1984-1993, while production of other shark oil totalled 227t (Anon., 1995a). However, as discussed below, South Korea alone imports an average of 327t of shark liver oil annually. Worldwide human consumption of fresh meat also continues to be reflected poorly in FAO data. The FAO yearbooks report average annual production of 4972t of chilled or frozen shark fillets and 9767t of dried, salted meat of mixed sharks, skates, and rays for the period 1984-1993 (Anon., 1995b). However, a separate document (Anon., 1991) reports that EEC imports of shark totalled 35 400t in 1988 alone. On the other hand, although world production of dried shark fins is reported by FAO to have risen dramatically from 866t in 1984 to 6012t in 1993, examination of Customs data by TRAFFIC Network offices suggests that much of this apparent increase is caused by double-counting of fins shipped back and forth between China and Hong Kong.

The following sections summarize available information on the use, markets, and trade of chondrichthyan products, the species from which they are derived, and the problems and possibilities inherent in interpreting production and trade data. The information reported here is taken from a variety of published and unpublished sources and from original research conducted by the TRAFFIC Network. Neither the list of products and species included here, nor the volumes reported for them should be considered comprehensive, as there are undoubtedly many uses of chondrichthyan products that have not as yet been documented.

Meat

Shark meat has traditionally been consumed in dried, salted, and smoked form in coastal communities worldwide. In most regions, large-scale commercial exploitation of sharks began only after the First World War. During this era, the belly flaps of Piked Dogfish began to be smoked and consumed in Germany, and shark meat was introduced into fish-and-chips (a traditional British take-away meal of fried fish and potato) in the UK. In 1925, the Ocean Leather Corporation, based in the USA, was formed and commercial shark fisheries developed in the USA, Mexico, and Venezuela to provide hides to the tannery. Salted and dried meat obtained from these fisheries began to appear in local markets (Kreuzer and Ahmed, 1978).

In many countries, industry and/or government marketing campaigns and market development efforts have been necessary to overcome consumer reluctance to accept sharks for human consumption. In Japan, government promotion of shark fisheries and industry based on the production of meat, cartilage, oil, and fins began in the early 1900s (Kiyono, 1996). In the USSR, interest in sharks arose only in the 1960s, as a result of increased bycatch of sharks associated with the growing tuna fishery. Following a number of investigations

Table 4

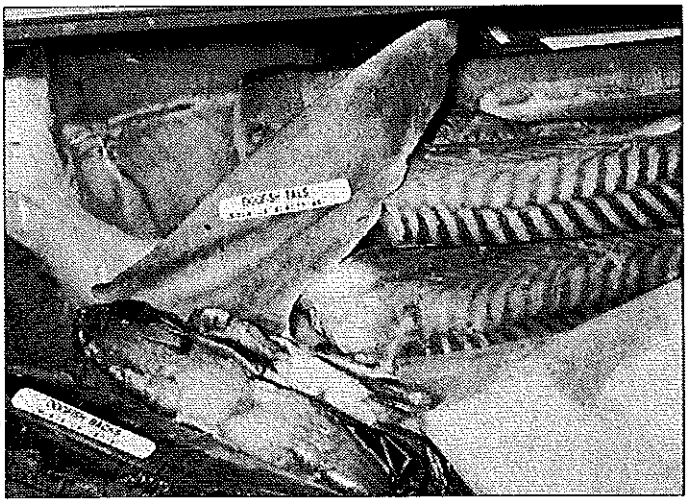
World chondrichthyan production as reported by FAO (t), 1984-1993

Product	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Shark fillets, fresh or chilled	312	523	928	3792	425	1089	2864	1836	1680	1331
Shark fillets, frozen	4197	2537	1179	787	2629	2000	2628	3434	7483	8066
Sharks, frozen	21 367	20 159	20 309	21 231	24 980	19 509	18 967	26 528	26 154	24 464
Skates, frozen	981	1543	2349	2788	2330	2262	13 051	26 183	10 426	11 285
Sharks, dried, salted, or in brine	6796	5100	6725	6352	6307	6573	6283	6394	9580	10 076
Sharks, rays, etc., dried, salted, or in brine	1888	2302	2683	4532	3655	5047	4379	488	388	2118
Shark fins, dried, unsalted	504	3231	2136	1314	4079	1787	1585	1358	1216	2755
Shark fins, dried, salted, etc.	362	294	420	659	1015	4370	3959	2690	2993	3257
Shark oil	51	39	27	9	18	13	13	17	15	25
Shark liver oil	98	74	55	36	24	18	22	36	26	6

Source: Anon., 1995a.

into canning and other preservation methods, a shark cannery was constructed in Murmansk. In Canada, government assistance was provided to the fishing industry for a number of years to encourage the production and marketing of Piked Dogfish (Ketchen, 1986). The FAO has also provided assistance in improving fishing, processing, distribution, and marketing techniques to a number of developing countries, including Trinidad and Tobago and Mozambique (Kreuzer and Ahmed, 1978; Trachet *et al.*, 1990; Anon., 1991).

Sharks often continue to be sold under market names designated to disguise their true identity in the marketplace. For example, beginning in the 1940s, several attempts were made in the USA to market the Piked Dogfish as "grayfish"; more recently, as other shark species have gained acceptance and are marketed as such, renewed attempts have been made to encourage consumer acceptance of this species under the market name "cape shark" (Rose, 1996d). Piked Dogfish is most commonly marketed as "rock salmon" in Great Britain, but may also be marketed as "huss," or "rigg." In Australia, Piked Dogfish and other species are marketed as "flake" (Bentley, 1996a). In Germany, Piked Dogfish backs may be marketed as *seeaal* (sea eel); in France, the skinless meat of a number of dogfish species is marketed as *saumonette* (Fleming and Papageorgiou, 1996). In Argentina, angelshark is marketed domestically as *gallina del mar* (chicken of the sea), while smooth-hound is marketed as *palo rosado* (pink stick) (Chiaramonte, 1996). Blue Shark may be marketed as Piked Dogfish or smooth-hound in Europe (Fleming and Papageorgiou, 1996), while mako and other sharks may be marketed in several regions as swordfish (Rose, 1996d; Fleming and Papageorgiou, 1996).



E. Fleming

Piked Dogfish *Squalus acanthias* backs and tail from the USA, imported to Belgium.

By whatever name, sharks, rays, skates, and chimaeras have gained increasing shares in recent years of both domestic and international markets. In Europe, the USA and South America, for example, fresh shark steaks and fillets are now commonly offered in supermarkets. The USA has become an important importer of fresh and frozen shark, and the importance of dogfishes and skates to European consumers has become more visible as declining domestic fisheries lead to rising imports of these species.

Preferred species

Shark species preferred for human consumption vary by country and region according to species availability and customary processing and preparation techniques. Generally speaking, however, certain species are especially recognized for their high-quality flesh. Shortfin Mako Shark is widely considered the world's finest-quality shark, and is used for sashimi in Asia and high-value fresh seafood markets in the USA and Europe, where it is sometimes comparable in price to swordfish. Shortfin Mako Sharks, owing to their high-quality meat, are typically offloaded and sold in overseas ports by Taiwanese distant-water longline vessels to preserve its quality, while other species are generally landed in Taiwan (Chen *et al.*, 1996). Other high-value shark species are Thresher Shark, and Porbeagles, both pelagic species caught in high numbers in directed fisheries and as bycatch in tuna and swordfish fisheries (Rose, 1996a). These species are widely sold by dealers of sashimi-grade tuna and swordfish, and the quality of their meat is likened to that of swordfish. Shark meat is often marketed in the same form as swordfish meat, as steaks or blocks, and in the USA is often consumed as broiled or grilled steaks (Frimoldt, 1995a; Rose, 1996d). Pelagic Thresher Shark and Bigeye Thresher Shark meat is considered inferior to that of Thresher Sharks, but is also widely marketed.

The Blue Shark, another pelagic species that is caught in large numbers in both directed and incidental fisheries, is less preferred for human consumption as it is relatively soft and the flavour considered strong (Frimoldt, 1995b), although Paust and Smith (1986) report that this species is used for sashimi in Japan. Limited markets also exist for this species in Europe. Surveys in France, for example, found Blue Shark in supermarkets and wholesale and open-air markets. Blue Sharks landed in the UK and Ireland are typically exported to France. Blue Shark is also consumed in Spain and Germany, and in Italy is deliberately marketed as the more valuable Piked Dogfish or smooth-hounds. Small Blue Shark fisheries have also arisen in Canada and the USA for export to the European market. The Salmon Shark, closely related to the Porbeagle and associated with the Blue Shark through much of its range, is caught commercially by Japanese longliners and is one of the most important species in Japanese landings. The species is reported to be consumed regularly in northern Honshu, the largest of the four main islands of Japan, but is not generally marketed domestically in significant quantities (Frimodt, 1995a), although this species and Porbeagles are exported for the European market (Paust and Smith, 1986). Attempts to market this species in the USA and Canada have thus far been unsuccessful (Paust, 1987; Paust and Smith, 1986; Rose, 1996a).

Requiem sharks are distributed widely and commonly selected for human consumption. The Sandbar Shark, a requiem shark found in the eastern and western Atlantic and in the South China Sea, has soft, reddish meat of acceptable quality and is consumed fresh, frozen, dried and salted (Frimoldt, 1995b). The Whitetip Shark is caught incidentally by high-sea longliners and is used as food in Europe, North America, and Asia (Frimoldt, 1995b). The Blacktip Reef Shark is widely consumed throughout the Indian, Pacific, and South Pacific Oceans, and is marketed fresh, frozen, or dried and salted (Frimoldt, 1995b). In Taiwan, the "belly" meat of this species is considered to be of the highest quality (Chen *et al.*, 1996). The Blacktip Reef Shark is eaten by Australian aborigines as *buundhdhaarr*, in which the liver and flesh are boiled separately and then minced and mixed together (Last and Stevens, 1994).

Tiger Sharks produce a good-quality meat and are widely consumed, being particularly favoured in the Caribbean (Frimoldt, 1995b). In the USA and in Central and South America, Blacktip, Dusky, Sandbar, Lemon, and Nurse Sharks are also consumed (Frimoldt, 1995a, 1995b; Rose, 1996a). These species are, however, typically reported in local and domestic markets rather than international trade.

As suggested above, dogfish and smooth-hounds are distributed widely and generally find ready acceptance in consumer markets in Europe, Australia, New Zealand, South America, and to a limited extent, Japan. France is among the world's largest consumers of dogfish, where, as *saumonette*, it is commonly sold in fish markets and supermarkets and especially to schools, hospitals, and other large institutions (Fleming and Papageorgiou, 1996). In Germany, retail prices for smoked dogfish belly flaps or *Schillerlocken* range up to the equivalent of US$30.00 per kg (Fleming and Papageorgiou, 1996).

Because sharks are long-lived predators, relatively high levels of mercury and other heavy metal contaminants can accumulate in their flesh, and this has bearing on species selected for human consumption. Large sharks of several species, especially Tope Shark, are often avoided (Bentley, 1996a). Most Tope Shark landed in France was exported to Italy until the late 1980s, when Italy began to refuse imports owing to mercury accumulation in its body tissues, and some processors elsewhere in Europe report not to import sharks of any species over 20kg owing to high mercury levels (Fleming and Papageorgiou, 1996). However, Tope Sharks are widely marketed as whole frozen carcasses in Australia, New Zealand, and Argentina, and found dried in Malaysia


A.L. Gaski / TRAFFIC

Hammerheads *Sphyrna* spp. before auction.

(Frimoldt, 1995b). In New Zealand, the Spotted Estuary Smooth-hound, Tope Shark, and Piked Dogfish are typically used for fish-and-chips. In some areas, for example, in Australia, fishery closures have been instituted as a result of findings of unacceptably high mercury levels in shark flesh. Other species, besides the Tope Shark, sometimes avoided because of their high concentrations of mercury include the Winghead Shark, Longnose Velvet Dogfish *Centroscymnus crepidater*, Roughskin Dogfish *C. owstoni*, Scalloped Hammerhead, Great Hammerhead and Smooth Hammerhead. Hammerheads are also frequently considered unpalatable owing to the high concentrations of urea in their flesh, but are nonetheless frequently consumed once salted and dried in some coastal nations (Frimoldt, 1995b). In Germany, hammerheads are actually imported for human consumption, and Smooth Hammerhead is sold in domestic fish markets in Spain (Fleming and Papageorgiou, 1996). In Somalia, hammerheads are reportedly considered preferred species for export markets elsewhere in Africa (Marshall, 1996b).

In Australia, the meat of Gulper Sharks *Centrophorus granulosus* and Leafscale Gulpers, and of Shortnose or Piked Spurdogs *Squalus megalops*, is reportedly smoked, dried, and salted for human consumption. Spotted Wobbegong *Orectolobus maculatus* is favoured for meat production, and other wobbegong species are occasionally marketed.

The Great White Shark is considered suitable for human consumption and often utilized when caught, but is not subject to targeted commercial fishing. The Broadnose Sevengill Shark, found throughout temperate areas of the Pacific, is a preferred species for meat production. The more widely distributed Bluntnose Sixgill Shark is not typically targeted for meat production, but may be consumed when caught (Frimoldt, 1995b).

The Whale Shark is edible but not commonly available or consumed by humans, except in some locations in Asia. In Taiwan, the Whale Shark is occasionally consumed, with preference for the meat anterior to the dorsal fin or between the anal fin and the caudal fin. This is the most expensive species of chondrichthyan on sale as meat in Taiwan, the flesh selling at US$2.56 to US$6.59 per kg in domestic markets (Chen *et al.*, 1996).

The Angelshark *Squatina squatina* is fished primarily in the Mediterranean coastal countries and is consumed both fresh, and dried and salted. The meat from both the back and the wings is consumed, and is considered similar in taste to skate (Frimoldt, 1995b). Related species include the Pacific Angelshark, marketed for human consumption in the USA and Mexico (Richards, 1987; Rose, 1996a), and Argentine Angelshark, widely fished and consumed in Argentina, Uruguay and Brazil. The Smoothback Angelshark *S. oculata* and Sawback Angelshark *S. aculeata* are utilized fresh, or dried and salted, in Africa and the Mediterranean (Compagno, 1984), while the Australian Angelshark *S. australis* and Ornate Angelshark *S. tergocellata* are reportedly marketed in Australia (Last and Stevens, 1994).

The Longnose Sawshark *Pristiophorus cirratus* is reportedly used in the preparation of fish-and-chips in Australia (Frimoldt, 1995b), the Narrow Sawfish *Anoxpristis cuspidata* is reportedly caught for its flesh in parts of Asia, and the Wide Sawfish *Pristis pectinata* is reportedly used as a food fish in parts of the Indo-Pacific (Last and Stevens, 1994).

The Giant Guitarfish produces high-quality meat from the pectoral fins (wings) that is often filleted and either frozen for prepared for consumption fresh, or dried and salted, throughout its range in the Indian Ocean and South Pacific (Frimoldt, 1995b). The Shark Ray is typically caught only incidentally in the Indian and Pacific Oceans but the meat is occasionally consumed (Frimoldt, 1995b). The Big Skate *Raja binoculata*, for which the most significant commercial fishery is located in Canada, yields large wings that are typically skinned and filleted and marketed in small quantities (Frimoldt, 1995a). The Thornback Ray is heavily fished in Europe; it appears frequently in French cuisine and is used in the UK for the fish-and-chips trade (Frimoldt, 1995b; Fleming and Papageorgiou, 1996). The Blonde Ray is the most valuable species of ray in Ireland for meat (Fleming and Papageorgiou, 1996).

Processing and preparation

Shark meat requires careful handling owing to the presence of high concentrations of urea in the body of the shark. Ammonia quickly begins to be produced if the carcass is not quickly chilled or frozen, producing an unpleasant odour that makes the product unacceptable to the consumer. Preventing the formation of ammonia requires immediate bleeding and icing or freezing and sharks cannot therefore be left in the water long after death. Smaller sharks, such as dogfish, are not bled but are immediately put on ice or frozen (Kreuzer and Ahmed, 1978; Anon., 1991). Fresh and frozen shark meat may be packaged in a number of forms for storage and shipment, including whole carcasses (headed and gutted), split carcasses, fillets, and blocks.

The urea content of the blood varies by shark species: the lowest urea content is reported for Piked Dogfish, the highest for hammerheads. The urea gives shark meat a somewhat bitter and acidic taste, affecting not only choice of species for human consumption but also processing techniques. In general, both carcasses and fillets for fresh consumption require washing or soaking in a brine solution. Very fresh meat from species such as the Piked Dogfish does not require soaking, but hammerhead fillets require soaking in brine for several hours (Anon., 1991).

In many areas, where facilities for immediate refrigeration or freezing or other necessary quality control measures are not available, sharks and rays are more commonly filleted and then salted and dried. Dried and salted shark meat is widely used in eastern and southern Africa, primarily to supply domestic and intra-regional demand. Frozen shark for export from the Seychelles and the processing of juvenile sharks into meat dough in Somalia have also been reported (Marshall, 1996d). In Tanzania, sharks may be cured by salting, drying, smoking, or a combination of these. Simple drying is generally preferred, owing in part to the high cost of salt in Tanzania (Barnett, 1996b). In Southeast Asia, rays are typically split, gutted, salted, and dried in the sun, or may be filleted, salted, and dried. In Thailand, rays are often smoked (Maynard, 1983). In the Solomon Islands, shark is often filleted and cut into thin strips that are salted and sun-dried or smoked. In some cases in the Solomon Islands, the meat is squeezed to get the blood out, cooked, washed, cooked again, and dried. Lime may be used to preserve the dried shark meat (Matthew, 1996).

In East Asia, processed forms of meat from chondrichthyans are common. In Taiwan, most shark meat is used in the domestic production of minced fish products, including fish balls, fish cakes, fish sausage, tempura, artificial crab or scallops, and fish "ham." Fish balls and tempura are very popular with consumers in Taiwan, but the status of production, although high, is difficult to assess. The advantage of this production method is the ability to utilize most fish regardless of size or species. The fish meat is mixed with salt, beaten, and ground, and the paste is then shaped and heated until the protein coagulates. Shark meat is particularly well suited to production in minced fish goods, because it gives a firm and elastic texture to minced fish products and because this form of processing neutralizes the strong ammonia flavour often associated with shark meat (Chen *et al.*, 1996).

In Japan, Shortfin Mako Shark and thresher sharks are marketed frozen, while Shortfin Mako Sharks, Piked Dogfish and Starspotted Smooth-hounds are used for sashimi, and Blue Sharks are used in fish paste. Shortfin Mako Sharks are also dried in some regions of Japan (Kiyono, 1996). In China, shark meat is used to produce salted shark meat, canned shark meat, and shark meatballs (Parry-Jones *et al.*, 1996).

Smaller shark species are occasionally found for sale live for human consumption. In China, live Whitespotted Bamboo Sharks and Spotless Smooth-hounds are sometimes collected from fishing vessels for sale to hotels and restaurants (Parry-Jones *et al.*, 1996). In Australia, live specimens of blind sharks have also recently begun to appear in fish markets in New South Wales (Bentley, 1996a).

The meat of smaller sharks, such as Piked Dogfish and smooth-hounds, usually having lower concentrations of both urea and heavy metals in their flesh, typically does not require soaking and the fish are finned and gutted and landed as whole carcasses, with the skin intact. The backs are marketed in Europe, for example, as *seeaal*, and Australia, and the belly flaps are smoked in Germany and made into *schillerlocken* (Frimoldt, 1995a). These species are typically marketed as fresh whole carcasses in South America, where they are sold as *cazon* (Rose, 1996a). Piked Dogfish landed in the USA and Canada are typically processed for export to Europe. The "back" or "tube" is the main body of the fish, accounting for 28-30% of the total body weight. This product is exported for sale as fillets, steaks, portions, and use in fish-and-chips. The belly "flap" or "nape" accounts for an additional seven per cent of the round weight (meaning whole or live weight), and is exported only to Germany. European markets favour larger dogfish for backs and belly flaps: fish of 2.3kg or more are sought for backs, while the German market favours belly flaps of 3.5cm or greater in length, requiring a fish of some four kilogrammes. Small fish are typically discarded or sold to scientific and laboratory suppliers for use in education or research. A smaller volume of whole, headed and gutted, and frozen dogfish is exported from the USA to Japan, and some dogfish meat is supplied to a manufacturer of *kamaboko*, a type of Japanese fish cake (Rose, 1996d). In Ireland, dogfish are processed as fresh, skinned, whole fish; frozen, skinless backs (in market/price categories of 500-800g and 800g-1.5kg); and frozen belly flaps (Fleming and Papageorgiou, 1996).

Rays and skates are typically processed as wings. In Ireland, nine commercially fished ray species are graded according to 16 different classifications, based on appearance and size. Throughout Europe, skate wings are sold fresh or frozen, with or without skin (Fleming and Papageorgiou, 1996).

Markets and trade

As the discussion below suggests, volumes reported by FAO of world production of chondrichthyans for human consumption appears to represent a small fraction of actual world production of these fish for human consumption. Although most nations report imports and exports of chondrichthyan meat, many countries do not report their domestic production. With these caveats in mind, it may be noted that world trade as reported by FAO (Table 5) suggests the increasing popularity of chondrichthyan meat in trade.

According to FAO data (Anon., 1996), reported world exports of fresh, chilled, and frozen shark meat rose from 22 203t in 1985, to 47 686t in 1994, while reported world imports increased from 33 838t in 1985, to 50 579t in 1994. Reported trade in shark fillets remains much lower in volume than that in other forms of processed shark meat. Exports peaked at 4698t in 1988. World trade in fresh, chilled, and frozen skates appears to remain significantly under-reported, with imports reported only for New Zealand and Norway, and exports only for the UK, Iceland, and Norway. An average of 1780t of unidentified sharks, rays, skates, and chimaeras were reported as exported annually during 1985-1994, with an average of 6077t of unidentified species imported annually during 1990-1994. The number of countries reported in trade also rose during this period, with

Table 5

FAO-reported world trade of chondrichthyans (t), 1985-1994

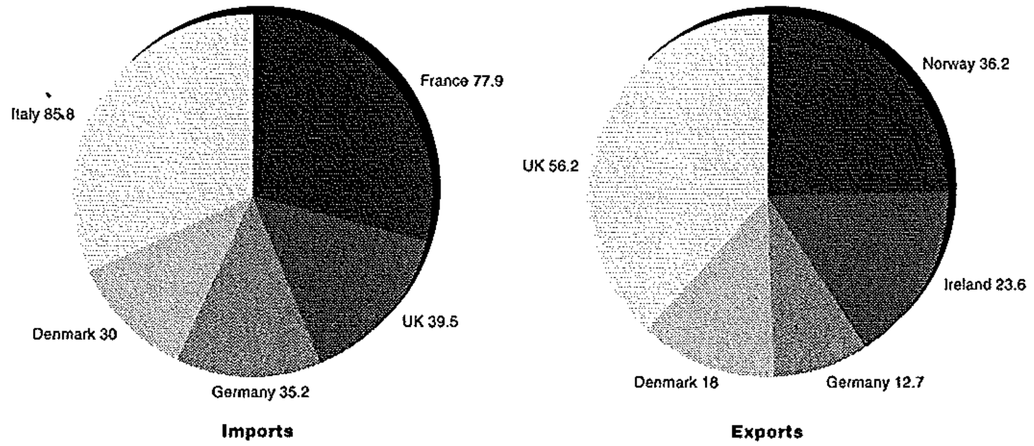
Product	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Imports										
Sharks, fresh/chilled	15 959	15 084	17 864	17 327	14 482	16 404	17 148	15 896	15 597	16 379
Sharks, frozen	17 879	16 514	19 669	20 710	21 805	26 420	28 093	27 910	28 017	34 200
Shark fillets, fresh/chilled	–	–	–	12	–	–	–	7	3	56
Shark fillets, frozen	610	487	997	2277	2744	1819	1430	1634	842	1108
Skates, fresh/chilled	–	–	–	–	–	0	0	0	0	0
Skates, frozen	–	–	–	–	–	81	239	1200	538	148
Sharks, rays, and skates, fresh/chilled	–	–	–	–	–	–	–	–	9	16
Sharks, rays, and chimaeras, frozen	–	–	–	3982	–	6300	6176	4708	8725	4450
Exports										
Sharks, fresh/chilled	16 314	16 411	19 723	18 365	13 795	18 033	18 411	16 494	21 626	20 342
Sharks, frozen	5889	6534	7906	10 261	10 065	14 191	20 891	21 745	26 146	27 344
Shark fillets, fresh/chilled	0	0	42	128	20	8	88	93	101	105
Shark fillets, frozen	2115	3249	3453	4570	4406	4177	3728	3637	3414	3246
Skates, fresh/chilled	169	165	222	78	33	39	40	153	295	440
Skates, frozen	704	593	337	215	338	338	490	382	344	326
Sharks, rays and skates,	19	125	12	0	10	252	1563	2829	1357	1167
Fresh/chilled sharks, rays, and chimaeras, frozen	704	597	452	1529	1503	1477	1856	864	1354	125

Source: Anon. (1996).

exports reported from 18 countries in 1985 and 37 in 1994, and imports reported from 12 countries in 1985 and 36 in 1994. The most prominent trading nations during this period are all located in Europe (Figure 1) and are Italy, France, UK, Germany, and Denmark, while the main exporters are UK, Norway, Ireland, Denmark, and Germany. Their importance as reflected in FAO data is likely to be owing in part to both their historic role in shark trade (specifically dogfish trade), and also to their more complete reporting of trade. For example, the USA is also among the world's most important traders of shark meat, but does not appear in the above list because trade in shark meat was not reported under a separate Customs classification until 1989.

Figure 1

FAO-reported trade in shark meat (fresh, chilled, frozen) by main importing and exporting countries (t), 1985-1994



Source: Anon, 1996.

East Asia

Japan is a major trader in fresh and frozen shark meat. Imports averaged 1856t annually during the period 1980-1994, while exports averaged 1196t for frozen shark and 2703t for frozen shark fillets. Japanese imports are supplied by Taiwan, South Korea, Canada, the USA, and, since 1992, China. Frozen shark from Japan is destined primarily for the EU (Italy, Belgium, Germany, Netherlands), Brazil and Peru, while frozen fillets are destined for the EU and the USA (Kiyono, 1996).

Taiwan is a significant producer of shark meat for domestic consumption, and exports annually some 1000 to 2000t of frozen shark meat. Some 60% of exports in 1993 and 1994 were to the USA, while other significant importers included Japan, Germany, Singapore, South Korea, and South Africa. Shortfin Mako Shark, in particular, is typically offloaded by distant-water vessels in foreign ports, although such overseas sale represents a relatively small proportion (1.4 per cent to 4.11 per cent) of Taiwan's total shark landings. Reported imports of shark meat were zero during 1989-1992, but totalled 13t in 1993, 94t in 1994, and 372t in 1995. Major sources of shark meat during these years were Hong Kong, Singapore, India, the Philippines, and Greenland (Chen *et al.*, 1996).

Shark meat is widely consumed in **South Korea**, and is used in ancestral worship ceremonies. South Korea imports frozen dogfish and other shark, 80% of which comes from New Zealand, and the remainder mainly from Singapore, Indonesia, Malaysia, Hong Kong, Panama, Chile, and India. Imports averaged 454t annually from 1988 to 1994. Exports of frozen dogfish and other shark meat averaged only 155t annually during the period 1988-1994, and are primarily to Japan, but small volumes are traded with Spain, the USA, Cote d'Ivoire, United Arab Emirates (UAE), New Zealand, and Andorra (Parry-Jones, 1996b).

In **China**, the earliest written reference to the consumption of shark alludes to the Northern Song Dynasty (960-1127 AD). It is reported that nowadays, in some cases, fishers prefer to sell shark meat from domestic fisheries to traders from Taiwan, Hong Kong, Japan, and South Korea, who offer higher prices than domestic processors (Parry-Jones *et al.*, 1996). Although limited international trade data are available, imports of frozen dogfish and other sharks appear to be increasing, for example, from 172t in 1992, to 536t in 1993, and 547t in 1994. Spain is the most important reported supplier to China, and other trading partners include Hong Kong, Singapore, Japan, USA, Australia, Vietnam, Russia, and Canada. Exports totalled two tonnes in 1992, 22.2t in 1993, and 24.7t in 1994, and were reported only to Taiwan and Japan (Parry-Jones *et al.*, 1996).

Southeast Asia

In **Indonesia**, shark meat is not widely favoured for human consumption, and market prices range from the equivalent of US$0.20 per kg for salted shark meat, to US$1.30 per kg for whole small Blacktip Reef Sharks. Rays are preferred to sharks: large whiprays sell for some US$1.30 to US$3.30 per kg. Exports of frozen shark meat were not reported before 1990, but increased from 240t in that year to 8293t in 1993. Exports of fresh shark meat were first reported in 1993, in which year 971t were exported (Bentley, 1996b).

Malaysia reports small and sporadic imports of frozen shark, with average imports of 21t annually during the period 1989-1993, from Australia, New Zealand, Norway, the USA, and Taiwan. A low volume of annual exports, averaging 30t a year from 1991 to 1993, is reported to the UK, Taiwan, and Singapore (Chen, 1996).

In the **Philippines**, Whale Shark fished off the southern islands of Pamilacan, Bohol, and Camiguin sells for roughly the equivalent of US$0.42 per kg for steaks, while the carcass may fetch US$437 to US$875, depending on size. Unit prices for Manta Rays *Manta birostris* in the same region are considerably higher, with meat sold at some US$10.50 per kg, or up to US$280.00 for the entire carcass. Customs data for trade of meat are not available for the Philippines. Processors reportedly use shark meat in the preparation of fish balls and tempura, the former of which are exported to the USA at some US$3.00 per kg, but no other information is available on the destination of these products (Chen, 1996).

Oceania

Shark meat has historically been the primary motivation for directed and incidental fisheries in **Australia**, being sold typically as fillets or in fish-and-chips. In recent years, a trend towards diversification of products has been evident. For example, in the Northern prawn fishery, small sharks caught as bycatch may be trunked, filleted, or skinned, and a recently established processing plant in Port Adelaide produces shark jerky from Tiger Sharks, mako sharks, sawsharks, and Blue Sharks for export to North and South Korea. Reported imports remain relatively small, averaging 21.7t of fresh, chilled, or frozen shark annually during the period 1988-1994. According to Australian Customs data, nearly half of imports are from New Zealand. New Zealand export data, however, report significantly more exports of shark meat to Australia than Australia itself reports importing from New Zealand, namely 721t in 1993 and 1138t in 1994. Reported exports from Australia include small, sporadic shipments to Singapore, Malaysia, Hong Kong, Taiwan, Japan, and the UK (Bentley, 1996a).

New Zealand exports shark meat to some 30 countries, with primary export markets in South Korea, Australia, and Japan, and smaller markets in France, the UK, and the USA. Reported exports to Australia consist mainly of frozen fillets of Tope Shark, Spotted Estuary Smooth-hound, and chimaeras, although exports of chilled shark meat of unspecified species have increased in recent years. South Korea is the major market for New Zealand's Piked Dogfish, while Japan imports mostly chimaeras. Skates represent the majority of chondrichthyan product exported to France for meat, and in recent years New Zealand skate has also found markets in Japan, Italy, South Korea, and the USA. Sporadic imports of fresh and frozen shark have been reported from Australia, Japan, Malaysia, China, and Taiwan during the period 1988-1995 (Hayes, 1996a).

South Asia

In **India**, shark meat is typically consumed dried and salted; the meat of large sharks is cut into strips with the skin attached, then salted and partially dried. Among the Edavar people of Kerala and among Muslims, particularly of the Calicut region, shark meat is traditionally consumed at weddings (Hanfee, 1996). In the Maldives, shark meat is typically dried and salted for human consumption, and during 1982-1991, an estimated 304t of dried shark meat were exported annually to Sri Lanka (Anderson and Ahmed, 1993).

East and southern Africa

The long shelf life and ease of transporting dried, salted shark meat has contributed to its importance in domestic and regional trade in Africa. This is in large part owing to inadequate storage facilities and transport infrastructure in most of the countries of the region, which result in a short shelf life for fresh marine products. Shark meat's high resistance to spoilage during curing has enabled its efficient utilization by artisanal fisheries in the region. In **Somalia**, **Madagascar**, the **Seychelles**, and **South Africa**, the majority of dried, salted shark meat is exported, within the region, owing to limited domestic demand. **Kenya** and **Tanzania** maintain a high domestic demand for shark meat, which, in Kenya, is partially met by imports from Zanzibar (in **Tanzania**), **Yemen**, and **Somalia**. Dried, salted shark meat produced in **Eritrea** is almost exclusively for export to **Saudi Arabia** and Yemen. No information is available on the use and trade of shark meat in **Mozambique**, although Japanese Customs report imports of frozen meat averaging 52t annually betweem 1989 and 1994 from Mozambique (Barnett, 1996a).

In the **Seychelles**, shark meat from artisanal fisheries is generally dried and salted for local consumption. In addition, a small percentage of shark meat production from these fisheries, as well as from landings by foreign longliners, is frozen for export. Data on exports of shark meat from the Seychelles begin to be reported in 1988 and from that year to 1994, exports averaged only 3.1t annually, ranging from 0.7t in 1993, to 9.7t in 1994 (Marshall, 1996d). In **Somalia**, meat is also primarily salted and dried for local consumption. In addition, small juvenile sharks are used in the small-scale local processing of meat dough. The dried, salted meat of both sharks and rays is exported to Kenya and Yemen from Somalia (Marshall, 1996b). Domestic prices for shark in **Tanzania** are relatively high, reflecting considerable internal demand. Shark meat is preferred fresh for local direct consumption and sale, but excess production is salted and dried. Shark meat produced in Zanzibar may be marketed equally in mainland Tanzania or in Kenya (Barnett, 1996b). **Kenya's** internal markets absorb all locally produced shark, as well as imports from Somalia, Yemen, and Djibouti. The volume of imports is not reported separately in Kenyan trade statistics, but is estimated to be between 225 and 495t, annually, from Somalia (Marshall, 1996b; Marshall, 1996c).

In **South Africa**, the export of shark meat to other African countries gained importance in the 1950s, and trunks were exported to the Mediterranean and Australia until 1968, when concerns about mercury levels in shark flesh ended this trade. Limited domestic demand currently exists for shark, skates, and elephantfish, which are marketed fresh, frozen, dried and smoked, or as dried biltong. Exports of frozen shark to Greece, Italy, Australia, Germany, Hong Kong, and Belgium averaged 172t annually between 1990 and 1993 and are derived primarily from line fisheries in KwaZulu-Natal. Skates were also previously exported to France, but exports ceased in response to stringent EEC import requirements for fisheries products. Although the Natal Sharks Board markets some shark products to raise funding for the beach meshing program, the meat is typically unsaleable, owing to high heavy metal content or poor condition (Smale, 1996).

Most of the shark meat produced in **Madagascar** is consumed domestically, although limited exports to the Comoros and Japan are reported. Provincial authorities report production of shark meat averaging some 236t annually between 1990 and 1995, with reported internal and external trade together averaging 46t annually during this period. National export statistics for 1990-1994 report no exports of shark meat from 1990-1992, and exports of 81t in 1993 and 31t in 1994. However, Japanese import statistics report imports of shark meat from Madagascar during all years in the period 1990-1994, averaging 17t annually during this period and including 46t imported during 1990-1992 (Cooke, 1996).

Europe

The EU is a significant consumer and trader of chondrichthyan meat, and Piked Dogfish, Small-spotted Catsharks, smooth-hounds, Porbeagles, Shortfin Mako Sharks, and skates and rays feature prominently in the diets of many Europeans. The region's role in world trade has increased in recent years. Declining landings of Piked Dogfish and other species are accompanied by rising imports for regional consumption. Furthermore, the development of pelagic fisheries for tuna and swordfish has resulted in rising bycatch and landings of pelagic sharks and their greater prominence in intra- and extra-regional trade (Fleming and Papageorgiou, 1996).

C. Allan

Shark on display at a fish restaurant in Brussels.

International trade by the EU in shark meat has grown steadily over the last decade. Customs commodity codes group such trade records by two categories, namely "dogfish" (*Squalus* and *Scyliorhinus* spp.) and "other sharks". Total EU imports of dogfish and other shark meat rose from 27 100t, in 1983, to an average of 37 266t, annually, for the period 1990-1994, with a peak of 42 134t in 1994. Dogfish represents some 55% of total shark meat imports, other species 45%. Exports during 1990-1994 averaged 12 756t, annually.

Patterns of trade within and outside the EU suggest that much of the shark meat exported from non-EU countries may be imported into one EU country for processing, then shipped throughout the EU for retail and consumption. Total reported imports for all EU countries are therefore likely to include repeat transactions, but 65% of dogfish imports and 69% of all other shark meat imports to the EU are estimated to be net imports to the EU. Imports of dogfish from non-EU countries averaged 13 195t during 1988-1994, while imports from other EU countries averaged 7251t annually. Exports, on the other hand, are primarily to other EU countries; these averaged 7043t annually, 1988-1994, compared to exports to non-EU countries of 182t annually, on average. A similar pattern is evident for trade in sharks other than dogfish, with non-EU imports rising from 8946t in 1988 to 14 512t in 1994. Imports from other EU countries rose from 2854t to 9198t during this period. Exports to other EU countries rose from 3186t in 1988, to 7678t in 1994, while exports to non-EU countries remained low, but increased from 244t in 1988 to 866t in 1994 (Fleming and Papageorgiou, 1996).

During 1988-1994, Norway was the largest of nine non-EU suppliers to the EU of fresh or chilled Piked Dogfish, followed by the USA. Imports of frozen dogfish were supplied by 25 countries worldwide, dominated by the USA and Argentina. As European dogfish landings decline, demand is increasingly met by imports of frozen dogfish from the USA, which are generally larger and less expensive than dogfish produced in Europe.

European dogfish are generally marketed fresh within the region in order to take advantage of the higher value of fresh product (Fleming and Papageorgiou, 1996).

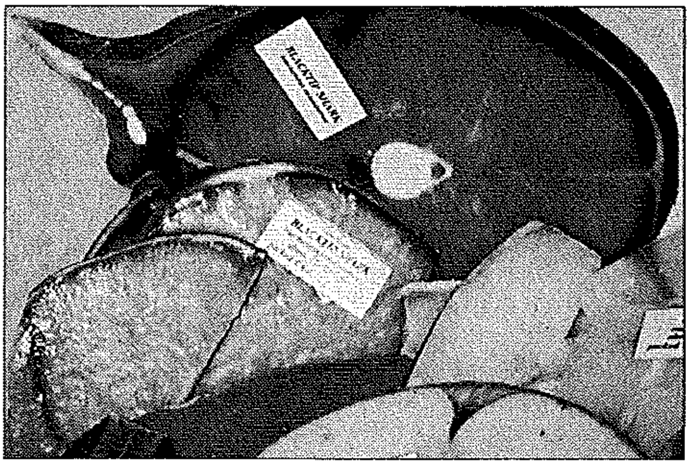
Frozen sharks were supplied to the EU by 52 countries during the years 1990-1994, with prominent suppliers including Japan, Argentina, and South Africa. France is the largest importer of dogfish meat within the EU, while Italy is the most important importer of other shark meat, and the largest importer of shark meat overall. Within the EU, the UK is the largest supplier of dogfish meat, while Germany is the most important exporter of other shark meat and the largest shark meat exporter overall (Fleming and Papageorgiou, 1996).

Norway exports most of its domestic Piked Dogfish landings to other European countries. Norway was a primary supplier of dogfish to Italy until the late 1960s, and to the UK until the early 1970s, but exchange rate fluctuations, declining Norwegian landings, and Italian policy on mercury contamination reduced the role of Norwegian fisheries in these countries' trade. During 1981-1995, Norway exported an average of 3000t of dogfish meat annually, primarily to Denmark, Italy, France, Germany, the UK, and other EU countries (Fleming and Papageorgiou, 1996).

Although not an important European producer of shark meat, **Germany** imported an average of more than 3500t annually during 1990-1994. Dogfish consituted just under 30% of imports, and was supplied primarily by Denmark and Norway. Other sharks types contributed over 70% of imports to Germany, Japan being by far the largest supplier of frozen shark during this period. Commercially important species include Nursehound, Smooth-hound, Shortfin Mako Shark, Blue Shark, Angelshark, Undulate Ray *Raja undulata*, and Cuckoo Ray, although skates and rays are not widely consumed in Germany. Most of the dogfish imported into Germany is consumed within the country, while other sharks are often re-exported to other EU countries, primarily Italy (Fleming and Papageorgiou, 1996).

The **Netherlands** is similarly a more important trader than producer within the EU. Imports of dogfish and other sharks increased from only 58t in 1990 to almost 7500t in 1994, 93% of which consisted of "other shark". Exports, negligible during 1990-1992, followed a similar trend during this period, increasing to nearly 1000t in 1993 and more than 3000t in 1994. The most heavily traded commodity is frozen shark, while frozen shark fillets were imported mainly from Germany and partly re-exported to other countries in Europe, and Piked Dogfish is imported from the USA, Denmark, and the UK. Species reported by traders and processors as appearing in imports include Longfin Mako Shark from Japan, Taiwan, and South America; Blacktip Shark and Shortfin Mako Shark from Oman; Piked Dogfish from the USA; Porbeagle; thresher shark; and Blacktip Reef Shark (Fleming and Papageorgiou, 1996).

E. Fleming



Blacktip Shark *Carcharhinus limbatus* steaks from Oman, displayed by a Dutch processor.

In the **UK**, Piked Dogfish is extensively used in the domestic market, particularly the fish-and-chips trade in southern England. Approximately 30% of fish-and-chip shops in the southern UK and six per cent in the northern UK use Piked Dogfish. In addition, sales of Piked Dogfish for consumption in the home are steadily rising.

Traditional supplies from UK domestic fisheries and from Norway have declined, with an increasing proportion of supply now imported from the USA and Canada. During 1990-1994, the UK imported an average of 2712t per year of dogfish and other sharks. Some 75% of imports were dogfish, of which the USA and Canada were the primary suppliers. Imports included fresh dogfish from Ireland, Denmark, USA, Canada, Norway, and Iceland; frozen dogfish from the USA, Canada, and Norway; and frozen dogfish fillets from Ireland and the USA (Fleming and Papageorgiou, 1996).

Processors of Piked Dogfish in the UK supply not only the domestic market, but now also export a significant proportion of domestic production to continental Europe. Exports consist primarily of dogfish backs to France, where dogfish landings have fallen sharply in recent years, and UK prices have been highly influenced by trends in French landings. In recent years, Germany has become a major importer of UK-processed dogfish. Smaller volumes of dogfish backs are exported to Belgium, Italy, and other countries, while dogfish belly flaps are exported exclusively to Germany.

In addition to that of Piked Dogfish, Porbeagle meat is highly appreciated in Scotland and England. Blue Sharks are landed in the UK for human consumption, but are not considered high-quality fish, and Blue Shark is typically exported to France. The Small-spotted Catshark is also occasionally used in the fish-and-chips trade. Skates and rays are processed whole, or just for their wings, with the skin either intact or removed, and are used domestically for human consumption, including the fish-and-chips trade. A significant proportion of landings of skates and rays is exported to France. Basking Shark was periodically available in limited quantities until the end of the 1994 fishing season, from a single-vessel fishery initiated in 1983 for liver oil. Imports of sharks other than dogfish averaged 680t during 1990-1994, while exports dropped from nearly 2500t in 1991 to just 230t in 1994 (Fleming and Papageorgiou, 1996).

Consumption of Piked Dogfish was minimal in **Ireland** until the late 1980s, when the country began to process dogfish on a significant scale. Previously, virtually all dogfish landed in Ireland had been exported to the UK and continental Europe, most of it unprocessed. Exports of dogfish increased from an average of 94t annually during 1990-1992 to roughly 280t in 1993 and 1994, some 7 per cent of total Spiny dogfish landings. Irish imports of dogfish and other sharks are minor, totaling only 50t from 1990 to 1994. Much of the dogfish and skate landed in Ireland is exported to the UK for sale mainly in fish-and-chip shops. Bycatch of sharks other than dogfish is typically landed for sale; Porbeagle and Shortfin Mako Shark are highly appreciated in Ireland, while Blue Sharks caught by driftnet and trawl nets are sold primarily for human consumption in Spain (Fleming and Papageorgiou, 1996).

France is one of Europe's most important consumers of shark and skate meat, supplied from both domestic landings and imports. Important species in domestic landings include the Piked Dogfish, Small-spotted Catshark, Nursehound, Starry Smooth-hound, Tope, Porbeagle, Angelshark, Common or Blue Skate, Thornback Ray, Cuckoo Ray, Undulate Ray, Longnose Skate, Shagreen Ray, Sandy Ray *Raja circularis*, Spotted Ray, Blonde Ray, and Painted Ray (species unidentified). France is the EU's largest importer of dogfish, and the second-largest importer of dogfish and other sharks combined. From 1990 to 1994, France imported an average of 5000t of dogfish annually, some 98% of which was reported as Piked Dogfish, marketed primarily as backs and whole, skinless fish. Within Europe, the UK is the largest supplier of dogfish to France, and France imported some 70% of the UK's dogfish exports in 1994. Other suppliers are the USA, Norway, Denmark, Ireland, and the Netherlands. Imports of sharks other than dogfish averaged 600t annually during the period 1990-1994. Consumption and trade of rays and skates are also important, with Thornback Ray the preferred species, but trade data are not available (Fleming and Papageorgiou, 1996).

Spain serves as an important consumer and supplier of shark meat within Europe. The meat of the Shortfin

Mako Shark is the most preferred, occasionally selling at prices comparable to that of small swordfish, and frozen Shortfin Mako Shark is usually marketed as swordfish. Market surveys in southern Spain found that the most common species marketed for human consumption, in descending order of value, are the Shortfin Mako Shark, Tope Shark, Thresher Shark, Smooth Hammerhead, Blue, Bigeye Thresher, Small-spotted Catshark, gulper sharks, Kitefin Shark, and Knifetooth Dogfish. Each of these species may be marketed as Shortfin Mako Shark or Tope Shark, or as *biennesable* (meaning "good taste"). Tope and Blue Shark, and occasionally other species, may be described as "pickled fish". Additional species may be landed opportunistically and marketed; for example, a few Basking Sharks caught incidentally in gillnets are marketed each year for less than US$1.00 per kg (Guzmán and Quintanilla, 1996).

According to *Eurostat* data for 1990-1994, the country's average annual importation of dogfish and shark meat approached 24 000t, almost 90% of which was shark other than dogfish. Spain is the second-largest importer of shark in the EU, after Italy, and the second-most important exporter after Germany. Frozen meat of dogfish and other shark was the most heavily traded form of shark meat. Imports of Piked Dogfish to Spain are supplied primarily by Portugal during 1990-1994. Imports from non-EU countries in Africa, Central and South America, and Asia were also prominent. Beginning in 1993, exports of shark increased markedly as Spain began to trade large quantities of frozen shark to Italy. Exports increased from just over 500t in 1992 to more than 2500t in 1993 and nearly 3000t in 1994 (Fleming and Papageorgiou, 1996).

Italy is the largest importer of dogfish and other sharks in the EU. According to *Eurostat* data, from 1990 to 1994, the country imported an average of over 12 000t of such fish annually, composed of 33% dogfish and 67% other sharks, while exports averaged 596t annually. Most of Italy's trade involved frozen shark products. Germany, which re-exports frozen shark acquired outside the EU, and France were the main EU suppliers, while Japan, Argentina, South Africa, and Mauritania were the primary non-EU suppliers. Since 1993, shark from Japan and South Africa have been imported *via* the Netherlands. Exports are primarily to Greece, France, Germany, and Spain (Fleming and Papageorgiou, 1996).

Analysis of national trade data from the General Direction of Veterinary Services and the National Institute of Foreign Trade by Laurenti and Rocco (1996) found that from 1985 to 1991, imports consisted of Piked Dogfish (38%), Porbeagle (29%), unspecified shark (25%), smooth-hound (6%), and Small-spotted Catshark (2%). According to data of the National Institute of Foreign Trade, Italy imported shark from a total of 66 countries during 1986-1992, although Japan and Argentina together supplied more than half of Italy's imports during this period.

International trade of skates and rays appears to be insignificant, although domestic landings are widely marketed as an inexpensive fish for human consumption.

The Americas

The USA is another major world consumer and trader of shark meat. Reported production of shark steaks and fillets alone rose from 3514t in 1984 to 5679t in 1993. Imports of shark averaged some 2600t annually in most years during 1989-1995, the years for which trade data are available. Some 60% of USA imports consist of dogfish, primarily from Canada, which are processed for re-export. The remaining 40% appear to consist almost entirely of pelagic species, primarily mako and thresher sharks and Porbeagles, which are imported from Chile, Ecuador, Mexico, Panama, Peru, Surinam, Uruguay, Canada, Portugal, Japan, Philippines, and Taiwan. Importers, exporters, and processors widely report that these high-quality meat species are the only ones other than dogfish which are of sufficiently high value to appear in trade, and are supplied primarily to restaurants and other dealers in high-quality fisheries products. By contrast, domestic landings of Sandbar and Blacktip

Sharks, and other coastal sharks are used primarily for domestic consumption, and are sold to supermarkets and to processors of frozen packaged products (e.g., frozen shark fillets, frozen shark medallions) (Rose, 1996d).

In **Canada**, Porbeagle and Blue Sharks are typically exported to Europe, while mako shark is consumed domestically or exported as steaks to the USA. Piked Dogfish is also consumed domestically in small quantities, but primarily exported to Europe. Dogfish and other sharks landed in Canada are also frequently exported to the USA for processing. Total Canadian exports of fresh and frozen dogfish and other sharks averaged 2259t annually during the period 1988-1995; this volume is likely to consist in large part of fresh dogfish shipped to the USA for processing, and the USA in 1995 reported imports of 1253t of fresh dogfish from Canada. Imports of dogfish are also rising and reached a total of 760t in 1995, again primarily from the USA (Rose, 1996b).

Sharks and rays are widely consumed in **Mexico**. Small sharks, including juveniles, are traditionally marketed fresh as *cazon* in both coastal and rural areas. Shortfin Mako Sharks and thresher sharks are typically headed and gutted and marketed fresh or frozen, either to urban areas, or for export, while other species are smoked or filleted, salted, and dried for local markets. Rays are marketed fresh as wings or strips, smoked, or dried and salted. According to data supplied by the Ministry of Fisheries, annual production of shark during 1990-1992 averaged 17 477t of fresh and chilled shark, 3891t of frozen shark, and 396t of dried, salted shark (Rose, 1996c). According to the FAO (1996), Mexico first began to report imports of fresh or chilled shark in 1990, and reported imports rose from 219t in that year to 863t in 1994. Smaller quantities of frozen shark began to be reported in imports in the same year, rising from 30t in 1990, to 246t in 1994.

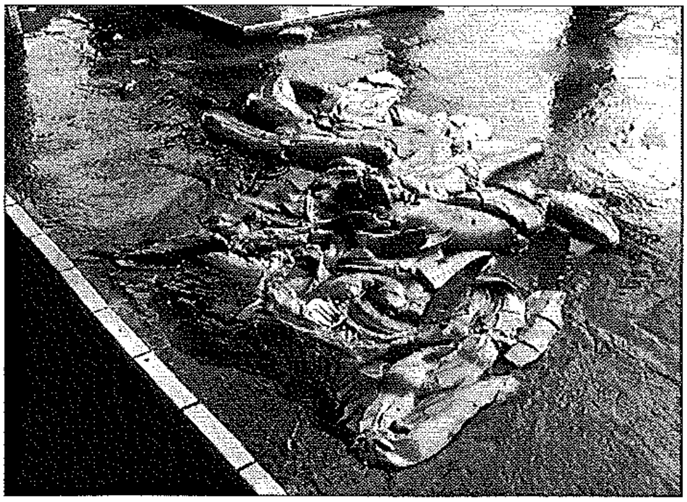
Mexico's reported exports of fresh or chilled shark rose from 143t in 1990, to 853t in 1994; no exports of frozen shark or of shark fillets are reported. However, the Bank of Mexico reported exports of fresh shark totaling 589t in 1992, 739t in 1993, and 853t in 1994, with exports of 12t of frozen shark reported in 1994. All shark exports are reported to be to the USA, with the exception of 0.3t of fresh shark reportedly exported to Japan in 1993 (Rose, 1996c).

In **Uruguay**, Tope Shark is salted and marketed for domestic markets, with demand peaking during religious holidays, while sharks landed by the tuna fleet are typically processed as headed and gutted carcasses and fillets, primarily for export. The National Fisheries Institute reports exports totaling 692t in 1994, consisting primarily of fresh and frozen shark as whole, gutted, or headed and gutted carcasses and fillets, to Brazil and Spain. Uruguayan Customs, however, register rising exports of 36t in 1993, 358t in 1994, and 497t in 1995, with countries of destination including Brazil, Germany, USA, Spain, Netherlands, and Israel (Villalba-Macías, 1996).

In **Argentina**, smooth-hound has become one of the most popular food fishes in domestic markets, accounting for as much as 20% of all fish types consumed in 1994. Export data for smooth-hounds are available only for 1992; in that year, a total of 285t were exported, primarily to Japan and South Korea. In recent years, smooth-hound is reportedly exported to Australia. Other chondrichthyan products are intended primarily for export, although exports of headed and gutted shark have declined from 3225t in 1990, to 1031t in 1994. Tope Shark is exported primarily to Italy, Greece, Spain, Australia, and Brazil, with total exports of this species averaging 474.5t annually during 1990-1994. An average of 41t of angelshark was exported during this period. Export data for rays and skates are not available, but traders reported exports to France, South Korea, and Spain (Chiaramonte, 1996).

Internal organs and other edible products

A number of shark products other than meat are used for human consumption. In 1141 AD, a Song emperor visiting high-ranking officials in southern China was served shark skin as part of an elaborate meal. In Taiwan and Japan today, shark skin is consumed as a food product. In Taiwan, both the skin from the body and the skin from the caudal fin are eaten. The skin of Dusky Sharks and Whale Sharks is served in restaurants, as is the skin of the upper lobe of the caudal fin from thresher sharks. The highest quality caudal skin is from the Giant Guitarfish. In processing of shark skin for human consumption, the skin is dried, the dermal denticles removed, the skin bleached and then dried again (Chen *et al.*, 1996). In Japan, skins that are flawed and therefore unsuitable for tanning are used to produce the gelatinous food *nikigori* (Kiyono, 1996).



A.L. Gaski / TRAFFIC

Shark livers in Taiwan.

A number of internal organs are also consumed directly. In Japan, the heart of Salmon Shark is eaten as sashimi (Kiyono, 1996). In Taiwan, shark stomachs and intestines are also cleaned and prepared for human consumption (Chen *et al.*, 1996), and the stomach bag is increasingly retained in Australian fisheries (Bentley, 1996a). Dried shark stomachs are also reportedly processed in Uruguay for pharmaceutical use, with a market price of US$1.00 each in 1995 (Villalba-Macías, 1996).

In the directed artisanal fisheries of the Solomon Islands, the intestines may be the only part of the shark not used; the remainder of the carcass, including the liver, is eaten. The skin is highly appreciated, and is processed by leaving meat on the skin, salting, and drying in the sun or smoking. At this stage the skin may be preserved for long periods of time. For preparation, the skin is boiled and the denticles scraped off, then cooked in a pot with coconut milk. Shark stomach is prepared in the same manner as the skin, the gills are boiled and eaten, and the liver is cut, salted, and eaten (Matthew, 1996). In the Maldives, the eggs of gulper sharks are eaten, and shark skins occasionally retained and sun-dried in strips; the skins are destined for export and are further processed overseas for human consumption (Anderson and Ahmed, 1993).

Shark and other chondrichthyan products have long been used in traditional Chinese medicine, with many edible products considered to be beneficial to health. The first reference to the use of sharks in Chinese medicine dates from the Tang Dynasty (618-907 AD), when the skin and bile were applied in compound recipes. The *Ben Cao Gang Mu* (*Compendium of Materia Medica*, 1590 AD) also notes the use of shark meat for general nourishment and skin for curing toxicity resulting from eating fish. Other parts used for medicinal purposes include the foetus, ovaries, brain, bile, skin, meat, liver oil, and the sting of Whip Stingray *Dasyatis akajei*, which is used for the treatment of cancer. Claims for the properties of shark products include delaying ageing, nourishing the intestines, strengthening the wrist, clearing phlegm, and promoting appetite. In Hong Kong, shark fin is also believed by some people to be helpful to diabetics, and shark cartilage is considered a health tonic and is used as an ingredient in soups (Parry-Jones, 1996a).

No data are available on production, consumption, or trade of these edible products, nor does anecdotal evidence point to international trade in these products. It is likely that such by-products are typically consumed domestically, although some sharks may enter the general trade in dried fish stomachs.

Fins

Unlike bony fishes, sharks achieve buoyancy through their lighter cartilage and large, oil-filled livers (Last and Stevens, 1994). Shark fins consist in large part of ceratotrichia, soft collagen and elastin fibres commonly referred to as fin rays or fin needles, which have been used for human consumption for centuries. Shark fins are among the world's most expensive fishery products; the value of shark fins varies according to colour, size, thickness, and fin needle content, but nearly all species have commercially valuable fins (Kreuzer and Ahmed, 1978; Subasinghe, 1992). Essentially tasteless, but appropriately gelatinous, processed shark fin needles resemble rice noodles in wet, dried, or cooked forms. Shark fin soup is typically prepared by adding other ingredients for taste, for example chicken or abalone. Shark fin substitutes, usually made from seaweed extract or a combination of similar products, are also occasionally found on the market, and are sold as "vegetarian sharkfin" or falsely marketed as true shark fin (Parry-Jones, 1996a).

The consumption of shark and shark fin has a long and venerable history in Chinese cuisine and culture (Phipps, 1996). Shark became an established part of formal banquets during the Ming Dynasty (1368-1644), when it was served to candidates taking the imperial government examinations in Beijing. Ironically, when a group of imperial officials on a mission to Southeast Asia on behalf of the Ming emperor found themselves in unfamiliar territories with nothing to eat, they were able to feed themselves by cooking shark fin discarded by the local population. By the Qing Dynasty (1644-1911), shark fin, specifically had become a traditional part of formal banquets. The Chinese listed shark fin as one of the "middle eight" culinary treasures and placed it second among the "eight culinary treasures" from the sea. Shark fin also became part of the Manchu-Han banquets, a culinary tradition that spread beyond the palace into the society at large, although limited to the wealthy who could afford it. With the end of the Qing Dynasty, the Manchu-Han banquet was no longer politically correct, but shark fin had by this time become a famous banquet dish and well established in both Cantonese cuisine and in Hong Kong (Phipps, 1996).

According to Cook (1990), consumption of luxury shark fin was discouraged in China by the government after the Second World War, but in the mid-1980s, relaxation of state market controls, increased disposable income, and growing official acceptance of shark fin consumption led to a dramatic increase in domestic demand for shark fin and to a corresponding impact on world fin prices and trade. Beginning in 1987, as a result of the development of domestic shark fisheries and shark fin processing facilities, China began to play an important role in world shark fin trade, both as a consumer and a processing centre. However, the results of TRAFFIC research suggest that much of the reported world trade in shark fins currently involves imports, exports, and re-exports between China and two other important processing and trade centres, Hong Kong and Singapore (Parry-Jones, 1996a).


Rob Parry-Jones / TRAFFIC

Shark fins in Hong Kong.

Hong Kong is currently acknowledged as the capital of shark fin cuisine worldwide, having access to the highest quality and most diverse cooking methods in the world. The popularity of shark fin in Hong Kong began to rise after the Second World War, when shark fin was a popular and affordable dish selling at some HK$0.50 per bowl. In the early 1970s, when the Hong Kong stock market experienced explosive growth, shark fin rice soup became a popular dish. By the 1980s and 1990s, a large number of exclusive and specialty restaurants serving shark fin had emerged. Demand is highest during October-February, popular months for weddings and other feasts, peaking in February with the Chinese New Year (Parry-Jones, 1996a).

Increasing Asian demand for shark fin, including the opening of China as a seemingly unlimited market for shark fin, has been accompanied by a significant increase in world shark fin prices during the late 1980s and 1990s. As a result, opportunities for cash earnings in subsistence and commercial fisheries have increased in some areas, contributing in some cases to increased catches or to increased landings of shark bycatch that was previously discarded, for example by tuna and swordfish longliners faced with declining catch and increased regulation of target species (Rose, 1996d). In some countries, national agencies or international organizations such as the FAO have offered assistance in developing markets for shark fins; the FAO, for example, has published a number of technical manuals detailing methods for the processing and marketing of shark fins (Trachet *et al.*, 1990; Subasinghe, 1992).

Preferred species

Both published reports and the results of interviews and field research by TRAFFIC investigators reveal widely different rankings by species, presumably owing, at least in part, to regional differences in species availability. For example, Kreuzer and Ahmed (1978) report that fins from hammerheads, mako sharks and Blue Sharks are the most highly valued, while only the fins from Nurse Sharks, the pectoral fins of sawsharks, and the upper caudal (tail) lobe of all species are not commercially valuable. However, these authors also note that white fins (e.g., those of hammerheads and Sandbar Sharks) are generally more valuable than black fins (e.g., those of mako sharks and Blue Sharks); research by Nair and Madhavan (1974) determined that fins from black varieties contain approximately half of the fin ray content of white fins, accounting for the difference in their value.

Subasinghe (1992) notes that hammerheads, mako sharks, and Blue Sharks are the most important species in world shark fin trade, while the fins of thresher and requiem sharks, Great White Sharks, guitarfish, Spadenose Sharks, and Tiger Sharks are also commercially valuable. Lai (1983) reports that species preferred by Hong Kong traders are hammerheads, mako sharks, and Blue Sharks, primarily, but also Great White Sharks, thresher and requiem sharks, and Tiger Sharks. The Tope Shark is also a species favoured for its fins, and in North America is thus commonly known as the Soupfin Shark (Frimoldt, 1995b).

In India, Nair and Madhavan (1974) report that the fins of Giant Guitarfish fetch the highest price; other species from which the fins are exported include the Spadenose Shark, Blacktip Reef Shark, and Scalloped Hammerhead. Trachet *et al.* (1990) report that in the South Pacific, only the fins of catsharks Scyliorinidae lack commercial value. Matthew (1996) similarly reports that some species, including sleeping sharks (presumably Tawny Nurse Sharks) and wobbegongs, are not used for their fins in the Solomon Islands.

The results of TRAFFIC field studies suggest a rather different ranking by species. Interviews with Hong Kong shark fin traders indicate that hammerheads, Tiger, Oceanic Whitetip, Blacktip, Dusky, and Blue Sharks are among the species preferred for their fins (Parry-Jones, 1996a). Although the fins of Blue Sharks are not of high quality owing to their low fin needle content, they are abundant and relatively inexpensive, and therefore important in the trade; estimates by fin traders suggest that they may contribute some 50-70% of shark fins traded in Hong Kong (Parry-Jones, 1996a; Rose, 1996d). Mako shark pectoral fins, the fins of thresher sharks, Nurse and Leopard Sharks, and rays and skates were reported as having little or no commercial value (Parry-Jones, 1996a). Generally speaking, retail prices for shark fins in Hong Kong range from approximately US$40.00 per kg (for Blue Shark) to US$564 per kg, although a retail price of as much as US$846 has been reported for a fin weighing 7.3kg, while shark fin soup ranges in price from US$4.5 to US$90.00 per bowl (Parry-Jones, 1996a).

In Taiwanese markets, the fins of Giant Guitarfish are considered superior, while fins of hammerheads and Dusky and Blacktip Reef Sharks are also considered high quality. Fins of Tiger, Great White and Shortfin Mako Sharks are considered medium grade, while those of Blue Sharks and thresher sharks are considered lower grade (Chen *et al.*, 1996). Dealers in Japan report that mako shark, hammerhead, and Sandbar Shark fins are considered superior, while the fins of Blue and Salmon Sharks are less valuable but more available (Kiyono, 1996). In the Philippines, the fins of guitarfish are highly preferred and earn some US$110.00 per kg for the fisher, while Whale Shark fins sell for approximately US$14.00 per kg (Chen, 1996). Although detailed market information is not available for Singapore, fins in trade are reported to include those of Blue Sharks, White Sharks, and Blacktip Sharks. Basking Shark fins imported from Norway are reportedly the preferred species, however, with retail prices of approximately US$400.00 per kg, or US$88.00 per bowl of soup (S. Fowler, *in litt.*, 30 August 1996).

In Tanzania, shark fins are classified as black or white depending on the species; black fins are derived primarily from the *Carcharhinus* species, and the preferred white fin derives solely from the Giant Guitarfish (Barnett, 1996b). Only the two dorsal fins and the caudal fin are taken from the Giant Guitarfish (Barnett, 1996b). In Madagascar, the dorsal and lower caudal fins of sawfish are considered of highest quality, while fins of the Zebra Shark are considered least desirable. The most common species in trade for fins are the Scalloped Hammerhead, Blacktip Reef Shark, Smalltooth Sand Tiger Shark, and sawfish. Species considered of little or no value are the Tiger Shark, thresher sharks, the Nurse Shark, Zebra Shark, Blue Shark, and Whale Shark (Cooke, 1996).

Fin dealers in the USA report that hammerheads and Sandbar Sharks produce the highest quality fins, while Dusky, Tiger, Blacktip, Bull, and Silky Shark fins are considered of high quality. Lemon, Whitetip, and Sand Tiger Shark fins are considered of medium quality, while mako sharks, Porbeagles, Blue Sharks, thresher sharks, and dogfish produce fins of low quality, with the exception of the lower caudal fin of mako sharks. Basking Shark and Whale Shark fins appear in small numbers in international trade (Rose, 1996d).

As with fins of Blue Sharks and other pelagic shark species, Piked Dogfish fins are of relatively low value. Only the pectoral and caudal fins of this species are used, and these in their fresh form together account for only 2.5-3.0% of the total body weight of each fish. However, owing to the tremendous volume of Piked Dogfish and other dogfish species caught in the USA and Europe, the fins have been routinely traded for at least the past 10-20 years. In many areas, including the USA and Europe, they may constitute a significant proportion by volume of the shark fins reported in trade.

In many cases, shark fin dealers are able to identify individual countries as major suppliers of particular species. Hong Kong dealers note that Japan and Spain are major suppliers of Blue Shark fins, the Philippines and the Middle East of Blacktip Reef Sharks, Mexico of hammerhead fins, and Mexico, Brazil, the Philippines, and Venezuela of Oceanic Whitetip and Tiger Shark fins (Parry-Jones, 1996a). Dealers in the USA, who routinely import fins from Latin America and Africa for re-export to Hong Kong, report abundant supply of hammerhead, Sandbar, and Blacktip Shark fins from Mexico; Sandbar and Blacktip Shark fins from Venezuela; mako shark, Blue Shark, and hammerhead fins from Peru; and dogfish fins from Argentina (Rose, 1996d).

Processing and preparation

Shark fins are processed and marketed in the following forms (Kreuzer and Ahmed, 1978; Lai, 1983):

- Dried, with the skin intact
- Semi-prepared, with the skin removed but the fibres intact
- Fully prepared with individual strands of the cartilaginous platelets showing separately
- Frozen prepared fins
- In brine
- As fin nets, in which the cartilaginous fin needles have been boiled, separated, and redried and packaged in loose groupings
- In canned shark fin soup

The stages of processing for common product forms such as dried fins and fin nets are illustrated in Figures 2 and 3.

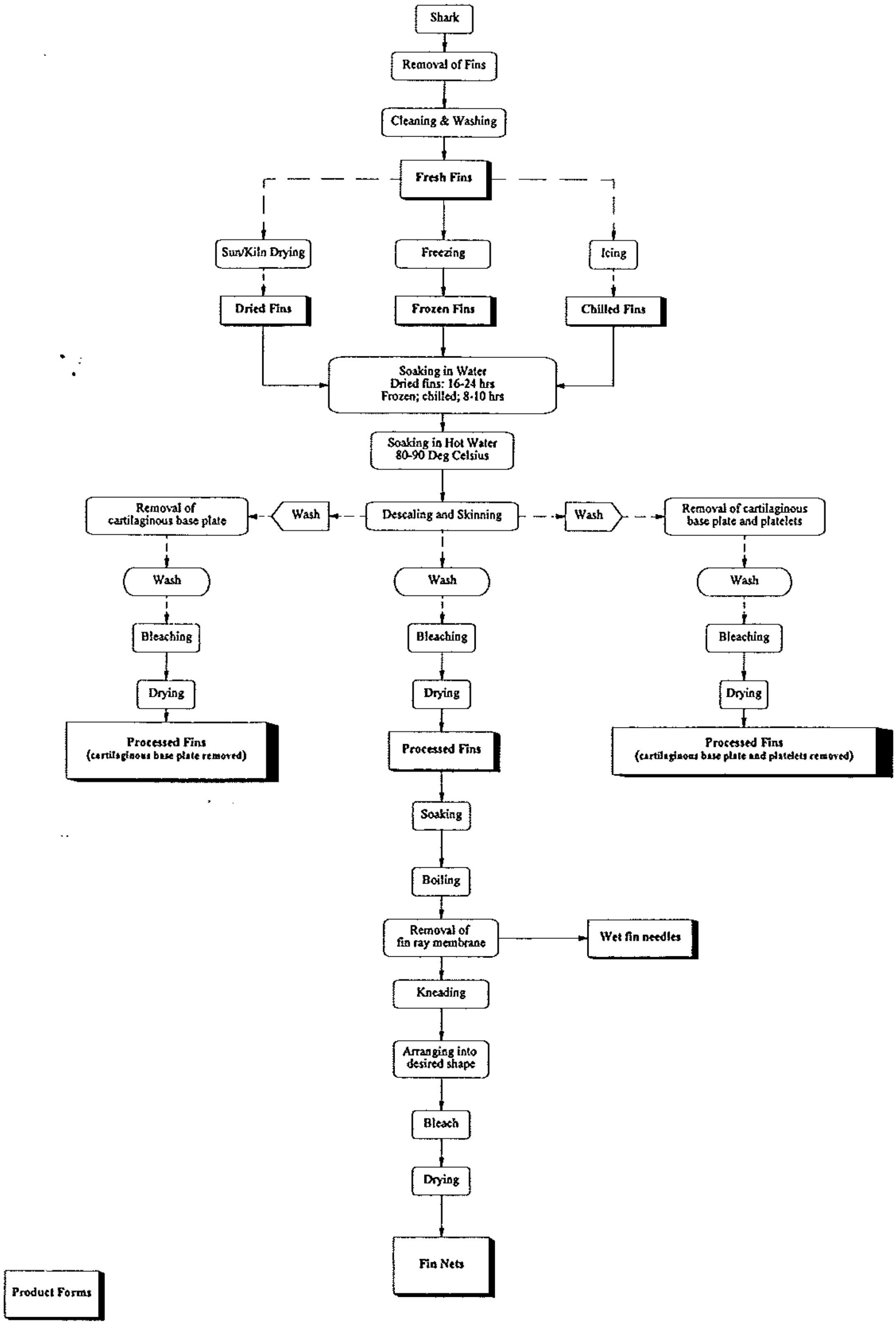
Fins from larger sharks are sold as fin sets, consisting of the larger more valuable fins: the first dorsal, pectoral, and lower caudal fins. Buyers offer a better price for a set of four fins from the same shark than for an assorted mixture. The lower caudal fin is the most valuable of the set owing to its higher fin needle content and size; in some species, the lower caudal fin may account for up to 50% of the weight of the fin set. The second dorsal fin, the pair of ventral fins, and the anal fin are typically sold as secondary or miscellaneous fins and often sold as mixed fins or fin nets after processing (Subasinghe, 1992). They are of lower commercial value and often taken only from large sharks or from species with particularly large fin sets, such as the Lemon Shark.

Shark fins are removed from the carcass as quickly as possible, and are cut at the fin base where the fin needles begin. The dorsal and pectoral fins are thick at the base, with muscle tissue extending into the base of the fins. The "half-moon cut" is therefore preferred for these fins in order to minimize the amount of meat left attached to the fin; a poor cut which leaves residual meat affects the odour and colour of the fin and results in a fin of lower quality and value. The caudal fin is removed with a straight cut. Freshly cut fins are cleaned and washed and may be stored on ice, frozen, or dried immediately (Subasinghe, 1992; Lai , 1983).

Kreuzer and Ahmed (1978) report that the average fin to body weight ratio for wet fins is five per cent, with a range of 1.5 to 11.2% (Table 6); the figure of five per cent (wet fin to carcass weight) is also used in the USA's management plan for sharks (Anon., 1993). Anderson and Ahmed (1993) derive a slightly lower estimate of 4.5% of body weight for wet fins and 1.44% for dried fins; the difference in estimates is likely to be owing in part to different species mixes. It is also likely to result from different methods of cutting the fin and different methods of preparation, as in the Maldives, the straight cut is often used, requiring further trimming by buyers. Similarly, in Tanzania, the straight cut is typically used by primary collectors in the hope that extra weight can be sold to fin exporters (Barnett, 1996b).

Figure 2

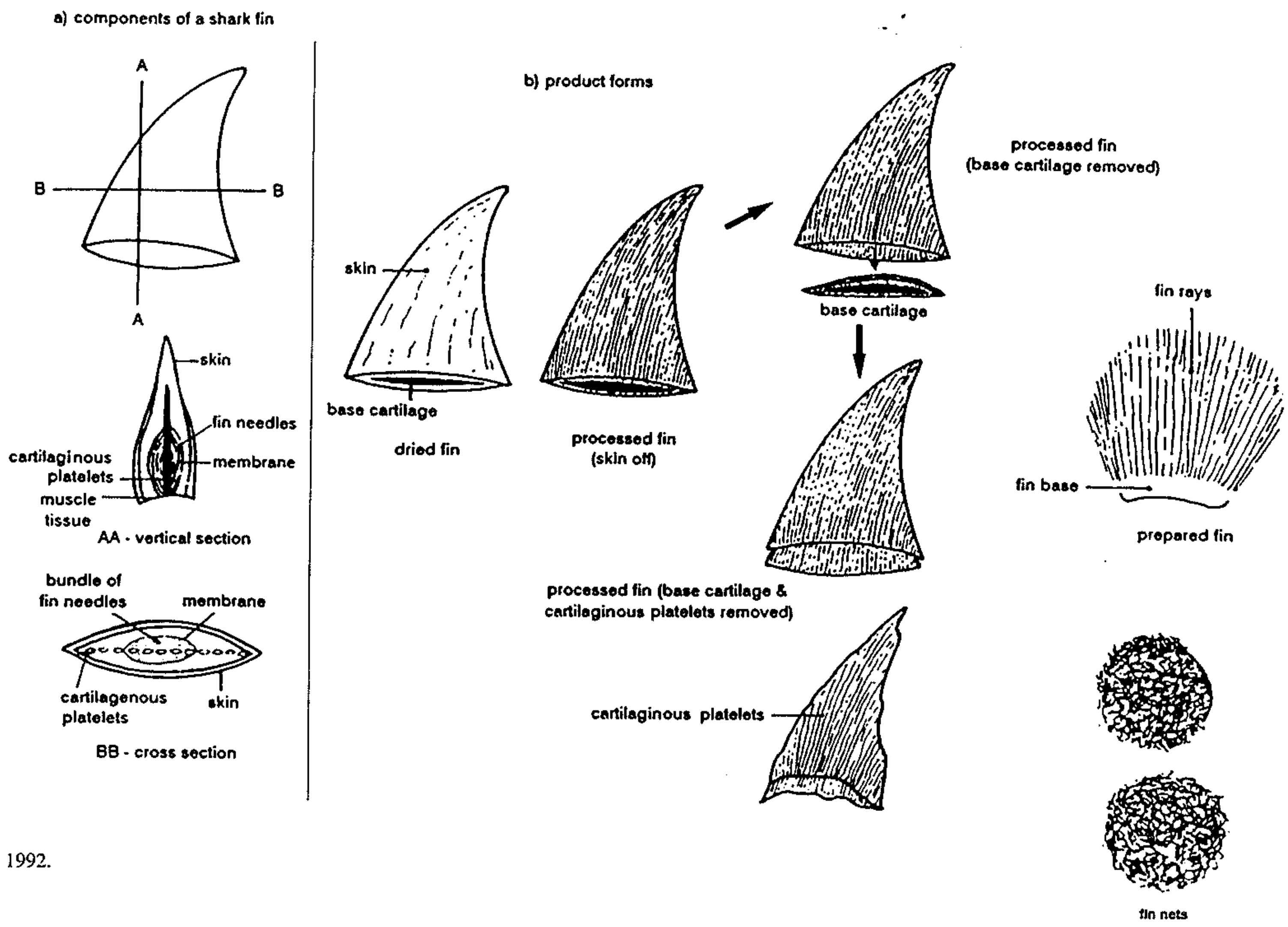
Flow chart depicting processing possibilities for shark fin



Source: Adapted from Subasinghe, 1992 and Lai, 1983.

Figure 3

Diagrams to show components of a shark fin and the appearance of various product forms



Source: Subasinghe, 1992.

Table 6

Proportion by weight of shark parts and products

Species	Percentage by weight							
	Trunk	Fillet	Head	Viscera	Liver	Bones	Fins	Skin
Horn Shark *Heterodontus fracisci*	33.6	20.8	38.6	15.6	5.2	5.8	11.2	9.6
Broadnose Sevengill Shark	52.0	35.0	29.0	13.7	4.4	6.8	5.0	9.8
Salmon Shark	–	–	–	–	12.0	–	–	–
Thresher Shark	–	–	–	–	10.0	–	–	–
Lesser Spotted Dogfish	36.6	–	20.0	39.2	6.6	–	4.1	–
Piked Dogfish	56.4	45.5	22.2	18.7	7.9	3.3	5.4	7.5
Copper Shark	41.8	35.4	26.5	26.6	12.7	2.2	5.1	4.2
Blacktip Shark	67.3	56.0	19.3	13.2	3.1	2.6	1.5	7.2
Tope Shark	44.7	–	14.9	35.7	2.9	–	4.5	–
Whitetip Shark	50.1	37.2	30.4	12.7	7.3	3.6	6.4	8.4
Smooth-hounds	60.8	45.9	22.0	13.0	2.7	9.4	4.5	5.4
Sand Tiger Shark	54.6	40.2	21.3	12.2	4.4	–	6.0	12.0
Smooth Hammerhead	62.0	54.4	18.3	13.7	5.5	3.4	5.3	4.2
Kitefin Shark	33.3	23.0	17.1	46.1	19.2	3.0	2.5	7.3
Silky Shark	61.2	52.3	21.3	9.2	2.9	3.9	4.8	4.9
Tiger Shark	47.6	36.2	21.3	28.1	17.5	3.0	4.9	8.0
Average[1]	**51.0**	**42.0**	**22.0**	**20.0**	**7.0**	**4.0**	**5.0**	**7.0**

[1] Includes other unidentified species.

Source: Gordievakaya, 1973.

Drying of shark fins can be performed in a number of ways. Fresh, cleaned fins can be hung from a line, either on board the fishing vessel or after landing, or may be sun-dried on mats, trays, or racks, turned periodically to avoid scorching or curling; large fins are typically hung to dry. In some cases, salt is lightly dusted over the fins and applied liberally to the cut before drying. Mechanical dryers may also be used, although traders prefer sun-dried to oven-dried fins. Drying results in a reduction by weight of approximately 30 to 50%, although moisture content and therefore loss of volume during drying varies by species. The fins may be packed for shipping in cartons, wooden cases, or burlap sacks (Lai, 1983; Subasinghe, 1992; Parry-Jones, 1996a).

Lai (1983) reports that in Hong Kong, wet and dried fins may be graded in one of two ways. Fins from domestic fisheries are typically sold wet, and graded first according to species and then by size. Fins that are imported are generally shipped in their raw, dried form. These may be graded first either according to the species or grouped according to skin color; given the difficulty of identifying species for imported dried fins, the latter system has become more widespread. The colour of the skin is classified as black or white, depending on species, with white fins generally priced more highly than black fins, owing to their generally higher needle content. Generally, these shark fins are then further classified according to size and other factors. Size is measured along the length of the fin base or from the center of the base to the tip of the fin. According to Subasinghe (1992), fins are graded as extra large (40cm and above), large (30-40cm), medium (20-30cm), small (10-20cm), very small (4-10cm), and mixed or assorted, the latter including ventral and anal fins. Dealers in Tanzania grade fins into seven categories by size alone: A (16 inches), B (13-15 inches), C (10-12 inches), D (8-9 inches), E (6-7 inches), F (3-5 inches), and mixed (> 3 inches) (Barnett, 1996b). In Madagascar, fins are classified as "good" and "bad", according to needle content, then further classified into three size classifications: >25cm, 15-25cm, and <15cm. In some areas, buyers also purchase miscellaneous small fragments and pieces, termed *poussière*, meaning "dust" (Cooke, 1996).

Nair and Madhavan (1974) report for India a grading system that distinguishes dorsal, ventral, and pectoral fins from caudal fins: for dorsal, ventral, and pectoral fins, grades are A (below 10cm), B (10-20cm), C (20-30cm), and D (30cm and above); and for caudal fins, A (below 20cm), B (20-30cm), C (30-40cm), and D (40cm and above). The type and quality of the cut, moisture content, appearance (for example, the presence of blemishes, burns, curling, and presence of insects), and smell also affect the grading of shark fins.

In Taiwan, wet shark fins are graded by size and weight, as follows: the primary fin sets are graded as upper grade (greater than 2kg), middle grade (1.5-2kg), lower grade (less than 1.5kg), and miscellaneous fins (the larger fins of small sharks, weighing less than 1kg), and pelvic and anal fins from any shark species (less than 1kg). Other factors considered in fin grading are water content, rehydration capacity, number of needles, length of needles, degree of whiteness, and ash content (Chen *et al.*, 1996).

Processing of shark fins begins with soaking in water; fresh fins are soaked for 8-10 hours, dried fins for some 16-24 hours. After initial soaking, the fins are further soaked in hot water until the skin is soft. Softened fins are then placed in chilled water and the skin and scales removed with a wire brush and/or metal scraper. The fins are again washed, any remaining meat and the cartilaginous base plate are removed, and the fins are then washed again in running water. In some cases, the fins may be soaked in a bleaching agent to remove blood from the cartilaginous base (Kreuzer and Ahmed, 1978; Lai, 1983; Subasinghe, 1992).

Soaked and washed fins are dried in the sun or with a mechanical dryer, retaining their original shape. In some cases, processors may remove the hard cartilage of the dorsal fins and the cartilaginous platelets between the two layers of fin needles before drying.

In Japan, the tail fin is typically simply dried on board the fishing vessel or after landing, while other fins are boiled, the skin removed, and the fin dried (Kiyono, 1996).

The fins may be further processed into fin needles or fin nets by again soaking the processed fins for up to 12 hours and then boiling them for up to 10 minutes to remove the gelatinous membrane and to expand and expose the fin needles. The fins are then transferred to chilled water and fin needles separated from the membrane. Fin needles may be removed to form wet fin needles, or may be further processed to fin nets. For fin nets, wet needles are arranged into bundles of approximately 100g each and then sun-dried (Kreuzer and Ahmed, 1978; Lai, 1983; Subasinghe, 1992).

Nair and Madhavan (1974) report that fin needle yield as a percentage of total wet fin weight for white varieties ranges from three to five per cent for the dorsal and ventral fins and two to four per cent for caudal fins, while yield for black fins ranges from two to three per cent for dorsal and ventral fins and 1.5 to 2.5% for caudal fins. The respective yields for dried fins are 12 to 25% and three to six per cent for white varieties, and six to 15% and four to six per cent for black varieties. Fin needle yield reported by these authors for caudal fins is apparently based on both the upper and lower caudal lobes, however; as the upper caudal lobe yields almost no fin needles and is not used commercially, the respective yields for the lower caudal lobes appearing in trade would be much higher than these figures might suggest.

Markets and trade

Shark fin soup is a Chinese delicacy that has been used for more than 2000 years to honour special guests or important occasions, and world trade in shark fin has occurred for centuries (Kiyono, 1996). According to the FAO, total world imports of dried and salted shark fins averaged 4700t annually during the decade 1984-1993, peaking in 1988 at 5915t. Total reported world exports averaged 4139t annually during this period, peaking in 1989 at 5481t (Anon., 1995a). Again, however, FAO published data remain substantially incomplete, as imports are reported only for nine countries, and exports for fifteen countries. Data are also often incompletely reported for the countries included; for example, the USA records imports but not exports of shark fins, and imports are included in published data from 1989 only.

Hong Kong Customs data provide a more comprehensive view than do FAO data of world trade in shark fins, as much of the world trade in shark fins passes through Hong Kong for processing, consumption, or re-export. For the period 1980-1995, Hong Kong recorded shark fin imports from 125 countries, and re-exports to 75 countries. Indeed, much of the trade volume recorded in FAO reports relates to trade *via* Hong Kong. As discussed below, a significant proportion of fins imported into Hong Kong are subsequently processed in China, and reported imports to China and Hong Kong since 1987 are greatly inflated by repeat transactions as fins are imported into Hong Kong, exported to China for processing, and then re-imported into Hong Kong. Much of the apparent increase in fin trade as reported by FAO is therefore actually owing to the increase in reported repeat shipments of fins between Hong Kong and China.

Hong Kong and China

Hong Kong reports minimal landings of sharks in domestic fisheries, so that exports of shark fins originating in Hong Kong's domestic fisheries represent a very minor contribution to world trade. Instead, Hong Kong's role in the fin trade is as a processor, consumer, and entrepôt for the global trade, importing fins in a variety of stages of processing for further processing, consumption, and re-export. Hong Kong's role in world trade is assisted by its status as a free port, in which tariffs are levied only on alcohol and tobacco (Parry-Jones, 1996a).

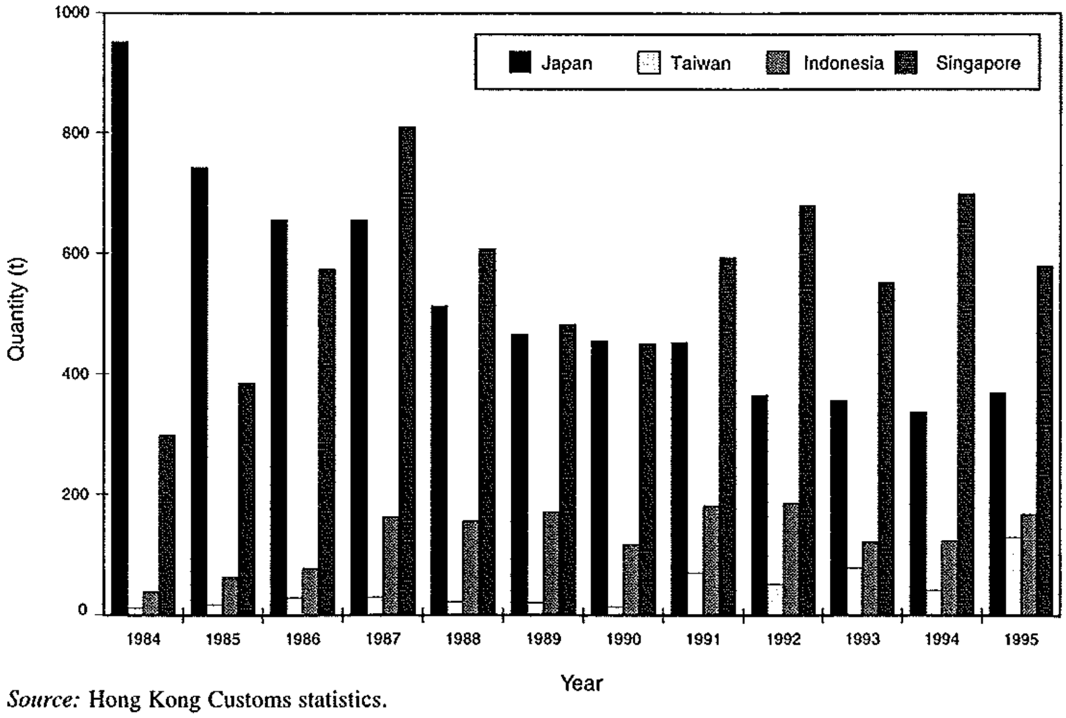
Shark fins typically pass through import or export houses, on to processors, in turn to wholesalers or retailers, and eventually to domestic consumers or alternatively to exporters or re-exporters. Some large-scale trading companies are vertically integrated to incorporate all these functions, and in many cases, also work with agents or subsidiaries in supply countries. The reliability of contacts in source countries plays an important rôle in determining trade paths to Hong Kong, and traders who rely upon unfamiliar exporters necessarily expend time and money travelling to source countries to ensure trustworthiness of contacts and the quality of fins (Parry-Jones, 1996a).

Lai (1983) reported that some 6-13% of shark fins imported to Hong Kong were re-exported to Chinese communities overseas, and that of the remainder, some 80% were consumed in restaurants. Restaurants often build long-term relationships with individual shark fin processors, or may import shark fins directly.

According to Hong Kong Customs data, total reported imports of shark fin rose from 2 742 303kg in 1980, to 6 121 896kg in 1995, an increase of 123.2% (Parry-Jones, 1996a). From 1980 to 1983, the most important suppliers of fins to Hong Kong were Japan, Singapore, and Mexico, Japan remaining Hong Kong's most important trading partner until 1987. From 1987 to 1995, important suppliers appear to have included China, Singapore, Japan, Indonesia, the USA and UAE (Figures 4-11). However, at least some of the countries for which significant trade volumes are reported are involved in trans-shipment, rather than, or in addition to, production for export. Singapore, for example, is primarily a point of processing and/or direct trans-shipment, while the USA is important both as a primary producer and a point of trans-shipment. Reported imports to Hong Kong from China appear to consist wholly or primarily of fins that are merely traded between the two countries for processing.

Figure 4

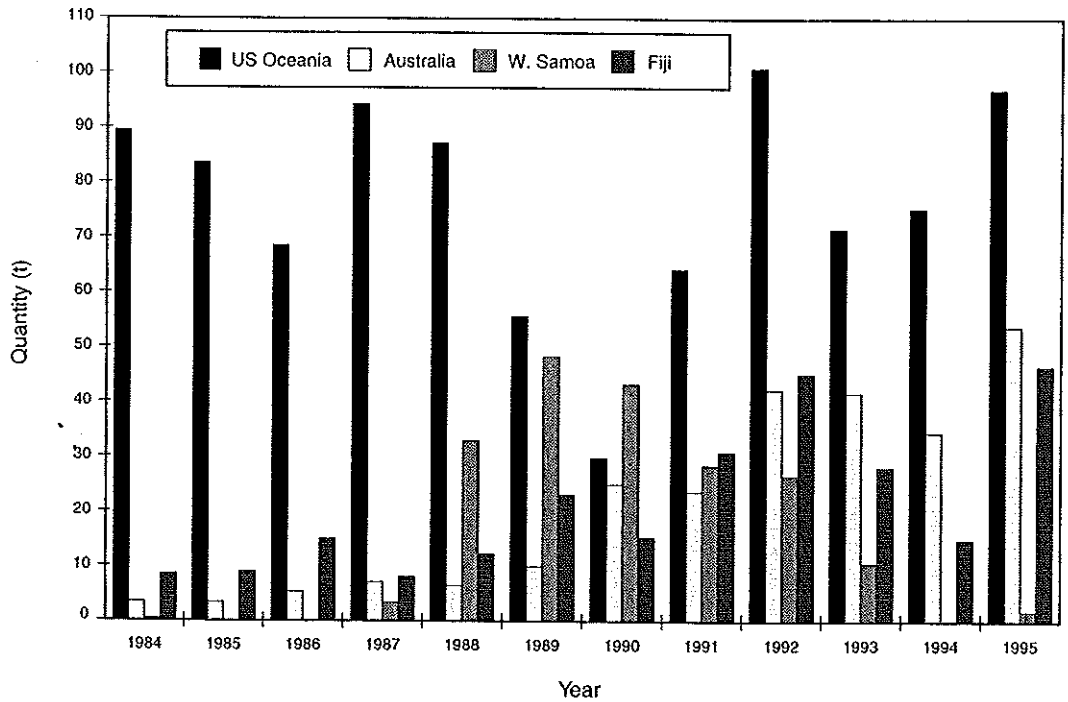
Volumes of dried shark fin recorded in Hong Kong's import statistics from selected East Asian and Southeast Asian countries of origin, 1984-1995



Source: Hong Kong Customs statistics.

Figure 5

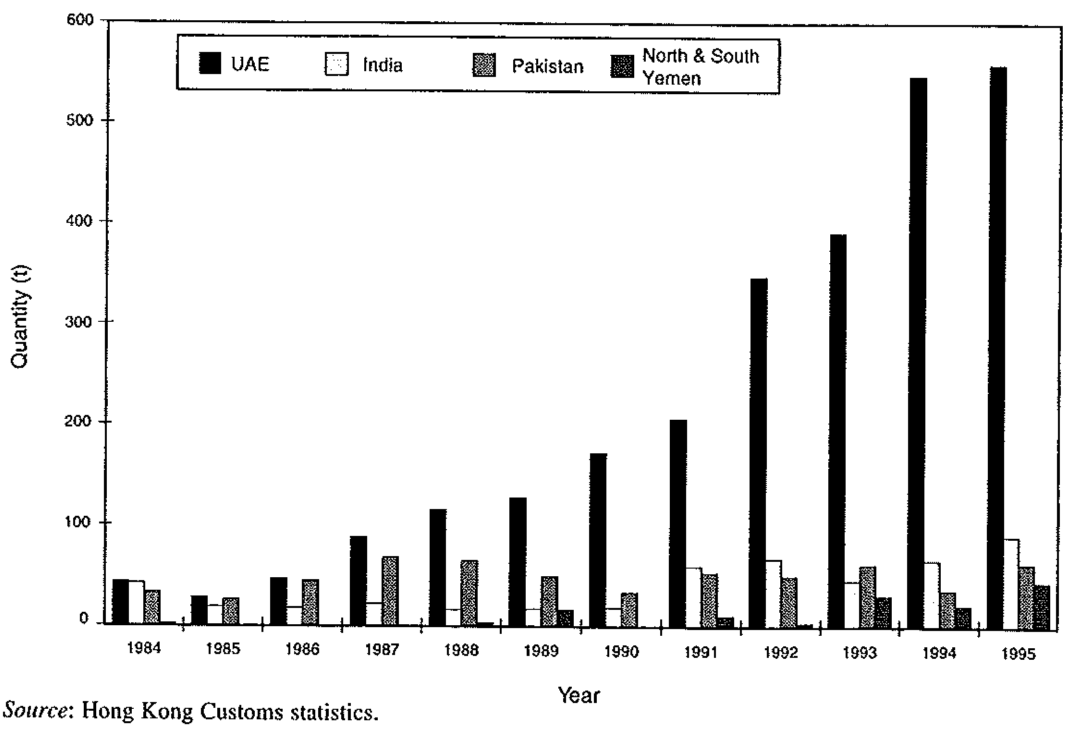
Volumes of dried shark fin recorded in Hong Kong's import statistics from selected countries of origin in Oceania and the Pacific, 1984-1995



Source: Hong Kong Customs statistics.

Figure 6

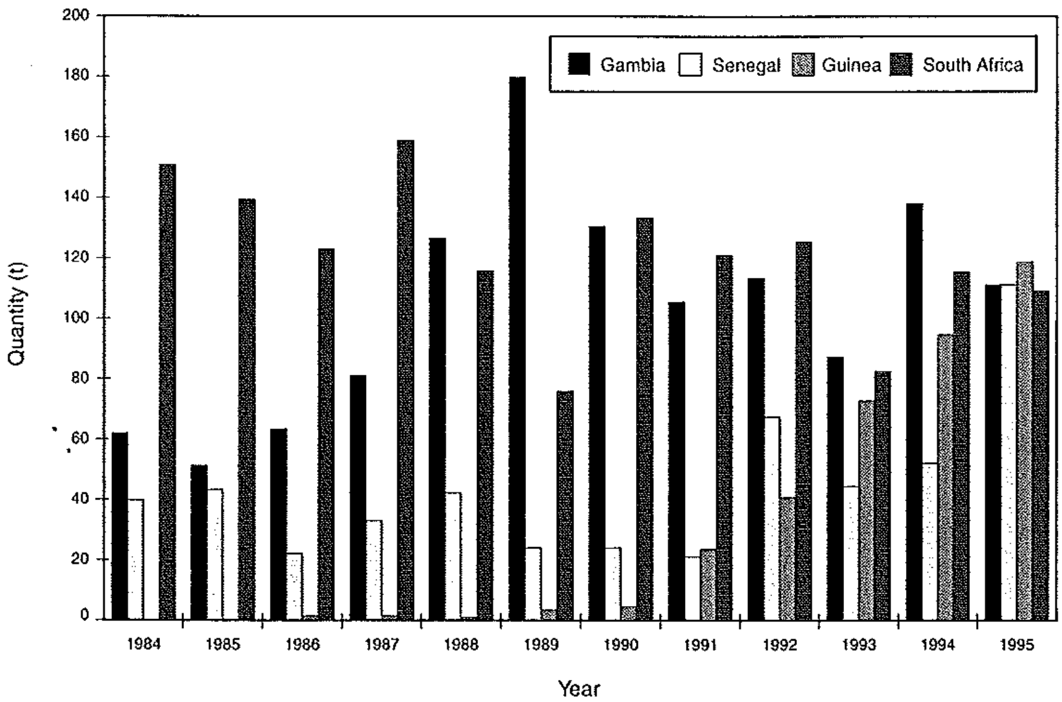
Volumes of dried shark fin recorded in Hong Kong's import statistics from selected Middle Eastern and South Asian countries of origin, 1984-1995



Source: Hong Kong Customs statistics.

Figure 7

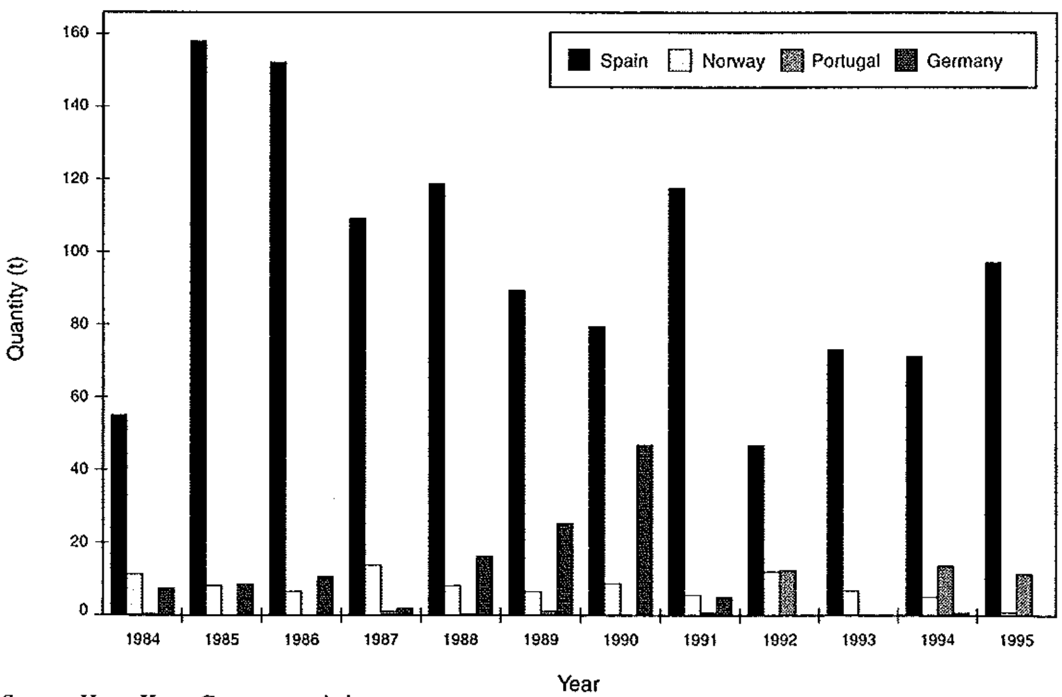
Volumes of shark fin recorded in Hong Kong's import statistics from selected African countries of origin, 1984-1995



Source: Hong Kong Customs statistics.

Figure 8

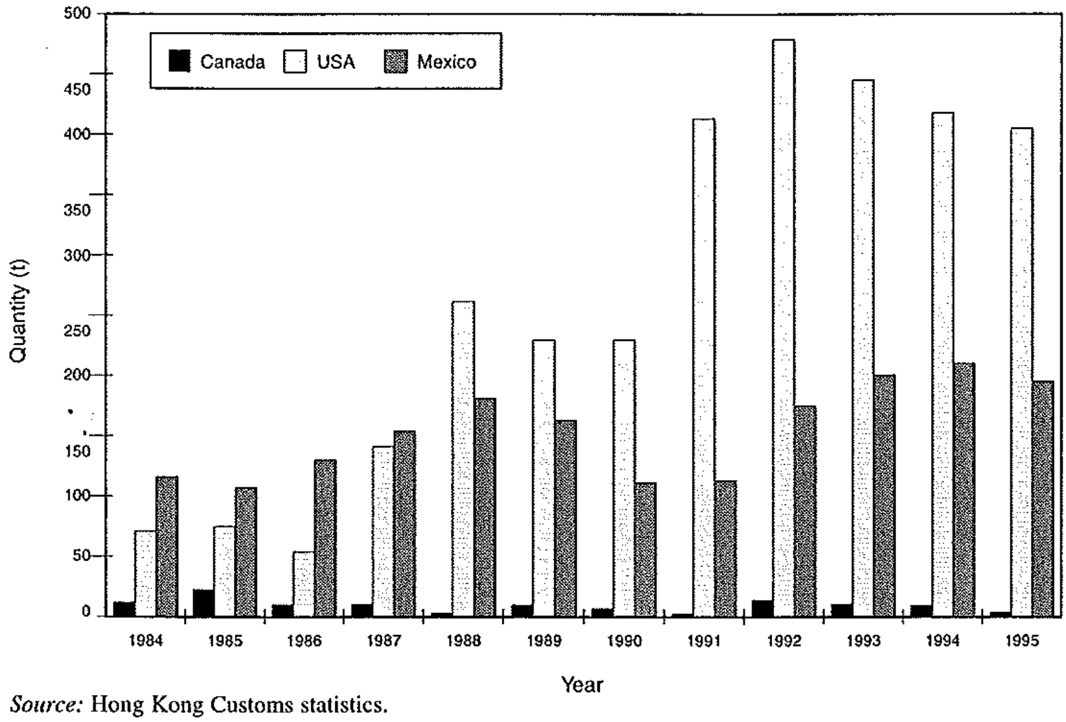
Volumes of dried shark fin recorded in Hong Kong's import statistics from selected European countries of origin, 1984-1995



Source: Hong Kong Customs statistics.

Figure 9

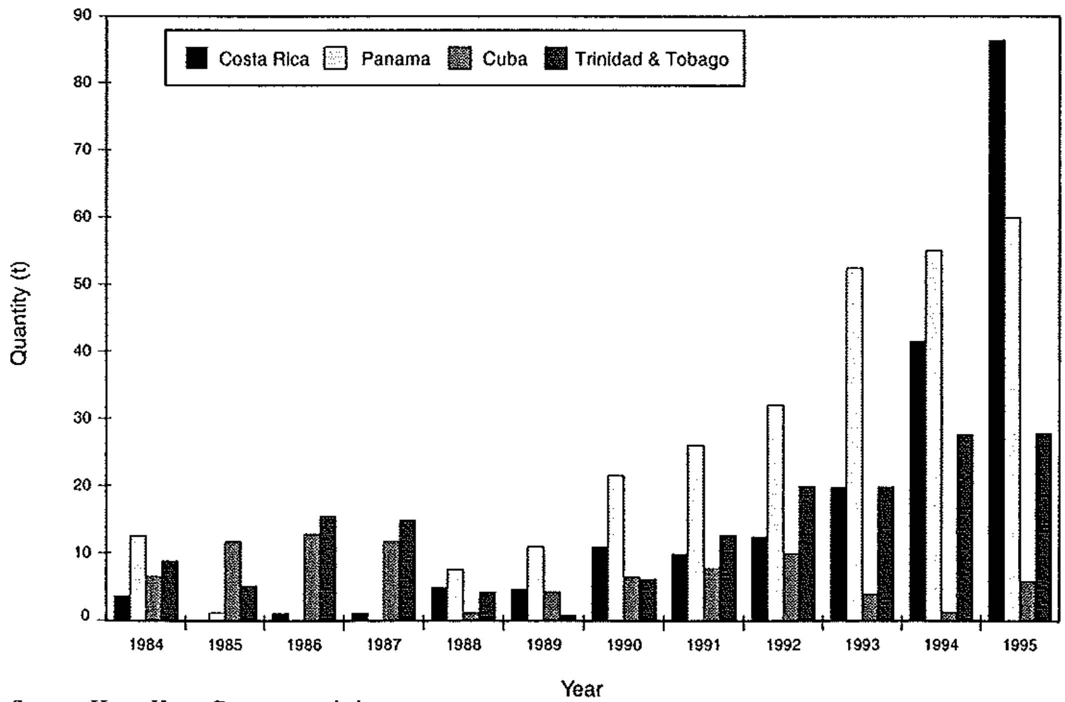
Volumes of dried shark fin reported in Hong Kong's import statistics from selected North American countries of origin, 1984-1995



Source: Hong Kong Customs statistics.

Figure 10

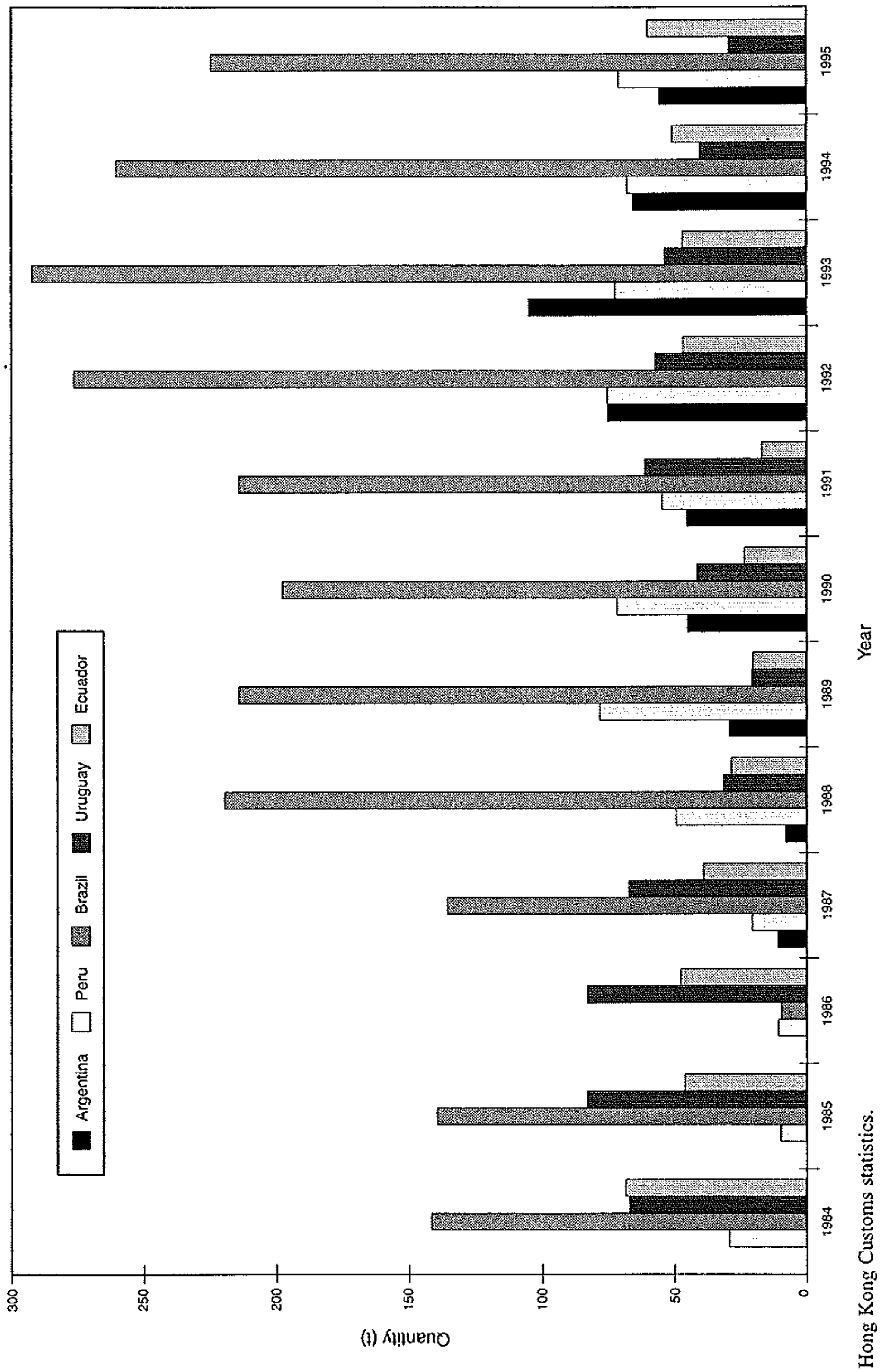
Volumes of dried shark fin reported in Hong Kong's import statistics from selected Central American and Caribbean countries of origin, 1984-1995



Source: Hong Kong Customs statistics.

Figure 11

Volumes of dried shark fin reported in Hong Kong's import statistics from selected South American countries of origin, 1984-1995



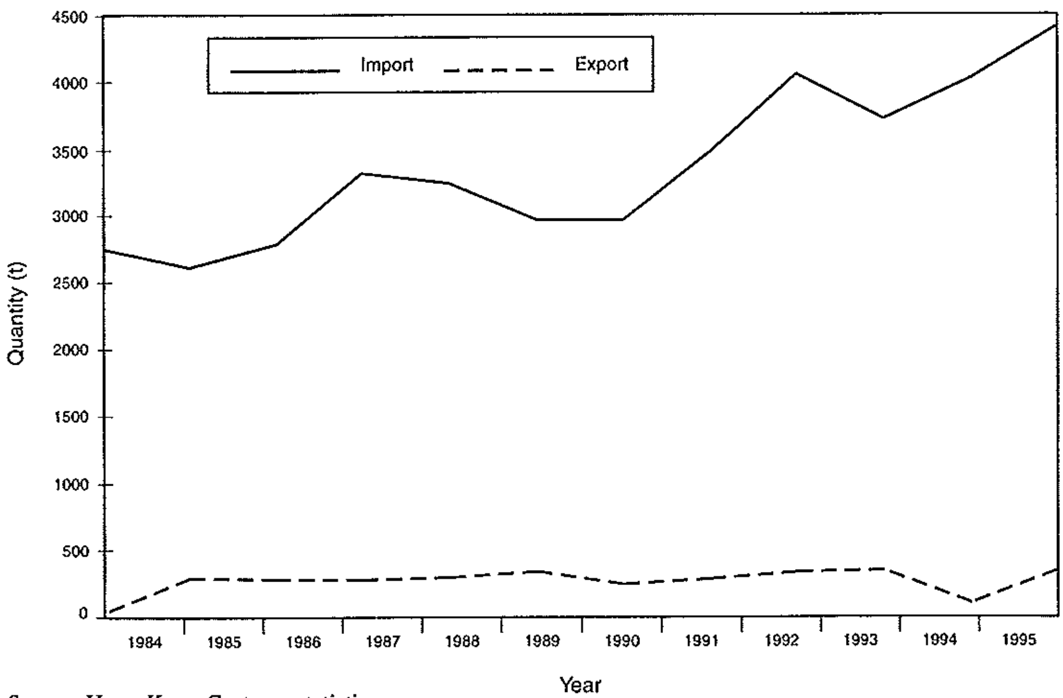
Source: Hong Kong Customs statistics.

Since the mid-1980s, tightening restrictions on the Hong Kong processing sector and the opening of Chinese markets have led to a shift in much of the processing of shark fins to China. Increasingly, therefore, many of the shark fins imported into Hong Kong are actually exported to China for processing, then re-imported for domestic consumption or trade. For example, from 1990 to 1995, around 51% of total imports of dried or salted shark fins into Hong Kong were re-exported. During this period, the volume of re-exports of dried shark fins from Hong Kong to China equalled some 45% of total imports into Hong Kong and around 88% of total re-exports from Hong Kong. Some 48% of the volume of Hong Kong's re-exports to China was then subsequently re-imported by Hong Kong. In other words, reported Hong Kong imports of shark fins consist in large part of trade that is counted twice, once when entering Hong Kong originally, and again when re-imported from China following processing. The significance of the re-import trend, especially, is magnified when it is considered that the volume of shark fins is reduced by some 30-50% during processing (Parry-Jones, 1996a).

The importance of shipments of shark fins between Hong Kong and China in total reported Hong Kong trade is illustrated in Figures 12 to 15, which suggest the direct relationship between trends in total Hong Kong shark fin imports and trade in the commodity between Hong Kong and China. The most significant increases in the volume of shark fin imported into Hong Kong began in 1987, when Hong Kong first began to import a significant volume of shark fin from China. During the period 1987-1995, imports of dried shark fin to Hong Kong from China rose from 235t, or seven per cent of total Hong Kong imports, to 1713t, or 28% of total Hong Kong imports. Hong Kong also began to import significant volumes of shark fins salted or in brine from China after 1987, total imports of such rising from 120kg in 1987, to 123t in 1988. Total re-exports of shark fins from Hong Kong increased by similar proportions, rising from 278t in 1980, to 842t in 1987, 1844t in 1991, and 2405t in 1992, much of this increase again accounted for by rising re-exports to China (Parry-Jones, 1996a). Taken together, these trends suggest that although Hong Kong's trade in shark fins with China has increased sharply over the last decade, trade with other countries has increased much more slowly.

Figure 12

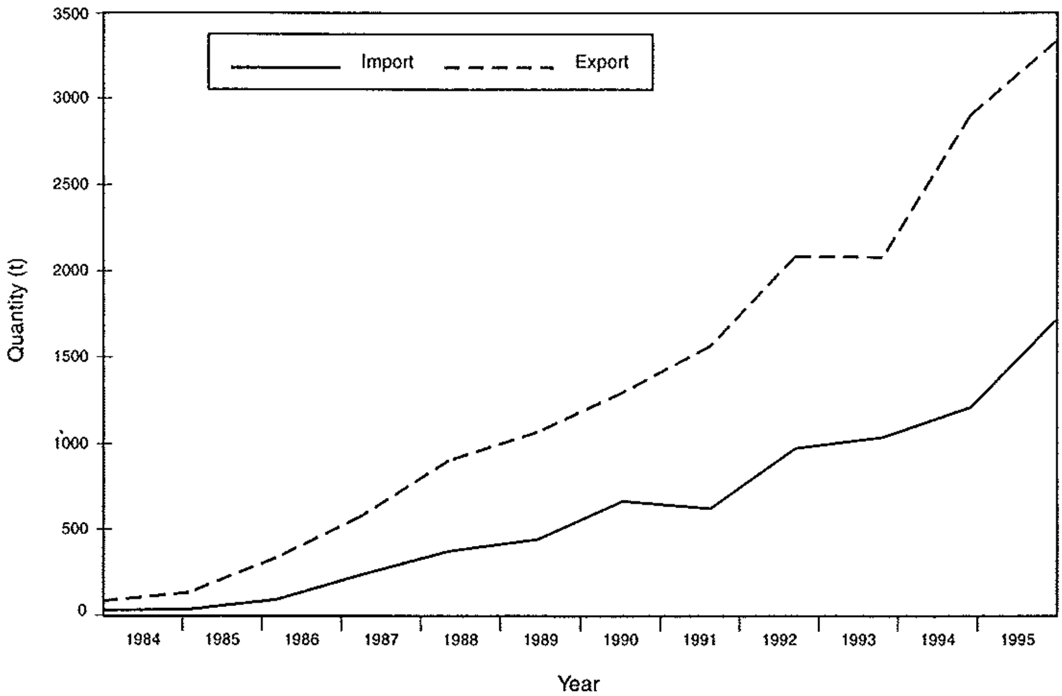
Hong Kong's dried shark fin trade with all countries (except China), 1984-1995.



Source: Hong Kong Customs statistics.

Figure 13

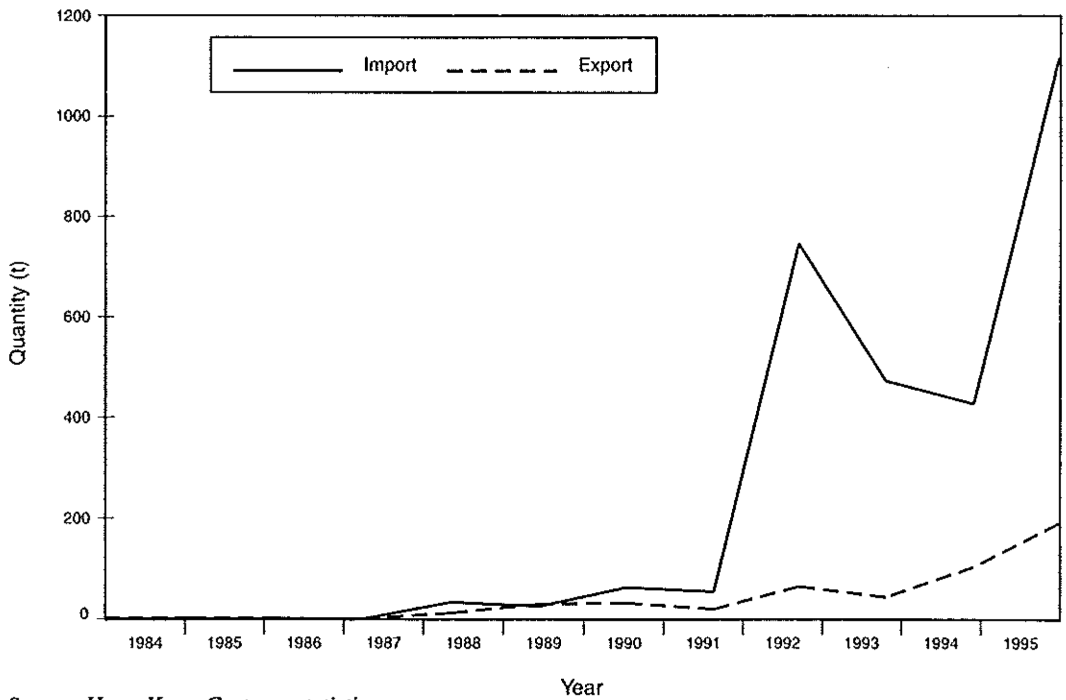
Hong Kong's dried shark fin trade with China, 1984-1995



Source: Hong Kong Customs statistics.

Figure 14

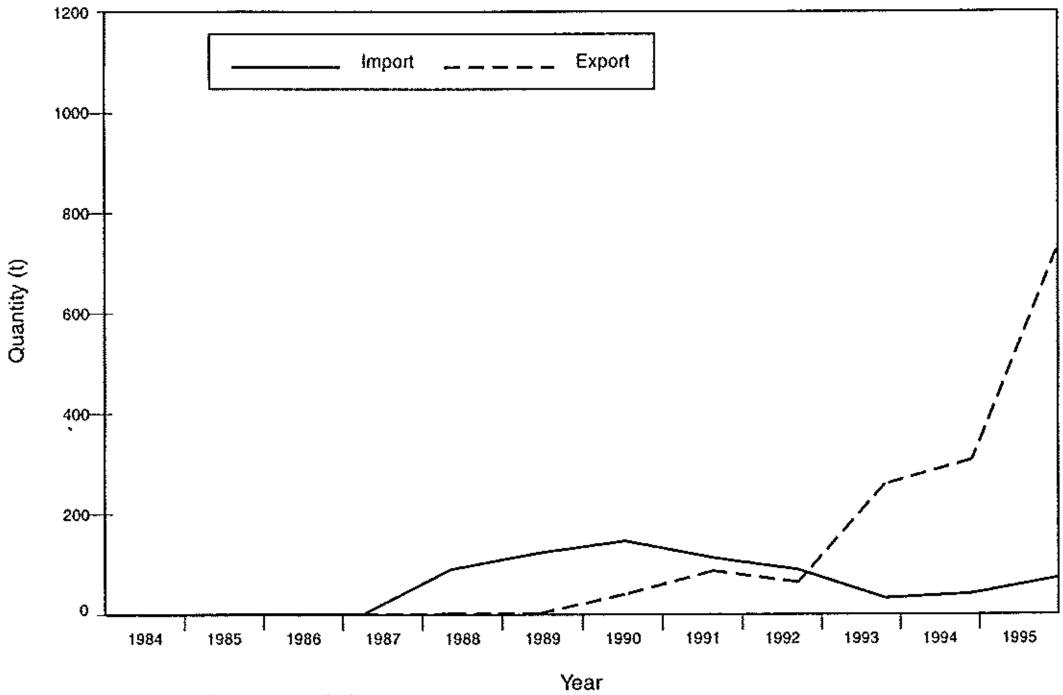
Hong Kong's salted shark fin trade with all countries (except China), 1984-1995



Source: Hong Kong Customs statistics.

Figure 15

Hong Kong's salted shark fin trade with China, 1984-1995



Source: Hong Kong Customs statistics.

The increase in the volume of fins imported by Hong Kong has been accompanied by an overall increasing trend in the average unit value of imported fins, which ranged from US$11.20 per kg in 1980, to US$41.00 per kg in 1992. Notable increases in the average unit value of fins occurred from 1986 (US$15.40) to 1987 (US$20.20), and again in 1988 (US$26.20), and from 1991 (US$28.70) to 1992 (US$41.00). Average unit prices declined slightly after 1992, to US$40.60 in 1995 (Parry-Jones, 1996a). Average unit prices mask significant variation in reported unit prices for imports by country, however, suggesting wide variation in the quality, stage of processing, and market price of fins, according to country of origin.

Rob Parry-Jones / TRAFFIC

Dried shark fin for sale in Hong Kong.

Much less is known regarding the volume of China's shark fin production, consumption, or of its direct imports, than is known for Hong Kong. Reported trade records suggest that China's trade with Hong Kong also represents a large proportion of China's total reported trade in shark fins. FAO reports China's shark fin production increasing from 40t in 1982, to an average of 764t in 1990-1992; however, these data are estimates based on unofficial sources and have not been verified or approved by the PRC Bureau of Fisheries. Chinese imports of dried fins, as reported by FAO, rose from 48t in 1982, to 1335t in 1990, while reported exports increased from 40t in 1982, to 809t in 1989. More recent data from Chinese Customs statistics report imports of shark fins totalling 9429t in 1992, 3079t in 1993, and 3375t in 1994, while exports totalled 2518t in 1992, 1214t in 1993, and 1353t in 1994. From 1992-1994, Hong Kong accounted for 75 to 94% of China's shark fin exports, and 58 to 59% of China's imports, except in 1992. In that year, Myanmar is reported to have exported 5397t of shark fins to China, causing the China's total imports for that year to be nearly triple the amounts imported in other years (Parry-Jones *et al.*, 1996).

China's role in world production and trade of shark fins remains unclear. China's import tariffs for shark fins were sharply reduced in 1985 (Table 7), but as of 1995 remained at 72% for reciprocal trade classifications - those applicable to countries or territories such as Hong Kong, with which China has favourable trade agreements - and near 100% for general classifications - applicable to all other countries. Import tariffs therefore undoubtedly continue to serve as a significant deterrent to the import trade of shark fins to China. High tariffs may lead to tariff evasion (by smuggling and mis-reported trade), but insufficient information is available to determine whether, or to what extent, this is the case. Shark fins imported from Hong Kong for processing are exempt from import tariffs altogether, provided that 30 to 50%, by weight, are returned to Hong Kong, and analysis of trade data suggests that the bulk of China's imports from Hong Kong are indeed processed for re-export to Hong Kong. Domestic production, and the proportion of domestic demand met by China's rapidly growing fisheries sector, cannot be assessed with any confidence (Parry-Jones, 1996a).

Table 7

Effective tariff rates (tariff and VAT) for imported shark fins into China

Years	Tariff classification	Shark fins, dried	Shark fins, salted or in brine
1980-1984	Reciprocal	185%	185%
	General	285%	285%
1985-1990	Reciprocal	95%	95%
	General	115%	115%
1991-1992	Reciprocal	95%	65%
	General	115%	85%
1993	Reciprocal	90%	35%
	General	115%	45%
1994-1995	Reciprocal	72%	72%
	General	97%	97%

Source: Economic Information and Agency, Hong Kong.

Future trends in Hong Kong's and China's shark fin trade are similarly difficult to predict. The net increase in imports of shark fin by both countries since the mid-1980s, and the sheer size of China's potential domestic market, suggest the probability of a continued rise in net world imports, albeit at much lower levels than those suggested by total world imports. However, it is widely believed by fin traders interviewed by TRAFFIC, that the current political climate in China and Hong Kong will cause some disruption to the shark fin market in coming years. First, while the increase in shark fin prices and in reported trade in the mid-1980s and early 1990s is viewed as the result of increased trade by Hong Kong and China, anti-corruption measures implemented in China during the mid-1990s are reported by some fin dealers to have significantly reduced demand for shark fins. Second, the climate of political instability and economic uncertainty foreshadowing and accompanying the return of Hong Kong to the China in 1997 is believed by many traders to be likely to reduce demand for luxury items such as shark fin (Rose, 1996d).

Other East Asian markets

Japan is one of the world's largest producers of shark fin. The ingredient is not used in Japanese cuisine, but is consumed in Chinese restaurants in Japan (Kiyono, 1996). Japan does not report domestic production of shark fins, but exported an average of 661t of shark fins annually during the period 1980-1994, in declining numbers, from 1073t in 1981, to 399t in 1993, according to its Customs statistics. Eighty-three per cent of shark fin exports are to Hong Kong, and over the past decade, Japan has rivalled China and Singapore as Hong Kong's most important suppliers of shark fins. The second-most important destination for Japanese shark fin exports is Singapore, and smaller volumes are imported by Thailand, China, and the USA. Japanese Customs do not report imports of shark fin, but records of Japan's trading partners (Hong Kong, Indonesia, Malaysia, South Korea, Singapore, Sri Lanka, Taiwan, and Thailand) report exports of shark fin to Japan averaging a total of 214t annually during the period 1986-1989 (Kiyono, 1996).

In **Taiwan**, imports of shark fin consist primarily of dried fin, followed by fresh, chilled, or frozen shark fin, with very little fin salted or in brine reported in imports. Little or no shark fin was imported from 1980 to 1986. More than 96t of dried shark fin was imported in 1989, but imports of dried fin have declined since, to just over 20t imported in 1995. Although Taiwan imported dried shark fin from as many as 24 different countries each year from 1989 to 1994, the bulk of imports were provided by Hong Kong, Indonesia, and Singapore. Exports totalled just over 41t during the period 1980-1986, then increased to more than 140t per year in 1987 and 1988, to 259t in 1989, and 283t in 1990. Exports declined thereafter to 2.3t in 1994 and 4.5t in 1995 (Chen *et al.*, 1996).

As in Japan, **South Korean** cuisine does not traditionally include shark fins, but these are consumed in Chinese restaurants in South Korea. South Korean production of shark fins is reported for adjacent-water fisheries only; reported production averaged 23t annually during 1980-1994, declining from 115t in 1980 to two tonnes in 1994. South Korean imports of shark fins averaged only five tonnes annually during 1987-1994, and were composed primarily of imports from Japan, Singapore, Spain, USA, Hong Kong, India, and Indonesia, but with smaller volumes from Malaysia, Brazil, Oman, China, Vietnam, and the Philippines. Exports of shark fin from South Korea averaged 60t annually during 1980-1994, declining from 94t in 1980, to 31t in 1994. During 1987-1994, Singapore received 78.3% of South Korean exports of shark fin, and the remainder was exported to Japan, Hong Kong, Saudi Arabia, the USA, Malaysia, Kuwait, Spain, Taiwan, China, and Libya (Parry-Jones, 1996b).

Southeast Asia

Singapore is by far the most important trader of shark fins in Southeast Asia. A number of import, export, and wholesale traders based in Singapore handle shark fins, and most have a retail outlet supplying pre-packed shark products and a wholesale sector supplying hotels and restaurants. Singapore imported an average of 1054t annually of dried or salted shark fins during 1990-1995 from 65 different countries, the most important of which were Hong Kong, India and Yemen; secondary sources included Japan, Pakistan, Spain, Sri Lanka, and Taiwan, according to Singapore's Trade Development Board statistics. (It is important to note that Singapore excludes records of imports from Indonesia from its Customs statistics, for political reasons.) Most of Singapore's imports are subsequently re-exported to Hong Kong; other countries of destination include Malaysia, Myanmar, Taiwan, and Thailand (Chen, 1996).

Other forms of prepared shark fins are also imported into Singapore, primarily from Australia, India, Japan, Sri Lanka, Spain, Hong Kong, and Thailand, and exported to Hong Kong, Malaysia, Taiwan, Japan, the USA, Thailand, Philippines, France, and Germany. Imports averaged some 53t annually during 1990-1995, peaking in

1995 at more than 142t, (necessarily excluding any from Indonesia). Exports of prepared shark fins averaged some 79t annually during 1990-1995 (Chen, 1996).

Indonesian exports of dried and salted shark fins increased from 179t in 1980, to a peak of 547t in 1987, then fell to 367t in 1993, as shark fins in brine began to be exported in 1989, rising from 43t in that year, to 193t in 1993 (Bentley, 1996b). Major importers of Indonesian shark fins are Hong Kong (46.3% of total reported exports of shark fin from Indonesia), Singapore (37.9%), Malaysia (10.4%), and Japan (4.5%). Indonesian import data are not available for a continuous time series, but suggest that imports of shark fins into Indonesia are minimal; in 1993, imports totalled 1.3t of dried fins and 1.8t of fins in brine. Imports are reported from Sri Lanka, Saudi Arabia, Taiwan, Hong Kong and South Korea (Chen, 1996).

Malaysia appears to be a net consumer of shark fins, with annual imports of dried fins ranging from 79t in 1989, to 209t in 1992, primarily from Indonesia and Singapore. Exports are minor, with an annual maximum of 13t for all years except 1990, when 40t were exported (Chen, 1996).

Small exports of dried shark fins are made from the **Philippines** and they increased in volume from six tonnes in 1990, to a peak of 36t in 1992, then dropped to 13t by 1994. No information is available regarding imports, nor the extent of domestic consumption (Chen, 1996).

Oceania

Australia imported an average of 8.5t of shark fins annually during 1988-1994. The majority of imports are shipped to New South Wales and Victoria, although most states receive consistent supplies. During 1988-1994, Australia imported shark fins from 26 different countries, with Hong Kong, Japan, Singapore, and Fiji by far the most important suppliers. Fins imported from Hong Kong and Japan arrive primarily in New South Wales and average prices per kilogramme have ranged from US$75.00 to US$100.00, since 1988. Fins from Singapore are imported into a number of Australian states, and the average price has risen from US$40.00 per kg, in 1988, to US$175.00 in 1994. Imports from Fiji began to be reported only in 1993, but in 1993 and 1994 represented Australia's single largest source of supply. Low average prices of approximately US$40 per kg suggest that imports from Fiji are unprocessed fins intended either for re-export or for further processing and export from Australia (Bentley, 1996a).

Although Australian Customs do not report export of shark fins, data from the Australian Quarantine and Inspection Service report that exports of shark fins, mostly in dried form, totalled 65.5t in 1992-1993, 49.9t in 1993-1994, and 45.9t in 1994-1995. Exports are reported from all states for most years. In addition to dried fins, small volumes of exported fins were recorded as frozen, fermented, canned, and/or brined. The establishment of shark processing facilities in recent years suggests that exports of processed fins may be increasing (Bentley, 1996a).

In **New Zealand**, fins from the most abundant species fished domestically (Piked Dogfish, chimaeras, and elephantfish) are not very valuable. Shark fins were first exported from New Zealand in the 1960s, when they were dried and exported to Hong Kong for use in fertilizer. New Zealand data for shark fin exports are not available; Hong Kong reports annual average imports from New Zealand of 606kg for 1988-1994, while Singapore reports average annual imports of 12t for 1991-1993 (Hayes, 1996a).

Export of shark fins represents the most important opportunity for **South Pacific island nations** to obtain cash earnings from shark fisheries, although much of the shark fin in trade appears to originate from foreign longline vessels landing fins in regional ports. Data from FAO and other sources report Fijian exports of shark fin averaging 26.7t annually, 1980-1994. Data for the Solomon Islands are reported only for 1987-1992, when exports averaged 3.9t annually. Vanuatu reports average exports of shark fins for 1980-1988 of 8.9t annually, while records for Kiribati show average exports of 1.5t annually, 1980-1989 (Hayes, 1996b).

South Asia

India has historically served as a producer of shark fin. Much of the trade is carried out by Tamils and Muslims from Tamil Nadu working in Madras, often with relatives based in Singapore and Malaysia, who serve as business partners. Fins are shipped primarily to Singapore, Malaysia, and Thailand for consumption, processing, and/or re-export. Wholesale prices for shark fins are reported to have increased dramatically from 1991-1992, in some cases by nearly 500%, although this increase was reflected only marginally in producer prices (Anon., 1992a). Reported exports of fins averaged 156t annually during 1988-1992, with Hong Kong and Singapore together absorbing some 90 to 100% of India's trade. Smaller and more sporadic exports are reported to the USA, Sri Lanka, Taiwan, Japan, South Korea, Bahrain, Kuwait, Germany, Ireland, the UK, and Spain (Anon., 1994b). It is noteworthy that final trade destinations, although known within India, are not reported in Customs statistics. The fact that these destinations are revealed in other sources (e.g. market reports) may reflect the importance of Southeast Asian nations as trans-shipment points, rather than consuming nations, for Indian fins, or merely a lack of reporting of trade to nearby countries.

Trade of shark fins also represents a significant source of earnings in other countries of the region. Shark fin exports from **Pakistan** averaged 217t annually during 1982-1991. **Sri Lankan** fin exports rose from 45t in 1982, to 123t in 1989; **Bangladesh** reported average exports of 41t during 1982-1988 (Anon., 1992b). In the **Maldives**, fin exports have been recorded since 1963, rising to significant levels in 1977, in response to a large increase in fin prices in that year. Exports averaged 18t annually during 1982-1991; although the price per kilogramme rose dramatically again in 1987, exports have been relatively stable for the past decade. Shark fins are brought by fishermen to Malé for sale to exporters, who further trim and dry the fins. The fins are exported by air to Singapore, then re-exported to Hong Kong (Anderson and Ahmed, 1993).

East and southern Africa

Markets for fins in east and southern Africa have become established to varying degrees over the last three decades, and a variety of trade routes have emerged. Kenya, Tanzania, Madagascar, and South Africa export shark fin directly, while Kenya and South Africa also import shark fin from neighboring countries, for re-export to Asia. Somalia exports most shark fin through Dubai, sometimes *via* Djibouti, and shark fin from Eritrea is predominantly traded through Yemen. Primary markets for regionally produced shark fin are Hong Kong, Singapore, and Japan (Barnett, 1996a).

Data from provinical authorities in **Madagascar** reveal average shark fin production of 14t annually, 1990-1994, and average shark fin exports of 10t annually, for 1990-1995, with a peak of 18t in 1991. According to national export statistics, however, shark fin exports averaged 18t annually during 1990-1994, increasing from seven tonnes in 1990, to a peak of 29t in 1992, before falling back to 17t in 1994, as world prices declined. In 1994, Hong Kong accounted for 72% of Madagascar's shark fin exports. Since 1992, West African buyers operating in Madagascar have increased the competitive nature of the trade in shark fin by buying directly from fishermen, by-passing traditional middlemen, and thereby narrowing the margin between producer and export prices. Fishermen are aware of preparation requirements and use the half moon cut, then dry the fins for three to five days before sale. Only one trader has attempted to process the fins before export, but the level of technical skill and rate of processing were inadequate to compete with processing centres in Hong Kong or China (Cooke, 1996).

Similarly, during the past five years in **Tanzania**, the number of traders operating has increased rapidly. As a result, local prices for shark fin have increased by some 70%, owing to increased competition among traders, while the profit margins of primary collectors and exporters have been reduced. However, reported exports of shark fin averaged only 0.05t annually during 1989-1994, as fin exports are often classified as "fish offal" in order to evade export duties (Barnett, 1996b).

In the **Seychelles**, reported exports increased from four tonnes in 1985 to an average of 16t annually during 1987-1994 (Marshall, 1996d). Neither landings, nor trade in shark fins, are reported for **Somalia**, but both artisanal and commercial fishermen are known to market fins at some US$12.00 to US$20.00 per kg, the latter at ports in Tanzania, Yemen, and Kenya, as well as in Somalia (Marshall, 1996b). Reported **Kenyan** exports of shark fin peaked in 1991 at 19t, then declined sharply to 4.3t in 1995; although Kenya is known to import shark fin from Somalia and Tanzania, no imports were reported between 1990 and 1995 (Marshall, 1996c).

South African exports of shark fins averaged 32t annually during 1991-1993. In addition, re-exports of 32t were reported in 1991. Imports during this period averaged 41t annually. Imports are likely to consist largely, or even entirely, of shark fins landed in South Africa by foreign vessels for re-export, and data by country available for 1993 report imports from Japan and Taiwan. Most shark fin exports in that year were destined for Hong Kong, with small volumes traded with Japan and Singapore. In addition to domestic and foreign commercial landings, the Natal Sharks Board beach meshing programme serves as an additional supply of shark fins in trade, as these are marketed in order to derive revenue for the programme (Smale, 1996).

Europe

In Europe, as well as in North America, Piked Dogfish fins obtained from large-scale, directed, commercial fisheries are often collected by processors for export to Asia, particularly to Hong Kong. Basking Shark fins from the UK were sold to a Norwegian firm up until 1994, and Norwegian exports of shark fin are known to include both those of Piked Dogfish and Basking Sharks, as well as Porbeagles. Shark fin trade is not reported in *Eurostat* data, nor, in most cases, by national agencies, so that the volume of imports to the EU is not known. However, trade statistics of trading partners suggest that exports of shark fin from EU countries is significant. During 1988-1994, the national trade statistics of Hong Kong, Singapore, Thailand, and Malaysia indicated exports from at least 13 European countries: Austria, Belgium, Luxembourg, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Switzerland, Turkey, and the UK (Fleming and Papageorgiou, 1996).

Spain is by far the most important European exporter of shark fin, and the only EU country to report trade in shark fin. During 1994 and 1995, Spain reported exports of 1960t of dried shark fin and imports of 730t (Fleming and Papageorgiou, 1996). Guzmán and Quintanilla (1996) report that for some of the species destined for the fish market, such as Shortfin Mako Sharks and thresher sharks, the fins are also retained and sold. During the processing of sharks aboard large freezer longliners, fins are removed prior to freezing for all species caught. In many fisheries, however, sharks may be finned and the carcass discarded. Some 60-70% of the shark catch is composed of Blue Sharks, and this species is frequently finned on board, anal fins taken in addition to dorsal, pectoral, and caudal fins. Scalloped Hammerheads and Great Hammerheads are always finned, while Smooth Hammerheads are finned in some areas where the meat is of low value compared to fins. The average price in 1996 for large, wet fins was US$8.15 to US$12.00 per kg. During market surveys, fins were reported to be in export trade to South Korea, Thailand, China, and Japan, as well as Hong Kong (Fleming and Papageorgiou, 1996).

Packaged and processed shark fin products are imported from Asia and marketed throughout Europe. Shark fin products most frequently marketed in Europe include canned shark fin soup, dried fins, and processed fins. The packaging and labelling on such products indicate that they are imported from Singapore, Surinam, Hong

Kong, Indonesia, and China. France appears to be one of the largest importers of shark fin products in Europe. However, the complex trade relationships which may be involved are illustrated by one brand of dried fin located during market surveys in Italy: in this case, the fins had been produced in Surinam, were exported to Singapore for processing, exported to France, then re-exported to Italy (Fleming and Papageorgiou, 1996).

Cleaning shark fins.

The Americas

Although the USA in recent years has played a significant role in world shark fin trade as a supplier, importer, consumer, and transshipment point, the USA does not report production or export of shark fins. Data reported by US seafood processing plants indicate domestic production of 118t in 1989, but this figure is likely to be significantly less than actual total domestic production. The development of large-scale, commercial, directed shark fisheries in the mid- to late 1980s was undoubtedly accompanied by an increase in shark fin production, much of it a by-product of directed fisheries for Piked Dogfish on the Atlantic and Pacific coasts. Since the late 1980s, much of USA's shark fin production is likely to have consisted of Piked Dogfish fins, as processors and dealers report that these fins are universally taken and have been in trade for at least the past 10 to 20 years. Indeed, the finning of dogfish is also reported to have occurred even earlier, when prices for dogfish meat were too low to make it economically viable to land and process the entire fish. After 1993, the implementation of landing quotas and other restrictions for the Atlantic coast fisheries, and the decline of the Atlantic Piked Dogfish fishery, have reduced the volume of supply available from the USA (Rose, 1996d).

Imports by the USA averaged some 54t annually during 1972-1985, then increased rapidly to a peak of 281t in 1992. Rising imports from Latin America and the Caribbean accounted for much of this increase, most notably from Brazil, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Mexico, Netherlands Antilles, Nicaragua, Panama, Peru, Trinidad and Tobago, Uruguay, and Venezuela. Significant imports from Canada, Africa, and the Pacific also began to appear in the late 1980s and early 1990s. Although the bulk of both domestic production and imports is exported or re-exported, there is also significant and apparently growing domestic consumption of shark fins in urban areas with large populations of ethnic Chinese. However, shark fins are typically exported to Hong Kong and Singapore for processing, then re-imported from Asia as processed fins (Rose, 1996d).

Exports of shark fins are not reported in Customs records, but Hong Kong reports imports of shark fins from the USA averaging 366t annually during 1988-1994, increasing from 261t in 1988, to a peak of 479t in 1992, then declining to 418t in 1994. Singapore reports average annual imports from the USA of 17t during 1990-1995, increasing from three tonnes in 1990, to 34t in 1995. China's Customs data, available for 1992 and 1994 only, report imports from the USA of 37t and 44t, respectively (Rose, 1996d).

Canadian Customs do not specifically report trade in shark fins, but market research conducted by TRAFFIC suggests that the fins primarily of Piked Dogfish and Blue Sharks are processed for export (Rose, 1996b). Dockerty (1992), analysing the Customs records of nine Asian importing nations (Hong Kong, Japan, Indonesia, Malaysia, Singapore, South Korea, Sri Lanka, Taiwan, and Thailand), reports minimum Canadian exports of shark fin averaging 18t annually during 1984-1990, increasing from seven tonnes in 1984, to 23t in 1990. Hong Kong Customs records report imports of dried shark fins averaging seven tonnes annually during 1988-1994 from Canada, and the USA reports average imports of dried fin from Canada of 14t annually during 1988-1995 (Rose, 1996b).

In **Mexico**, shark fins are typically removed by processors for drying and sale, and in many cases are collected by the agents of fin dealers at open-air markets. For the years 1978-1988, Mexico's Ministry of Fisheries reports average exports of 137t of shark fins annually; data are not available from this source after 1988. Hong Kong Customs report average imports of shark fin from Mexico of 150t annually during 1984-1994, peaking in 1994 at 207t. Much of Mexico's shark fin exports are, however, likely to be shipped first to the USA, which country's Customs report imports of shark fin from Mexico averaging 29t annually during 1986-1995 (Rose, 1996c).

In **Uruguay**, shark fins are retained in both artisanal and large-scale commercial fisheries. Prices paid to the fisher range from US$8.00 per kg for the majority of species taken in artisanal fisheries, to US$17 per kg for Sand Tiger Shark fin. Fins may be exported in either frozen or dried form, with export prices of US$14.00 per kg, and US$27 to US$140 per kg, respectively. Reported exports remain low, averaging seven tonnes annually during 1993-1995. Countries of destination reported in trade statistics for these years are Mexico, USA, Hong Kong, Singapore, and China, with Hong Kong accounting for the majority of exports (Villalba-Macías, 1996).

Argentina exported an average of 56t of shark fin annually during 1990-1994. With declining exports of shark meat, the contribution of shark fin to total exports of shark meat and fins increased from 1.6% by weight, or seven per cent by value, in 1990, to five per cent by weight and 23% by value, in 1995. Reported exports of Tope Shark fins declined from 21.5t in 1990, to 0.5t in 1994. Despite declining exports of meat, the relative importance of Tope Shark fins to total exports of products from this species also declined during this period, from 0.8% by weight and 3.1% by value, in 1990, to 0.1% by weight and 1.5% by value in 1995 (Chiaramonte, 1996).

Shark skins – primarily for leather

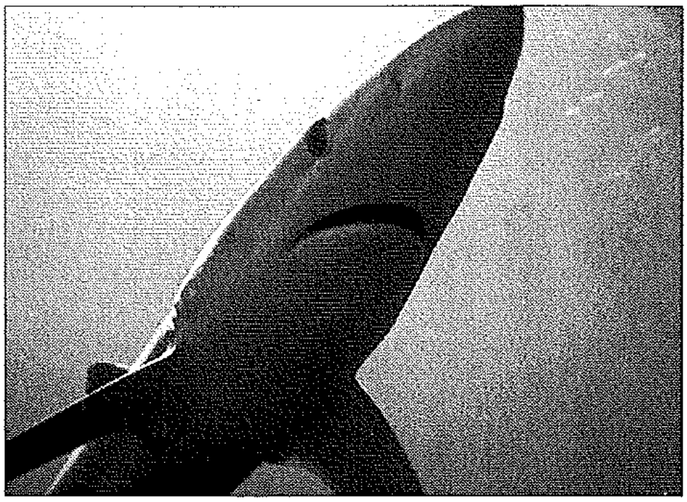
Shark skins are characterized by the presence of small placoid (toothlike) plates, called dermal denticles, on the skin and the attachment of the muscles directly to the skin. These characteristics make it difficult to skin sharks and to process their hides. Shark skins were originally used as a rough abrasive for rasping and polishing; shark skin in its rough form is known as shagreen. Boroso leather, made from the hides of small shark species, is made by polishing the denticles to a high gloss, and is an extremely expensive leather. The discovery by the *Ocean Leather Corporation* of a chemical process for removing the denticles from shark skins brought shark hides into wider usage for tanned leather. Shark leather is extremely durable and has an attractive grain that sometimes resembles crocodile skin (Kreuzer and Ahmed, 1978). Traditionally, the Japanese used shark skin in armour and sword handles. Currently, shark leather is used in Japan for handbags and watch straps (Kiyono, 1996), and in the USA primarily for cowboy boots, belts, and watch straps (Rose, 1996d).

A significant market for shark leather originally developed only in the USA, with other markets subsequently evolving in Japan and Europe (Kreuzer and Ahmed, 1978). Even in the USA, however, fisheries based primarily on the production of hides have historically proven unsuccessful economically. Tanneries require skins from sharks of 1.5m in length or greater, and it is difficult to supply a sufficient number of large sharks in a single area over a long time period. Moreover, the skins of large mature females tend to be heavily scarred owing to wounds inflicted during mating, so that many large hides are not marketable or are of low value (Kreuzer and Ahmed, 1978).

The increasing popularity of fresh and frozen shark meat also discourages the use of shark skins for leather production. Shark is often sold as gutted, or headed and gutted carcasses, and the skin left intact to protect the meat and delay oxidation. Shark skins are damaged by exposure to fresh water or to ice, but on-board processing for the production of meat typically includes gutting and immediate refrigeration or freezing of the carcass. On the other hand, retention of shark skins is much more feasible during production of dried and/or salted meat from large sharks, especially in small-scale fisheries with short trip durations (Kreuzer and Ahmed, 1978; Limpus, 1987). Production of shark leather therefore remains significant in some countries, such as Mexico (Rose, 1992; Rose, 1996c).

Preferred species

According to Kreuzer and Ahmed (1978), shark species preferred for the production of leather are the Tiger, Nurse, Lemon, Dusky, Sandbar and Bull Shark, Porbeagle, Night Shark *Hyporion signatus*, Blacktip and Shortfin Mako Shark, Scalloped Hammerhead, Shortnose Saw Shark *Pristiphorus nudipinnis*, Blue Shark, and Taiwan Gulper Shark *Centrophorus niaukang*. These authors report that Nurse Sharks produce the most highly valued hide, and that the Blue Shark is the preferred species among Japanese tanners, but that its leather is not marketable in the USA or Europe (Kreuzer and Ahmed, 1978; Limpus, 1987).


Charles Hood/WWF UK

Blue Shark *Prionace glauca*.

Tanneries in the USA and Mexico, on the other hand, report that Tiger Shark is the preferred species for the production of leather, while the skins of Lemon, Dusky, Blacktip, and Whitetip Sharks are also suitable, and the skins of Nurse Sharks may be tanned, but are of considerably lower value (Rose, 1996c, 1996d). In Zanzibar (Tanzania), preferred species for leather are the Great Hammerhead and the Scalloped Hammerhead (Barnett, 1996b). Compagno (1984) and Last and Stevens (1994) report that the skin of the Spotted Wobbegong *Orectolobus maculatus* is highly favoured for leather, while Ornate Wobbegong *Orectolobus ornatus* and Tasselled Wobbegong *Eucrossorhinus dasypogon* are also occasionally used.

Other species reported to be utilized for leather include the Spinner Shark, Bignose Shark, Common Hammerhead, Great White Shark, Broadnose Sevengill Shark, thresher sharks, Tawny Nurse Shark, Basking Shark, Piked Dogfish, Kitefin Shark, Smoothback Angelshark, Sawback Angelshark (Compagno, 1984; Frimoldt, 1995b), and sawfish (Anon., 1985).

In many cases, species that are heavily fished for consumption fresh or frozen may not be utilized for their leather, owing to different processing requirements. For example, Shortfin Mako Shark, thresher shark, and Porbeagle skins are not likely to appear in markets and trade. Processing and marketing practices vary widely, however, according to available facilities for storage and processing, characteristics of the fishery, and other factors. In Mexico, for example, skins are frequently taken from a number of species used for the production of dried and salted shark meat (Rose, 1996c).

Processing and preparation

Shark skins are removed by starting a main cut down the centre of the back of a shark from which the fins have already been removed. Additional cuts are made around the head, behind the gills and pectoral fins, and around the edge of the lower jaw. The skin is then peeled back with the aid of a knife, fleshed, washed with saltwater, and salted. The H-shaped hides are packed by folding the flesh side in, and then sorted by species and grades prior to shipment to the tannery (Kreuzer and Ahmed, 1978; Rigney, 1991).

All shark hides intended for leather tanning are graded according to the number of imperfections (spots, cuts, scars, damage from prolonged exposure to the sun). Generally speaking, the skin is graded by inspecting three sections: the centre and two flanks. A top grade hide has no imperfections, while if all three sections are damaged, the hide is worthless. Grading of Blue Shark hides in Japan is also based on the area damaged, but requires that no imperfections be found in the centre of the skin (Kreuzer and Ahmed, 1978). One Australian marine tannery also grades according to the following sizes: grade 1 = over 2m, grade 2 = 1.5-2m, and grade 3 = 1-1.5m (Rigney, 1991).

Markets and trade

The *Ocean Leather Corporation* of the USA succeeded in monopolizing the production of shark leather for several decades, and in the mid-1980s reportedly handled some 50 000 shark skins annually. More recently, tanneries in Europe, Japan, Australia, and Thailand have begun to process shark leather, and attempts have been made to utilize skins which would previously have been discarded, in the Bay of Bengal region (Bostock, 1991; Rigney, 1991). Unfortunately, neither domestic production data nor trade data for shark skins are available from the majority of producing countries, including Australia, Japan, China, Bangladesh, Thailand, or Europe.

East Asia

Shark skins are used in China to produce shagreen (untanned shark skin, both polished and unpolished), and tanneries are also believed to exist, although no international trade is known to occur (Parry-Jones *et al.*, 1996). Although Japanese tanneries are known to produce shark leather, no specific information on markets and trade is available.

Southeast Asia

In Indonesia, shark skins are tanned to produce high-quality shoes and handbags for the domestic market; it is not known whether Indonesian shark leather appears in international markets. In Thailand, the skins of both sharks and rays are tanned domestically, but again, no information is available on external trade (Chen, 1996).

Oceania

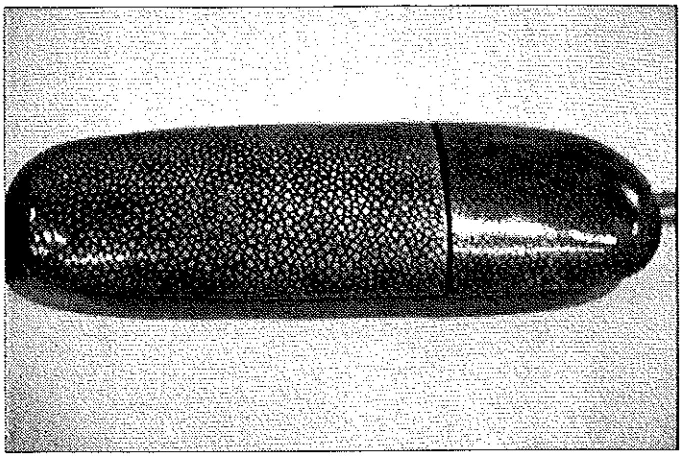
As of 1991, Australia was also reported as exporting shark skins to New Zealand, not for the production of leather, but for use in sanding porcelain doll heads (Rigney, 1991). In late 1995, an Australian processor and exporter established facilities to export the hides of Tiger Sharks, mako sharks, sawsharks, and Blue Sharks to Japan, although more recent information is unavailable (Pengelley, 1995).

Indian subcontinent

Shark skins are occasionally used for leather tanning in India and are used to manufacture handbags, sandals, watch straps, wallets, and bicycle handle grip covers, but it is not known whether such products enter international trade (Hanfee, 1996). In the Maldives, shark skins continue to be used for sanding wooden boats. They are also occasionally retained for sale, but local prices are generally too low for fishermen to prepare the skins (Anderson and Ahmed, 1993). TRAFFIC market research also indicates production of shark skins in Bangladesh.

East and southern Africa

The use of shark skins appears to be extremely limited in east and southern Africa. The only documented trade in shark skin occurs in Zanzibar (Tanzania), which reportedly exported some 100kg of skin to Hong Kong in 1994 and 300kg in 1995. Reported export value per kilogramme was US$0.04 in 1994 and US$7.20 in 1995. The trade is limited to skins available in the immediate proximity of a single exporter, as sharks landed elsewhere are not skinned immediately upon landing (Barnett, 1996b). In Madagascar, skins may occasionally be collected for sale, but the expertise for tanning is rare or non-existent (Cooke, 1996). There is no documented use of shark skins for local or export markets elsewhere in the region (Marshall and Barnett, 1996).



Rob Parry-Jones / TRAFFIC

Leather glasses case made from chondrichthyan skin.

Europe

Shark skin and leather are traded in Europe, although data are unavailable for most of the countries in the region. Spain appears as one of the most important traders of shark skin in Europe. According to data from the General Subdirection of Statistics and Planning, Spain imported an average of more than 2800t of shark skin and 125t of leather annually during 1994 and 1995, and exported an average of more than 800t of skin and 200t of leather annually during these years. Shark skin also continues to be used by fishermen in southern Spain to polish and sand their boats, although this practice is less common than in the past. Until recently, Germany served as a significant shark leather market that imported raw skins from Mexico *via* Italy and Switzerland, Indonesia, and South America. Shark leather was commonly used in the manufacture of furniture and in bookbinding, and occasionally for the manufacture of shoes and handbags. Apparently, however, restrictions placed on the German national tanning industry in the early 1990s led to the substitution of German-tanned leather with imports of tanned skins from the UK, France, and Italy. Watch straps are currently the only shark leather product known to be produced in Germany. In France, a tannery in Paris specializes in fish skins. Shark and ray leather is used to make luxury accessories, such as wallets and jewellery. Ray skin is well known in France as *galluchat* and used by renowned leather goods manufacturers (e.g. Hermès) and has been used in the furniture trade. *Dasyatis sephen*, of Asian origin, is reportedly one of the species used for *galluchat*. Shark skin watchstraps and belts were found throughout Paris by TRAFFIC researchers. In addition, shark leather is reportedly tanned in Italy for export and for the production of watch straps and possibly other products (Fleming and Papageorgiou, 1996).

The Americas

The principal demand for shark leather in the USA is for the manufacture of cowboy boots in Texas, with smaller sales to manufacturers of small leather goods, particularly watch straps and belts, in the USA, Europe, and Asia. The *Ocean Leather Corporation* no longer exists, and a single tannery processes shark skins along with other exotic leathers. The popularity of Western boots has declined since the 1980s, so that tanning of shark skins within the USA has reportedly fallen off sharply. In previous years, the tannery purchased some raw skins from USA suppliers, but owing to the difficulty of processing raw skins, now purchases only crusted skins of Tiger, Dusky, Blacktip, Whitetip, and Nurse sharks from a single supplier in Mexico. Tanned shark leather continues to be imported directly by brokers and leather goods manufacturers (Rose, 1996d).

Available trade data are inadequate to determine the sources and species most important to the production and trade of shark leather. The USA imported over US$3.5 millions' worth of shark skin from 1978-1987, primarily from Mexico, but also from other countries such as France and Japan. Customs data for 1984-1990 report average annual imports of 11 984 whole skins, rising from 1189 skins in 1984, to a peak of 36 818 skins in 1989. Imports from Mexico were likely to have consisted of a mix of raw, crusted, and tanned skins, while imports from other sources are likely to have included only tanned leather. In 1989, USA Custom commodities were revised and shark skin was no longer included in its own commodity code (Gaski, 1991). After 1989, the only data available on USA trade in shark skins and leather products are those reported by the *US Fish and Wildlife Service*; these data are likely to significantly under-represent volumes in trade, and report all trade of shark skins under a single species category: Tiger Sharks. Moreover, inconsistent units of measure make it difficult to assess the volume of skins traded (Rose, 1996d).

During the 1980s, a significant trade in shark skins occurred across the US-Mexico border when shark skins were imported by US companies, cut, exported to Mexico for assembly into Western boots and other products, and then re-exported from Mexico to the USA. In addition to this cross-border trade for boot making, a number of shark skins and shark leather goods entered the USA directly from Mexico. During 1987-1990, US imports from Mexico included 69 283 skins, 38 380 partial skins, and an additional 715m², 65m and 413kg of skins; 192 430 pairs of shoes and boots; 22 335 small leather products; and 26 large leather products. Reported US exports of shark skins, leather, and leather goods to Mexico during the same period totalled 2528 skins, 15 916 partial skins, and 120m of skins; 11 202 pairs of shoes and boots; 11 699 small leather products; and 1134 unidentified products (Rose, 1991). Although Mexico is known to be a major supplier of shark skins to the USA, the nature of the trade and the fact that US exports are more commonly under-reported than are imports make it difficult to determine what proportion of these skins and leather products originated in Mexico.

There are a number of shark skin tanneries currently operating in Mexico. Buyers in the Yucatan purchase wet, salted skins from processors at approximately US$4.00 each, and are generally able to use the skins from all species. At least one Mexican shark leather tannery has historically purchased raw shark skins from several Central American countries (Rose, 1996c). Shark skins are exported to the USA, as stated, and to a lesser extent to Europe, and are used for the domestic manufacture of boots and small leather goods. Tanneries on both the Gulf of Mexico and Pacific coasts report that shark skins are becoming more difficult to supply, however, as a result of increased marketing of fresh and frozen shark meat, as carcasses are often processed whole with the skin intact, or as splits (halves), which destroys the belly flap favoured by tanneries and leather goods manufacturers. The Bank of Mexico reported exports averaging four tonnes of raw shark skins annually during the period 1983-1993, and 14t of finished skins annually during the period 1984-1988 (Rose, 1991; Rose, 1996c).

Shark skin is reportedly collected in small volumes for export in Argentina, but production and trade data are not available. Processors in Argentina report that Mexican companies have attempted to purchase shark skin in Argentina, but an export trade has failed to develop owing to the small sizes of abundant species (Chiaramonte, 1996).

Shark liver oil

Sharks have no swimbladder; instead, hydrostatic functions are performed by their large livers saturated with oil. Shark livers vary in size and weight by species and by season, and the relative weight of the liver to total body weight tends to increase with size (Kreuzer and Ahmed, 1978). Shark liver oil has been widely used historically as a lubricant, in the preservation of small vessels, in the tanning and curing of leather, and for a variety of other uses. For example, the Maoris of New Zealand used the liver oil of the Tope Shark in cosmetics, traditional ceremonies, and mixed with pigment in painting canoes, houses, and carvings (Hayes, 1996a). In the late nineteenth century, a fishery for Piked Dogfish existed off the Atlantic coast of the USA exclusively for liver oil, which was used for the tanning and curing of leather. After the Second World War, dogfish liver oil also began to be used as a rubber extender (Jensen, 1965). In Japan, shark oil was used as a lubricating oil in combat aeroplanes during the Second World War (Kiyono, 1996). In India, a shark liver oil factory was established in Calicut in 1854 (Hanfee, 1996). In South Korea, locally processed shark liver oil was historically used in paint and cosmetics, but is now used mainly in the production of animal feed (Parry-Jones, 1996b). In Ireland, Basking Shark liver oil was used to light street lamps as early as the 1740s, and until the 1930s, liver oil of Stingrays *Dasyatis pastinacea* was used to treat rheumatism and other ailments, and used by fishermen who soaked their underwear in it to protect themselves against cold weather (Fleming and Papageorgiou, 1996).

In the 1930s, global markets developed for shark liver oil for use in the production of vitamin A supplements, but by the 1950s, these markets had collapsed owing to the development of synthetic vitamin A. Currently, a limited market remains for shark liver oil, sold in capsule form as a health supplement. The liver and body oils of Piked Dogfish and other sharks continue to be used in the USA and in Europe in the tanning and curing of leather (Buranudeen and Richards-Rajadurai, 1986). Shark liver oil is also sometimes used as an ingredient in *Preparation H*, an over-the-counter haemorrhoid ointment manufactured in the USA and distributed internationally (Rose, 1996d), and in Japan, is used in sanitary wipes used for cleaning toilets (Kiyono, 1996).

Shark liver oil also yields squalene, an acyclic hydrocarbon ($C_{30}H_{62}$) that appears to serve a biological function related to living at great depths and that is used in the manufacture of lubricants, bactericides, pharmaceuticals, and cosmetic products such as skin creams. Squalene is included as a non-active ingredient in pharmaceutical applications because it imparts increased skin permeability, while squalane, a compound produced by hydrogenating squalene, is miscible with natural skin oils and is therefore useful as a skin moisturizer. Diacyl glyceryl ethers, another form of chemical compound found in shark liver oils, is reported to be effective in the healing of wounds and to prevent the multiplication of bacteria, while it is also said to protect against radiation (Summers and Wong, 1992; Buranudeen and Richards-Rajadurai, 1986; Kreuzer and Ahmed, 1978).

In 1993, the chemical compound squalamine was isolated from dogfish. Studies conducted in the USA since 1993 suggest that the chemical is effective against bacterial infection, and also acts against viruses, including HIV. A pharmaceutical company in Pennsylvania, in collaboration with the National Institute of Health, is currently testing the use of squalamine for potential use in the treatment of several sexually transmitted diseases, including herpes, gonorrhoea, and chlamydia (Mestel, 1995). In 1996, researchers at Johns Hopkins Medical Institution reported that in preliminary tests using laboratory animals, synthetic squalamine also appeared to slow the process of vascularization in solid brain tumours, suggesting that squalamine may be useful in the treatment of cancer (Altman, 1996).

Preferred species

Several species of shark are known or reported to yield liver oil rich in vitamin A; these include the Tope Shark, Piked Dogfish, Cuban Dogfish *Squalus cubensis*, catsharks *Galeus* spp., Longfin Mako Shark, Starspotted Smooth-hound, and hammerhead sharks (Frimodt, 1995a and 1995b; Kreuzer and Ahmed, 1978). In India, Tiger Sharks, hammerhead sharks, and sawfish are reportedly among the species utilized (Hanfee, 1996).

Sharks that have a high squalene level tend to have a lower vitamin A content in their liver oil. Shark species preferred for the squalene content of their liver oil are usually found at depths of some 600 to 1000m and include the Shortspine Spurdog, Leafscale Gulper Shark, Birdbeak Dogfish, Needle Dogfish *Centrophorus acus*, Lowfin Gulper Shark *C. lusitanicus*, Taiwan Gulper Shark, and Basking Shark (Kreuzer and Ahmed, 1978). Also reported to have high yields of squalene from their liver oil are the Longnose Velvet Dogfish, Mandarin Dogfish *Cirrhigaleus barbifer* and Kitefin Shark (Compagno, 1984; Last and Stevens, 1994).

Several other shark species are exploited for their liver oil for more generalized uses. These include the Roughskin Shark *Centroscymnus owstonii*, Bluntnose Sixgill Shark, thresher sharks, Great White Shark, Salmon Shark, and Porbeagle (Compagno, 1984; Frimoldt, 1995a, 1995b; Kiyono, 1996). The Smoothback Angelshark and Sawback Angelshark are reportedly utilized for their liver oil in Africa and the Mediterranean (Compagno, 1984). Last and Stevens (1994) report that Bramble Sharks *Echinorinus brucus* are utilized for their liver oil in South Africa, while the Snaggletooth Shark is exploited in India.

Other species reportedly used for their liver oil are Plunket's Dogfish *Centroscymnus plunketi*, Tawny Nurse Shark, Sand Tiger Shark, Shortfin Mako Shark, Bignose Shark, Spinner Shark, Silky Shark, Bull Shark, Blacktip Shark, Oceanic Whitetip Shark, Blacktip Reef Shark, Dusky Shark, Sandbar Shark, Sicklefin Lemon Shark, Whitetip Reef Shark, Winghead Shark, Smooth Hammerhead, angelsharks, and the Wide Sawfish, which yields liver oil suitable for medicinal use, soap-making, and leather tanning (Last and Stevens, 1994).

In the Maldives, Tiger Sharks, Whale Sharks, and Bluntnose Sixgill Sharks are targeted for their livers, and several additional species may be used. Smalltooth Sand Tiger and Bignose Sharks are considered to yield excellent quality oil, while Shortfin Mako Sharks, Silvertip, Grey Reef, Oceanic Whitetip, Spot-tail and Sicklefin Lemon Sharks, hammerheads and Giant Guitarfish yield liver oil of average quality. Tawny Nurse Sharks, variegated sharks (species unidentified), thresher sharks, Silky Sharks, Blacktip Reef Sharks, Blue Sharks, and Whitetip Reef Sharks are considered to have poor quality but usable oil (Anderson and Ahmed, 1993).

Processing and preparation

Shark liver oil intended for the production of squalene should be prepared within 15 minutes of the death of the fish (Kreuzer and Ahmed, 1978). It is reported that production of one tonne of squalene requires the livers of 2500-3000 sharks (Kiyono, 1996). Several methods have been reported for the extraction of liver oil. In Papua New Guinea, the oil is extracted by heating or by placing the livers in aluminium containers in the sun; the separated oil is then collected in tanks or drums (Anon., 1994c). In one oil refinery plant in India, livers are chopped to small pieces in a large mixer, cooked in a steam boiler, and the refined oil separated from the solid contents (Dahlgren, 1992).

In the Philippines, one processor reported purchasing livers of Piked Dogfish from local fishermen using hook-and-line gear. The average size of landed sharks is small, at some 35-40cm. The liver is chopped and boiled with water. As the oil rises to the surface, it is skimmed off and allowed to cool before residues are removed. Each boat trip yields some 15l of crude oil from some 60-80 sharks, which is purchased at US$14.00 to US$17.50 per litre. Crude shark oil is sold to buyers in Manila, in gasoline drums, each of which holds approximately 200 litres of oil, which takes an estimated 800-1000 sharks to produce. Refined oil is packed in 25-litre containers. A drum of refined squalene oil (equal in capacity to about eight containers) sells for some US$7700 (Chen, 1996).

In the Maldives, shark liver oil for treating wooden boats is obtained by rinsing the liver in seawater, cutting it into strips or small cubes, and placing the pieces in an oil drum or other metal container. The liver is left in the sun for a span of hours or days, then boiled until the water evaporates. The resulting oil is then strained through a gunny sack. To prepare higher-value liver oil for squalene, the liver is removed, placed into a container for sun-warming, then broken up by hand. The resulting fluid is left to stand until any sediment settles to the bottom. The oil is then strained off into a suitable container. The squalene content of the oil is checked by exporters using a hand-held refractometer. Shark liver weight averaged 27.8% of body weight, with an estimated average yield of liver oil of 0.23kg of oil per kilogramme of shark (Anderson and Ahmed, 1993).

Markets and trade

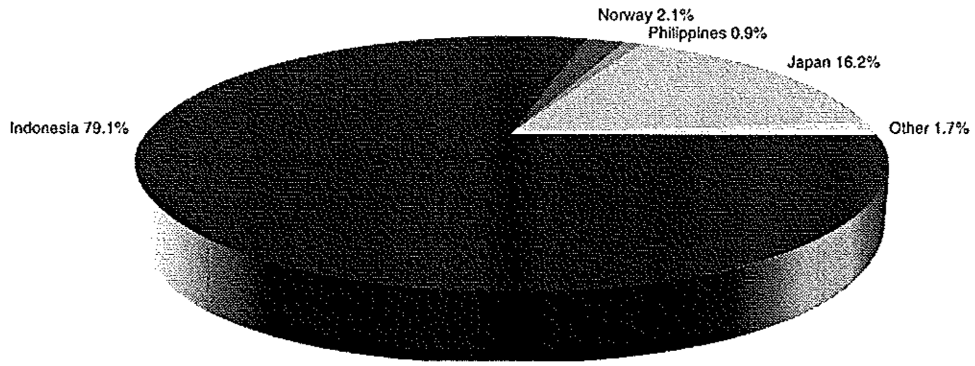
In the 1930s and 1940s, the use of shark liver oil as a lubricant and source of vitamin A prompted a boom in fisheries for Tope Shark and the Piked Dogfish, but the development of synthetic substitutes soon caused the shark liver oil market to collapse. Although the oil is still used in the manufacture of cosmetic and pharmaceutical products, little production or trade information is available. One trend suggested by TRAFFIC's regional market studies is the decline, in the case of many former suppliers, of the processing and marketing of shark livers and liver oil, at least in part owing to the difficulty of collecting the livers and to the strong odour of the products. Much of the current production of shark liver oil therefore appears to have shifted to developing countries.

East Asia

South Korea appears to be among the world's largest consumers of shark liver oil. Domestic production from adjacent waters averaged 28t annually during 1980-1994, and both shark livers and shark intestines are reportedly landed for the production of oil used in the manufacture of animal feed. Crude shark liver oil and squalene intended for human consumption are imported into South Korea, where the oil is packed locally. Imports increased from 1.7t in 1985, to an average of 358.7t for 1988-1994, with an average value over the latter period of US$10.24 per kg. The most important suppliers of oil to South Korea from 1987 to 1994 were Indonesia, Japan, Norway, and the Philippines (Figure 16). Key suppliers have shifted over the past decade, from the Philippines from 1985 to 1986, to Japan and Indonesia for the years 1987-1988, and Indonesia for 1989-1994. By 1994, Indonesia supplied 93% of reported imports. Imports are also sporadically reported for the USA, Sweden, Netherlands, Spain, India, Australia, and France. Bottled shark liver oil capsules are both manufactured domestically and imported from Australia. Small volumes of shark liver oil have also been exported to Canada, the USA, Hong Kong, Indonesia, Malaysia, and Norway, although no exports were reported in 1993 or 1994 (Parry-Jones, 1996b).

Figure 16

South Korean shark liver oil imports by country of origin and volume, 1987-1994



Source: Statistical Yearbook of Foreign Trade, 1984-1994, Republic of Korea Customs Administration.

Japan has historically been one of the world's most important producers of shark oil, and Japan's Central Sea, Suruga Bay and Sagami Bay, were among the best-known fishing grounds for deep-sea sharks in the world. Japan produced an average of 3844t of shark liver oil annually during 1926-1940, and continued to produce an average of 2909t annually during 1948-1962, dropping to an average of 1057t annually during 1963-1969. Thereafter, the annual average produced was 223t, during the period 1973-1980, after which production data ceased to be available. Japanese Customs include shark liver oil in the general category of fish oils, so that trade information is not available either, but South Korean Customs data report imports of shark liver oil from Japan averaging 52t annually for 1987-1994. Several Japanese cosmetic manufacturers use squalene in their products, but both imported shark liver oil and synthetic squalene are utilized, so the importance of genuine liver oil is not possible to quantify (Kiyono, 1996).

Shark liver oil is produced in **Taiwan**, but its importance has declined substantially owing to the decreasing availability of source species, competition from synthetic vitamin production, and the difficulty of retaining the liver undamaged by processing. Domestic production declined from 64t of shark liver oil in 1980, to two tonnes annually during 1990-1994 (Chen *et al.*, 1996).

Shark livers are retained in **China** and the oil used in manufactured cosmetics and liver oil capsules, although production is reported to have declined. Dogfish alkene (*jiaoshaxi*) is used medicinally in the treatment and prevention of cancer, heart attacks, and hepatitis, and dogfish oil (*jiaoshayou*) is used in cosmetic treatments. Parry-Jones *et al.* (1996) also report the possible formation of a joint venture between an Indonesian company and a Chinese pharmaceutical manufacturer, in which livers would be shipped from Indonesia to China for processing and the liver oil re-exported to Southeast Asia, but no further information is available. Manufacture of packaged shark liver oil products is also known to occur in **Hong Kong**, but again no further information is available (Parry-Jones, 1996a).

Southeast Asia

Indonesia is among the largest producers of shark liver oil in the region, with South Korea reporting imports of liver oil from Indonesia of 364t in 1994 alone (Parry-Jones, 1996b); however, trade data are not available from Indonesia as Customs data do not include a separate classification for shark liver oil (Bentley, 1996b).

In the **Philippines**, a targeted fishery for Piked Dogfish was initiated in 1967 to extract their liver oil for export to Japan. During 1979-1981, the Philippines exported an average of 263t of shark liver oil annually, primarily to Japan. Exports fell to 45t in 1993, and amounted to 112t in 1994, with exports in those years reported only to Japan (134t or 85% of total exports) and South Korea (23t or 15% of total exports) (Chen, 1996).

Oceania

Although shark liver oil is not reported in **Australian** Customs statistics, information from the Australian Quarantine and Inspection Service suggests that a significant volume has been consistently exported from southern Australia, although this has declined sharply in recent years; reported exports totalled 31.9t in 1992-1993, 17.1t in 1993-1994, and 2.0t in 1994-1995 (Bentley, 1996a). Reported Japanese imports of shark liver oil from Australia appear to confirm a peak in Australian exports in 1992-1993; Japanese imports during 1989-1992 averaged 23.62t annually, rising from four tonnes in 1989, to 66.5t in 1992 (Hayes, 1996b). Data for other years and from other sources are not available, so that it is not possible to confirm a trend.

New Zealand was a net exporter of shark liver oil during the 1940s, and domestic trade in shark oil from deep-water dogfish commenced following the declaration of New Zealand's EEZ in 1978. In 1985, 23t of shark liver oil were exported, and 2.9t of frozen shark livers exported in July-December 1986, but more recent trade data are unavailable. The directory of New Zealand exporters currently lists two companies exporting shark liver oil to the USA (Hayes, 1996a).

Small volumes of shark liver oil are also exploited throughout **the South Pacific region.** During 1985-1987, an experimental fishery for squalene-rich deep-water sharks was conducted in Fijian waters. In the Solomon Islands, a small commercial fishery exploits deep-water sharks for the production of shark liver oil for export to Japan; exports of liver oil to Japan averaged 4.82t during 1989-1992 (Hayes, 1996b). Recently, a small enterprise has been formed in Papua New Guinea for the production of shark liver oil from gulper sharks. The oil is reportedly exported to Japan, where it is used to manufacture shark liver oil capsules, soap, and cosmetic oils marketed as products that slow the ageing of the skin (Anon., 1994c).

South Asia

In **India**, a shark liver oil factory existed in Calicut in 1854 but closed owing to competition with the trade in imported cod liver oil. The industry was revived in 1940, but closed again some 10 years ago owing to difficulty in obtaining raw material. Liver oil extraction continues as a cottage industry, and the oil is used as a preservative for small craft, sent to refineries, or sold to Bombay for encapsulation. The value of the liver oil varies by species depending on the quality; 1992 prices were reported as ranging from US$4-6 per 15kg (Hanfee, 1996). A shark liver oil refinery in Kakinada was reported in 1991-1992 to have the capacity to handle some 200kg of liver daily, and to have purchased 21t of liver in 1991. The factory converts refined oil into vitamin A and D capsules, adding synthetic vitamins. One kilogramme of refined oil reportedly produces 10 000 capsules, and a packet of 1000 capsules sells for approximately US$2.00. There are also a few other companies that purchase shark liver for oil extraction (Dahlgren, 1992). The residue from liver oil is used for fish meal production for pigs and poultry (Hanfee, 1996). TRAFFIC market research also indicates production of shark oil or liver oil in **Bangladesh.**

In the **Maldives**, shark liver oil has traditionally been used in the treatment of small wooden vessels, primarily for subsistence use but also to a limited extent for local markets. The liver oil applied to the outside of the hull is mixed with *kadi*, a red powder imported from India that acts as a wood preservative. Use of shark liver oil is declining, but remains important. In 1980, a new market emerged for shark liver oil when Japanese buyers visited the Maldives in search of a reliable supply of high-value liver oil for squalene production for use in cosmetics and pharmaceuticals. The resulting gulper shark fishery produced an average of 36t of shark liver oil annually during 1980-1991, rising from eight tonnes in 1980 to a peak of 74t in 1982, then declining to 34t in 1991. All of the high-value shark liver oil produced is exported by sea to Japan (Anderson and Ahmed, 1993).

East and southern Africa

Shark liver oil is used or traded domestically within **Eritrea, Somalia, Kenya, Tanzania,** and **Madagascar** for use in maintenance of traditional fishing vessels, with local prices reported at US$0.50 per litre in Somalia in 1995 and US$4.50 per kg in Tanzania in 1996 (Marshall and Barnett, 1996). In Madagascar, most liver and oil is used or sold locally for wood waterproofing treatment and other applications. The only data available on production and trade are from Mahajanga provincial records for 1991 and 1992, which report shark liver oil production of 6256kg and 12865kg, respectively, by a joint Malagasy-Japanese company, probably for export to Japan. Oil production was based on a deep-water fishery for *requin marron* (species unidentified) near the Ile Juan de Nova, which ceased when France asserted its claim over the island (Cooke, 1996).

In **South Africa**, demand for vitamin A from shark liver oil led to the development of a directed shark fishery during the 1940s. By the end of the Second World War, South Africa was producing six million international units of vitamin A oil, but the fishery declined sharply after 1952, owing to falling demand. Shark livers are no longer marketed locally, nor for export (Smale, 1996).

Europe

European markets for shark liver oil or squalene products appear to be growing, and market surveys found shark liver oil, in the form of liquid, capsules, or shark liver oil-based ointments, on the market in Belgium, France, Germany, Greece, Iceland, Netherlands, Spain, and the UK. One Belgian distributor of squalene reported rising exports of this product to France, Portugal, Germany, and Switzerland, while in the UK, an affiliate of a US-based company distributes shark liver oil of Norwegian origin, manufactured by the US parent company, to other European markets. Growing European markets for shark liver oil products are also testified to by the development of new fisheries for liver oil in Spain in recent years (Fleming and Papageorgiou, 1996).

In the UK, a single-boat fishery arose for Basking Sharks for the industrial sale of its liver oil to a medicinal union in Norway. In the early 1980s, the Scottish Basking Shark livers were sold to Norwegian buyers for £600 (US$910) per tonne; by the late 1980s, the price had dropped to £230 (US$377) per tonne. Given the small scale of the fishery, and high costs for transporting the liver to Norway (around UK£135 or US$221 per tonne), the trade became economically unviable, and ceased in 1990. The current reported price for Basking Shark liver oil is US$1.25 per kg in Norway (Fleming and Papageorgiou, 1996).

Norwegian markets for Basking Shark liver oil are reportedly depressed owing to the entry of large quantities of inexpensive gulper shark liver oil supplied by Spanish fisheries, and Kitefin Shark liver oil from Portugal. The livers of these species are reported to yield more oil than Basking Shark liver, with livers weighing 20-33% of the total body weight, and yielding 70-80% oil that is 33.6% squalene. Piked Dogfish liver oil continues to be processed in Norway, primarily for use in the cosmetic industry and as a health supplement, and is currently traded at about US$0.60 per kg. According to published data from FAO for 1988-1994, Norwegian annual imports fluctuated from a low of 30t to a high of 358t in 1994. Exports averaged 3.6t until 1992, then increased to 11t in 1994 (Fleming and Papageorgiou, 1996).

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Shark products, including liver oil and squalene found on sale in Europe during 1996.

In **Spain**, squalene has been authorized as an active ingredient in cosmetic and pharmacological products, and two additional squalene products, an anti-haemorrhoid ointment and suppositories, are currently being considered for official registration. However, market surveys conducted in Spain during 1996 did not detect any shark liver oil products offered for sale in retail outlets. In northern Spain, a research programme and targeted demersal shark fishery currently being established by the *Instituto Español de Oceanografía* will explore increased commercialization of shark liver oil in an effort to improve utilization of domestic shark landings.

French fisheries catch significant numbers of deep-water sharks. Trade of shark liver oil is reported by a perfumery in southern France and in the manufacture of cosmetics and pharmaceutical products. In Germany, shark oil is reportedly used in the lathe industry. The Portuguese Dogfish is one of the deep-water species taken by French fisheries for this purpose (Fleming and Papageorgiou, 1996).

The Americas

In the **USA**, fisheries dealers and processors report that shark liver oil was produced in the past but that shark livers are now rarely taken because they are "messy," difficult to process, and have a strong odour. Although shark liver oil capsules are manufactured in the USA and available on the domestic market to a limited extent, recent Customs data are not available to determine the quantity of imports to supply this market. US Customs data for imports of shark liver oil are available for 1972-1986, and reveal limited and sporadic imports from Canada, Japan, Mexico, Norway, and Switzerland, totaling 43 116kg for the entire period (Rose, 1996d). Packaged capsules manufactured in the USA are in turn marketed worldwide (Rose, 1996d).

In Mexico, shark livers are occasionally retained and the oil consumed directly or sold in local markets for medicinal use, while a small number of manufacturers offer shark liver oil capsules for the health food market (Rose, 1996c). Oil from Tope Shark livers is reportedly exported from **Argentina** to Chile for pharmaceutical use, but trade data are not available (Chiaramonte, 1996). Shark liver oil is also retained for sale in **Uruguay**, with prices to the fisher of US$1.20 per litre, but no data are available on the volume of production, and it is not known if oil is traded externally (Villalba-Macías, 1996).

Shark cartilage

Several pharmaceutical and food products are produced from the soft and hard cartilage of sharks. Kreuzer and Ahmed (1978) reported that in Japan, the soft cartilage of sharks or skates is cut into pieces, boiled, cleaned, boiled again, and then dried in the sun to form a product known as *meikotsu*. The rostra or "noses" of Narrow Sawfishes are reported to be ground for sale in apothecaries' shops in southern China as a medicinal product (McDavitt, *in litt.* to S. Fowler, 1996). Chondrichthyan natrium, a chemical compound found in the hard and soft cartilage of sharks, is used in Japan as a treatment for eye fatigue and rheumatism – Blue Sharks are considered a good source – and chondroitine is a pharmaceutical substance used in eye drops (Kreuzer and Ahmed, 1978; Kiyono, 1996). At least one pharmaceutical company in Japan uses chondrichthyan natrium in the manufacture of eye drops, although mammalian sources are also used as a source (Kiyono, 1996). A chemical extracted from shark cartilage has also been used in the development of a synthetic skin for burn victims.

In recent years, shark cartilage powder and capsules have been marketed extensively worldwide as a treatment for cancer. Bovine and other mammalian cartilage has demonstrated effectiveness in inhibiting vascularization in tumours, and several trials have been conducted to explore the potential use of shark cartilage in the treatment of cancerous tumours. Trials with shark cartilage have demonstrated that concentrated extracts directly applied to the affected area inhibit vascularization in laboratory animals (Lee and Langer, 1984; Luer, undated). Positive research results were widely publicized beginning in the 1980s by I. William Lane, a nutritionist and biochemist from the USA whose book *Sharks Don't Get Cancer* (Lane and Comac, 1993) and featured interview on the television programme *60 Minutes* in 1993 prompted a boom in sales of freeze-dried cartilage in powder in capsule form. However, conclusive tests involving human subjects are not yet available, and there is as yet no evidence that shark cartilage administered orally contains sufficient amounts of active ingredients to be effective or even that it reaches the affected area (Luer, undated; Dold, 1996).

Preferred species

Although mammalian, and particularly bovine cartilage, is also being tested in the treatment of cancerous tumours, all sharks have a skeleton that is entirely cartilaginous, and are therefore viewed as a significant potential source of cartilage for pharmaceutical use. One Hong Kong-based dealer reports that Blue Shark cartilage is preferred because of its high chondroitine content (Parry-Jones, 1996a), but no further information is available regarding preferred species. In general, shark cartilage appears to be produced as a by-product of existing shark fisheries, so that species composition parallels that of local and regional fisheries.

Processing and preparation

A variety of methods are used in the preparation of shark cartilage for pharmaceutical use. Cartilage is generally retained and sold by the processor. In Mexico, small-scale processors sun-dry the vertebrae only prior to sale to manufacturers, while in both Mexico and the USA, large-scale manufacturers of shark cartilage products may purchase raw frozen vertebrae directly from fish wholesalers/processors for freeze-drying. Industrial fan dryers may also be used to dry the raw cartilage. Some Piked Dogfish processors in the USA retain the head and vertebrae, while at least one US-based manufacturer of shark cartilage powder and capsules imports heads, jaws, and "breast" as well as the vertebrae (Rose, 1996c, 1996d). In Argentina, sharks are typically marketed headed and gutted, but the heads are used for production of cartilage powder (Chiaramonte, 1996). Discards of cartilage from the processing of shark fin in Hong Kong are exported to Japan, presumably for the production of shark cartilage powder (Parry-Jones, 1996a), and at least one shark cartilage manufacturer in Japan produces shark cartilage reportedly obtained only from shark fins (Rose, 1996d), although most dealers report that both the vertebrae and gills are used (Kiyono, 1996).

Markets and trade

Shark cartilage is a relatively new product on the market, and neither national fisheries agencies nor Customs agencies report the volume of production or trade. Major producing nations, according to TRAFFIC market research, include the USA, Japan, and Australia. It is likely that shark cartilage is supplied by and/or manufactured in a large number of additional countries, but tracing trade routes is difficult owing to the nature of the trade. The volume of production is also difficult to assess because a limited number of companies appear to actually manufacture the cartilage powder; these companies purchase cartilage directly from the vessel (if the shark is processed on board), from processors or retail outlets, and/or from shark fin dealers, who often handle a variety of dried products, such as shark fin, shark cartilage, fish maws, and bêche-de-mer Holothuroidea. Manufacturers often import cartilage from abroad as well as from domestic suppliers, then market their own brand names and/or supply ground cartilage to other companies both domestically and abroad. Medical research provides a significant market for cartilage in some countries.

East Asia

Shark cartilage is processed in Taiwan, and both processed and unprocessed cartilage exported to Australia, New Zealand, Japan, and the USA. Taiwan also imports shark cartilage powder from the USA and Japan for domestic sale (Chen *et al.*, 1996). Japan is known as a key producer country for shark cartilage powder and capsules, and shark cartilage products of Japanese origin are widely marketed abroad, for example in the USA and Mexico (Rose, 1996a). Although detailed market information is not available from Japan, one Hong Kong fin dealer reports that cartilage is obtained from discards by fin processors for export to Japan. Blue Shark cartilage is reportedly sold for US$7.00 per kg, while cartilage from other species is sold for US$3.80 per kg (Parry-Jones, 1996a). Packaged shark cartilage pills are marketed in Hong Kong, and shark cartilage is used as an ingredient in soups as a health tonic, but information regarding the origin of the cartilage thus used is lacking (Parry-Jones, 1996a).

Oceania

Bentley (1996a) reports that although Australian Customs do not record exports of shark cartilage, data from the Australian Quarantine and Inspection Service report exports of "frozen backbones" from the state of Victoria in 1992-1993 and 1993-1994, although such exports appear to be minimal, totalling 0.9t in 1993-1994. The New Zealand directory of seafood exporters lists two companies that currently export shark cartilage powder to the USA (Hayes, 1996a).

Indian subcontinent

Shark cartilage is collected in India (Hanfee, 1996), but further information on production, processing, and marketing are not available.

East and southern Africa

According to TRAFFIC field research in east and southern Africa, exports of cartilage from that region appear to be currently limited but the subject of considerable interest on the part of dealers. For example, shark cartilage is reportedly exported in unknown volumes from Kenya, and fisheries dealers there report receiving import requests from USA companies (Marshall, 1996c). Although imported shark cartilage is marketed in South Africa, there is currently no evidence of domestic production (Smale, 1996).

Europe

Shark cartilage products are commonly marketed in Europe (Belgium, France, Germany, Greece, Italy, Netherlands, Spain, UK), although little information is available on sources of supply. One US-based manufacturer with subsidiaries in England, Holland, Spain, and South Africa distributes shark cartilage capsules and powder of Australian origin within Europe (Fleming and Papageorgiou, 1996). Spain appears to import, package, and distribute shark cartilage, with sources known to include Brazil. Spain has also recently begun to export shark vertebrae to Asia, possibly for use in the manufacture of shark cartilage powder and capsules (Fleming and Papageorgiou, 1996).

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Shark cartilage goods on sale in Europe, 1996.

The Americas

In the USA, some four or five companies actually process shark cartilage powder, which is in turn sold worldwide under dozens of brand names. Processors in the USA import raw cartilage from several countries, and import processed cartilage and cartilage powder from Japan. One major manufacturer obtains all of its supply of raw cartilage overseas; the cartilage undergoes primary processing in Costa Rica, then is imported into the USA for further processing and bottling. Packaged cartilage products are marketed within the USA and exported to some 35 countries worldwide, while 5 to 10% of the processed cartilage powder is exported to foreign manufacturers for bottling under their own brand names (Rose, 1996d).

Additional cartilage processing plants are located in Mexico (Rose, 1996c). Shark processors sun-dry or freeze-dry shark vertebrae and occasionally the cartilaginous base of fins, either for sale to domestic manufacturers or for export to the USA (Rose, 1996c). Although Mexico's shark fisheries are among the largest in the world, many manufacturers report that they continue to import processed cartilage powder from Japan rather than obtaining supplies domestically (Rose, 1996c). In Argentina, shark cartilage is reportedly dried and ground before export to the USA (Chiaramonte, 1996). TRAFFIC market research indicates the use of shark cartilage in Panama, but production and trade data are not available.

Fishmeal, fertilizer, fish oil, and related products

Processing waste from sharks, skates, and rays may be used in the production of fishmeal for use in animal feeds or fertilizers, or to yield fish oils for industrial uses. Smooth-hounds are reported to be commonly used for the production of oil and fishmeal in Europe, and the meat of Basking Sharks, typically targeted primarily for its liver oil, is also frequently used in the production of fishmeal as a by-product of this fishery (Frimoldt, 1995b). In the production of rays and skates, only the wings are typically used for human consumption, and the remainder may be discarded or used to produce fishmeal (Frimoldt, 1995a). Processing waste of Piked Dogfish is also reportedly used in the production of fishmeal and fertilizer (Compagno, 1984).

Only limited information on the use of chondrichthyans in the production of fishmeal and fertilizer was collected during the TRAFFIC regional studies. Both shark meat and cartilage are reportedly used in the production of fishmeal in China (Parry-Jones *et al.*, 1996), and domestically produced shark oil is used in the production of animal feed in South Korea (Parry-Jones, 1996b). In India, residues from shark liver oil production are used in the production of fishmeal for animal feed (Hanfee, 1996). In Thailand, cartilage, small sharks and rays, and processing wastes are used in fish meal production, and shark liver sometimes used to produce feed for shrimp aquaculture (Chen, 1996). Shark processing wastes are also routinely collected along with other fish waste for the manufacture of fishmeal in Mexico (Rose, 1996c).

By-products from processing of both shark and skates are used in production of fishmeal in the Netherlands, and in Germany, chondrichthyans are processed for fishmeal aboard factory trawlers. In Spain, shark waste is collected together with other fish offal and may be used in the production of fishmeal, although it appears increasingly common for such waste merely to be discarded (Fleming and Papageorgiou, 1996). In Argentina, angelshark is sometimes used in the production of fishmeal (Chiaramonte, 1996).

Sharks as bait

In many areas, small sharks that are unmarketable are not discarded, but instead are used as bait, often in shark fisheries themselves. In the directed US-shark fishery in the Gulf of Mexico, large numbers of small Atlantic Sharpnoses caught incidentally are nearly always used as bait by the same vessels (Rose, 1996d). In southeastern USA, restrictions on gillnet fisheries have led to shortages of baitfish, so that fishers increasingly purchase Piked Dogfish heads from northeastern fisheries (Rose, 1996d). In the UK, Small-spotted Catsharks and Nursehounds are used as bait in pot fisheries for crustaceans and molluscs. Although these species were previously obtained from trawl bycatch, in recent years, the UK whelk fishery has reportedly led to their increased exploitation. Catches used as bait are not landed and are therefore unreported (Fleming and Papageorgiou, 1996).

Teeth, jaws, and other curios

Shark teeth and jaws have traditionally been used in many cultures in making both functional and ceremonial objects. In the Solomon Islands, Melanesians use shark teeth in carvings, while the Gilbertese use shark teeth for making the *terere*, a traditional Gilbertese fighting sword which features shark teeth lashed to both edges and a Stingray spike at the end (Matthew, 1996). In Hawaii, shark teeth were used as a cutting edge, and were used to make knives, war clubs, and other weapons made for hand-to-hand combat (Taylor, 1993).

Shark teeth and jaws are widely used in local curio trades. Kreuzer and Ahmed (1978) and Anderson and Ahmed (1993) note that the Shortfin Mako Shark is a preferred species for its teeth. The Great White and Tiger Sharks also yield particularly large, and therefore valuable, jaws and teeth. Typically, a fully grown shark yields approximately 150 teeth of saleable size (Kreuzer and Ahmed, 1978).

Use of shark teeth and jaws, particularly for sale to tourists and tourist shops, has been reported in India (Hanfee, 1996); the Maldives (Anderson and Ahmed, 1993); the South Pacific (Hayes, 1996b); Thailand (Chen, 1996); east and southern Africa (Marshall and Barnett, 1996); Europe (Fleming and Papageorgiou, 1996); North America, and South America (Rose, 1996a). In Europe, shark teeth and jaws can be observed for sale in the UK, in tourist markets in southern Spain, and in advertising displays in Germany (Fleming and Papageorgiou, 1996). Demand appears to be limited and usually confined to tourist areas, so that teeth and jaws are collected only occasionally. In southeastern USA, shark teeth are frequently collected from beaches (Rose, 1996d).

Other shark products reported to appear in the curio trade include preserved shark foetuses in the USA (Rose, 1996d), and stuffed shark curios observed for sale in Thailand (Chen, 1996). In southern Spain, curios include dried and stuffed shark heads, stuffed whole sharks, and stuffed rays (Fleming and Papageorgiou, 1996). In the Seychelles, shark vertebrae are made into walking sticks for sale to tourists (Marshall, 1996d). The rostra or "saws" of sawfish and sawsharks (e.g., *Pristiophorus cirratus*) also enter the curio trade; for example, sawshark rostra are marketed in Tanzania (Barnett, 1996b) and in Madagascar, where prices range up to US$30.00 each (Cooke, 1996). As in the case of teeth and jaws, such markets appear to be limited and opportunistic rather than organized (Cooke, 1996).

Aquarium specimens

Nurse Sharks are frequently maintained as live specimens in public aquaria, and in some areas of the USA, juveniles may be captured for sale to private hobbyists. Live catshark juveniles and egg cases are also imported to the USA from Indonesia for sale to private aquarists (Rose, 1996d). The freshwater stingray *Potamotrygon laticeps*, found in the Amazon Basin, is also known to be collected for the aquarium trade (Axelrod *et al.*, 1986), as is the Epaulette Shark *Hemiscyllium ocellatum* (Last and Stevens, 1994). Small freshwater stingrays from Thailand are also reportedly sold in Malaysian aquarium shops (S. Fowler, *in litt.*, 30 August 1996).

Other products and uses

A variety of additional uses have been reported for chondrichthyan species and their products. For example, glue made from sharks was used in traditional Japanese lacquerware (Kiyono, 1996), and shark bile from the gall bladders of the Starspotted Smooth-hound is also reported to be used in traditional Chinese medicine in the treatment of laryngopharyngitis (Jianxin, 1995). More familiar is the widespread use of Piked Dogfish carcasses for dissection in biology courses and for medical research.

DISCUSSION AND CONCLUSIONS

The results of TRAFFIC's study of chondrichthyan trade provide considerable insight into the sources of supply, the nature of demand for various products, the dynamics of the trade and associated socio-economic issues. This information provides an essential foundation upon which understanding of the conservation implications of this trade can be built. The following discussion examines the extent to which conclusions regarding conservation problems and potential remedies can be drawn from current knowledge of both fisheries for and trade in chondrichthyan products.

Implications of current levels of fishing for management and conservation of chondrichthyans

Analysis of the effects of current levels of fishing is extremely difficult, as available information on chondrichthyan fisheries worldwide remains significantly fragmented. Because chondrichthyan fisheries are often incidental or seasonal and have historically made a minor contribution to overall fisheries production, little emphasis has been placed by national and international fisheries agencies on gathering data on these species or their exploitation. As a result, data on the volume and species composition of chondrichthyan catches is often sparse or non-existent. Trends in existing data on catches and landings typically cannot be interpreted, as insufficient information is available to distinguish the effects of trends in fishing effort or markets from real trends in the status of stocks. National agencies often do not report chondrichthyan catches at all, report them as a single category or as "sharks" and "skates and rays", or report sharks, but not related species. National reporting by species is rare and generally occurs only in the few cases where chondrichthyans are included in existing management plans. There is consequently a paucity of reliable information on which to base status assessments at the local, not to mention the global, levels.

Many important chondrichthyan fishing nations and territories, such as Japan, Taiwan, Indonesia, the Philippines, and Mexico, do not maintain species-specific data on landings. For many fisheries, including that of the growing Chinese fleet, neither the volume of catches and landings, nor the species composition are known. Even in the few existing managed chondrichthyan fisheries, for example that of New Zealand, management systems designed for other species are believed to result in significant under-reporting of chondrichthyan catches and landings, and, as in the case of the USA, continued difficulties in species identification arise.

Chondrichthyan landings are derived from both directed fisheries and incidental catch, though the proportion of total harvests supplied by each source remains unknown. Several nations and territories (e.g., Japan, Taiwan, South Korea, China, Sri Lanka, Spain and France) have offshore or distant-water fleets, regulation of which is difficult, with large incidental catches of sharks, rays and skates that are unreported or under-reported, as well as their near-water fleets. The low relative value of chondrichthyans compared to many target species, such as tunas and billfish, encourages high rates of chondrichthyan discards in these fisheries in order to conserve limited cargo space. Further encouraging high rates of discards is the fact that, as sharks accumulate high concentrations of urea in their blood, these species typically require immediate on-board processing and refrigeration or freezing, and often must be stored separately from the rest of the catch. An estimated 230 000 to 240 000t of chondrichthyans may be discarded annually in high seas fisheries alone, or only shark fins retained (Bonfil, 1994). Although distant water fisheries are of special concern owing to the sheer volume of incidental catches, varied but largely unknown rates of chondrichthyan bycatch also occur in a number of coastal and offshore fisheries, including shrimp, prawn, and other trawl fisheries, gillnet fisheries targeting demersal species, hook-and-line fisheries, tuna purse seine fisheries, and longline fisheries targeting tunas and billfish.

In recent years, the practice of "finning," or removing a shark's fins and discarding its carcass, has been raised as an issue in the management and conservation of sharks and rays. In general, species most likely to be finned and discarded include species captured in large numbers in offshore and distant water fisheries, such as the Blue Shark; species with high-value fins, such as hammerheads; and species for which the meat and other products are not marketable, (e.g., the Blue Shark in many areas). Finning generally appears to occur more frequently in incidental than targeted chondrichthyan fisheries. Although finning may also occur in directed shark fisheries, the economic viability of directed fisheries often depends on the marketing of both meat and fins, and in some cases additional products such as skins, livers, and cartilage.

The management and conservation implications of bycatch in general, and finning in particular, depend upon a number of factors, including the volume and species composition of bycatch and the destination of bycatch - i.e., whether retained, discarded alive, or discarded dead. In most cases, chondrichthyan bycatch is not reported, and species composition is poorly known. The destination of bycatch is also largely undocumented, and depends upon highly variable factors, including catch rates of target species, relative values of targeted species and bycatch, the availability of markets for chondrichthyan bycatch, vessel processing and storage capacity, and trip duration.

The conservation significance of incidental catches also depends upon mortality rates among different species and for different fisheries. In trawl, gillnet, and possibly purse seine fisheries, mortality of chondrichthyan bycatch is usually probably 100%. In some cases, this incidental catch is landed and utilized. For example, shark bycatch from prawn trawlers in Kenya is typically landed and reported in national landings statistics (Marshall, 1996c), and small juveniles caught incidentally in Mexico are popular in many regional markets and appear to be landed frequently for sale (Rose, 1996c). Estimates of landings based on such incidental catches may inflate reported landings without necessarily implying greater conservation impact than that of fisheries reporting lower chondrichthyan landings.

Longlines, on the other hand, permit some survival among hooked sharks because they allow limited movement and thus respiration and the elimination of metabolic wastes, and sharks may be released alive, but mortality varies among species (Bonfil, 1994). For example, species believed to be highly dependent on forward movement for the elimination of metabolic wastes include shark species of the families Carcharhinidae and Sphyrnidae, but this aspect has not been extensively studied (Horan, 1995). Sivasubramaniam (1992) reports that in the Bay of Bengal tuna fisheries, large numbers of requiem sharks are alive when brought aboard, but that Blue Sharks and mako sharks typically are not. Furthermore, although chondrichthyans may be released alive, post-release mortality may occur as a result of stress induced during capture (Horan, 1995).

Many researchers have raised concerns regarding the impacts of incidental catch on pelagic species (Casey, 1992). Species such as the Blue Shark, thresher sharks, mako sharks, the Porbeagle, Salmon Shark, Silky Shark, Oceanic Whitetip Shark, and hammerheads are relatively abundant and widely distributed, but may be of conservation concern owing to the sheer numbers caught incidentally. Others, such as the Great White Shark, Whale Shark, Cookiecutter Shark *Isistius brasiliensis*, Cookiecutter Shark *I. labialis*, Largetooth Cookiecutter Shark *I. plutodus*, Pygmy Shark *Squaliolus aliae*, Spined Pygmy Shark *S. laticaudus*, Pygmy Shark *Euprotomicrus bispinatus*, and Longnose Pygmy Shark *Heteroscymnoides marleyi* are caught in relatively low numbers, but are less abundant and therefore potentially at risk from pelagic fisheries. Generally, however, too little is known of the species or of the fisheries to assess conservation impacts confidently.

Interpreting reported trade in chondrichthyan products

With fisheries for sharks and other chondrichthyans largely unregulated and unmonitored, trade statistics could be expected to provide a readily available source of information for assessing the management and conservation implications of growing domestic and international markets for chondrichthyan products, particularly for shark fin. For example, trade statistics have been used to estimate catches and landings where reliable records for those are unavailable, or have been compared to reported catches and landings to estimate the volume of unreported catches and landings. In the latter case, discrepancies between reported shark fin exports and reported shark catches and landings may be interpreted as evidence of finning.

There are, however, several important limitations on the use of such data, and considerable caution is warranted in any attempt to relate reported trade to real catches and landings, to global trade patterns, or even to market trends. As discussed below, trade data for chondrichthyans are problematic and are often poor indicators of the real volumes in trade, so that estimates of production or assessments of market trends derived from trade statistics may be similarly flawed. Furthermore, chondrichthyan catches and landings are known to be widely under-reported, particularly in the case of artisanal fisheries, incidental fisheries, and high seas fisheries.

Comparison of trade data and reported landings for a given country or region may in fact suggest that under-reporting of catches and landings is common, without necessarily indicating that finning occurs on a significant scale.

Trade in fins

World trade in shark fins is an increasing source of concern to conservationists owing to the high value of fins in international markets, reports of finning from a number of fisheries, and the potential for further increase in demand as a result of the opening of markets, particularly in China. Increasing trade in shark fins is especially evident in part because trade data are more readily available for shark fins than for other chondrichthyan products. For example, Hong Kong Customs data for trade in shark fins have been made widely available, and FAO trade records for this product, although incomplete, are fuller than for any other shark product, in part because they include Hong Kong trade data. Both FAO and Hong Kong Customs data confirm the widespread perception that world trade in shark fin is rising. The rate of this increase, the fisheries affected, and the management implications remain less clear.

One key finding of the TRAFFIC Network study is that a significant proportion of reported world trade in shark fins may appear more than once in official Customs statistics. This occurrence applies particularly to shark fin trade among Hong Kong, China, and Singapore, the world's largest shark fin trading nations. Repeated counting of fins in international trade also occurs in a number of regional entrepôts, such as the USA (for Latin America and the Caribbean, and to a lesser extent Africa) (Rose, 1996d) and Yemen (for Africa and the Middle East) (Marshall and Barnett, 1996).

To illustrate the type of trade pattern by which double-counting of fins occurs, one may consider the example of dried shark fins exported from Peru to the USA, where they are mixed with other imported and domestically produced fins, repackaged, and shipped to Hong Kong. The Hong Kong trader then ships the dried fins to China for processing, re-imports the processed fins, then exports the processed fins to the USA. Hong Kong import records report the same fins twice, and export records report the same fins twice. An examination of total reported world imports would count the same fins in trade five times. An examination of total reported world exports would count the same fins four times.

This finding may have important implications for interpreting available trade data. In the case of Hong Kong, analysis of trade between Hong Kong and China concluded that much of the apparent increase in shark fin imports to Hong Kong may be attributed to a shift in the location of processing from Hong Kong to China, which results in over-reporting when the same fins are reported in more than one trade transaction (Parry-Jones, 1996a). While total reported shark fin imports into Hong Kong suggest a dramatic rise in world trade in fins, separating out repeat transactions for processing suggests a much more gradual increase in the volumes traded.

Assessment of Asian imports of shark fin from outside the region is similarly obscured by the difficulty in distinguishing between initial transactions of fins from repeat transactions of the same fins. For example, the USA records imports of shark fin, but does not report exports. Reported imports of shark fin to Hong Kong, from the USA, suggest that the USA is a major supplier of shark fin, however. Both an increase in reported imports and interviews with fin traders based in the USA suggest that reported trade from Hong Kong to the USA consists in large part of re-exports of fins that have previously been shipped through or processed in the USA (Rose, 1996d)

The main reason that recounting of the same fins in international trade readily occurs, is that re-exports are often not recorded as such in Customs data. Further, fin dealers may accumulate fins from domestic fisheries or foreign sources for a considerable amount of time before re-exporting. During this period, the fins are likely to be sorted and repackaged, in which case the original country of origin for the fins will not appear in trade records. In many cases, dried or frozen fins may be imported for processing, then re-exported in one of several forms of processed fins. Not only does the volume by weight of traded fins change during this period, but trading countries may not report separately each of the product forms in which fins are traded.

In many cases, TRAFFIC studies indicated that complete export data for countries are not available, and/or that significant loopholes or inadequacies exist in export procedures. TRAFFIC research in east and southern Africa clearly demonstrates resulting difficulties in interpreting trade data. For example, in Madagascar at least 25% of shark fin exports cannot be traced to any particular fishing region in which official statistics are compiled, and in Tanzania, shark fin is likely to be classified as fish offal when exported. In addition, many of the countries studied in eastern Africa experience illegal cross-border trade in shark fin that is by nature unmonitored. The volume of shark fin exports from the majority of countries studied was therefore believed to be much higher than that reflected by official export statistics (Barnett, 1996a).

Even accurate statistics may be misleading, however, when the basis for assessments of production. Several countries that serve as important producers of shark fin are also characterized by significant levels of domestic consumption, which will not be reflected in reported trade figures. For example, China is undoubtedly an important producer, but there is no evidence that shark fins produced in China enter world trade to any significant extent (Parry-Jones *et al.*, 1996). In addition, Taiwan is one of the world's largest producers of shark fin, with reported annual production averaging nearly 1000t during 1980-1996, but imports remained below 100t annually during 1980-1995 and exports are much lower because most production is consumed domestically (Chen *et al.*, 1996).

The difficulty of relating reported world trade to global or national production of shark fins is compounded by the fact that few countries report domestic production of shark fins. In those countries where production is reported, it may significantly underestimate real production, as in many cases, fins are retained by the fishermen as a supplement to their wages and sold independently to dealers or processors (Kiyono, 1996; Parry-Jones *et al.*, 1996; Matthew, 1996). Fins are also frequently sold at sea to vessels of other nations (Parry-Jones *et al.*, 1996).

Official trade data also pose some difficulties to efforts to monitor price trends, and thus market trends, for shark fins. In some countries, values for exports may be mis-reported in an effort to avoid export duties or requirements for repatriation of hard currency. In Madagascar, for example, interviews with fin traders revealed some reported export values of as little as US$40.00 per kg at a time when market prices were approximately US$100.00 per kg. Import values may be similarly mis-represented, although in the case of Hong Kong, a free port, reported values may more accurately represent real market prices.

Trade data for chondrichthyan products are of limited use as a conservation tool, in that they do not necessarily indicate the fisheries, regions, or species of greatest management concern. Many of the chondrichthyan products in trade are not identified, and in some cases (e.g., processed fins) are not identifiable, to species level. Nor are trade records sufficiently precise to indicate the country or region of origin and impacts on specific fisheries, countries, and regions are likely to vary considerably according to characteristics of the fisheries, market conditions, and local and external demand for a wide range of shark products.

To assess the impact of rising world demand for shark fins on shark fisheries, it would be necessary to examine on a regional and local basis a number of variables. First, an understanding is needed of the absolute and relative values of shark fins in relation to products of other fishery species, to other shark products, and to local costs of living. The relative value of shark fins is likely to vary considerably, not only owing to fluctuations in demand and supply, but also according to species availability, quality of cut and processing, the number of dealers to which sellers have access, difficulty and cost involved in transportation and shipment, and relationships among local and external buyers. Therefore, prices for shark fin from Hong Kong, for example, will vary according to market level, and trade destination - locations are as varied as from Fiji to France - and other factors.

As an example of influences on prices for shark fin in a given locality, Taiwan, where most production is consumed domestically, has market prices directly linked to domestic supply, so that a significant increase in production is accompanied by a dramatic fall in prices. As a consequence, ex-vessel prices for wet shark fins are relatively low: US$7.69/kg for top-grade fins, US$5.49 for middle-grade fins, US$4.03 for lower grade fins, and US$1.83/kg for miscellaneous and pelvic and anal fins. An examination of Taiwanese shark fisheries and trade by TRAFFIC Taiwan concluded that shark fin, far more expensive on a per unit level, was not a substantially greater dollar earning export than the high-volume, lower price frozen shark meat. This suggests that the lucrative fin trade, although an important reason for shark fisheries, is not the only motive for fishers to target and retain shark catch (Chen *et al.*, 1996).

By contrast, fin dealers in the USA report the entry of numerous entrepreneurs into the trade over the last decade, increased market development and communications, and thus increased competition for shark fin supplies. As a consequence, dealer prices to the fisher for shark fins have in some cases risen above average world prices in an effort to obtain reliable supplies. Samples of ex-vessel prices for wet primary fins range from US$37-46/kg for large fins, US$26-37/kg for medium fins, and US$11-13/kg for small fins, while secondary and low-grade fins range in price from US$3-9 per kg. Prices for dried fins, which lose approximately 50% by weight during drying, are approximately double in price. This increase in shark fin prices is considered to have stimulated the development of a directed shark fishery in the southeastern USA greatly (Rose, 1996d).

The increase in trade networks and fin prices also appears to have stimulated the development of markets for shark fins in Africa. Domestic prices for shark fin have in many cases risen dramatically over the last decade, leading in many cases to increased fishing effort in directed shark fisheries. Chinese fin traders from Hong Kong in West Africa are reported to supply outboard motors and fishing gear to local fishermen in return for any shark fins harvested, and anecdotal reports suggest that finning occurs on a significant scale in many areas (Parry-Jones, 1996a; Marshall and Barnett, 1996). By contrast, small-scale directed coastal shark fisheries in Argentina have contracted in recent years, as exchange rate fluctuations have caused fuel prices to rise dramatically and local prices for shark fins to fall (Chiaramonte, 1996).

An assessment of the management implications of rising shark fin trade, and of finning, must take into account the different characteristics of directed and incidental fisheries. In most cases, chondrichthyan fisheries are predominantly incidental, and a rise in world shark fin prices may variously result in no significant increase in landings, an increase of fin landings despite stable catches, or increased catches and landings as vessels increasingly target sharks either generally or on a seasonal basis. Because neither catches nor landings are routinely reported in such fisheries, and because few studies link trends in landingsto trends in target fisheries, it is difficult to determine which is the case. Directed shark fisheries typically utilize a variety of products in addition to fins, but an increase in the value of fins and other products may encourage new entrants into the fishery and/or new investments in gear, in order to increase effort, where there is no effective regulation of entry or effort.

Despite the importance of shark fin trade as an impetus to rising shark landings, it would be misleading to characterize this trade as the sole or even the primary force driving shark catches and landings. Economic and market constraints clearly encourage the finning (and discarding of the remainder of the shark) of some species in some fisheries, most notably in distant-water fisheries, where limited storage capacity and high potential for spoilage contribute to high discard rates. Further contributing to finning and discarding in these fisheries is the predominance of Blue Sharks in the bycatch of many fleets, as markets for meat from this species remain non-existent or extremely limited in most regions. However, in many cases, a number of species may be retained for their meat and other products, for example, the Shortfin Mako Shark, Porbeagle, and Thresher Shark. In general, even less valuable species caught in directed shark fisheries are not discarded, but are consumed domestically. As discovered in Taiwan (see above), even given relatively low unit values for meat, this shark product may be of equal worth in earning potential as shark fins and other products with their higher international prices, given that the meat accounts for a much larger proportion of total body weight (see Table 6).

Production and trade data for products other than shark fin are, as stated earlier, less comprehensive than those for fins. In many cases, the carcass, once finned, is marketed domestically rather than traded internationally, and this domestic trade is unreported. Available trade data are not specific regarding product forms - for instance, a Customs classification for frozen shark might include whole carcasses, split carcasses, headed and gutted carcasses with the fins removed, chunks of meat, or fillets. Even if the product form is known, conversion factors needed to assess the live or carcass weight represented by traded volumes vary widely by species, processing technique, country and region, as suggested by a list of sample conversion weights taken from the FAO (see Table 8).

Table 8

Selected conversion factors (landed weight to live weight)

Country	Species	Product form	Factor
Canada	Unspecified large sharks	Fresh, gutted	1.200
Mexico	Unspecified sharks	Fresh, gutted, head off	1.500
Ecuador	Unspecified dogfish	Frozen fillets, skin off	2.000
Germany	Unspecified sharks	Frozen fillets, skin off	2.590
UK	Dogfishes, Tope Sharks	Fresh fillets, boneless	2.700
Indonesia	Sharks, skates, rays, etc.	Gutted, split, smoked	4.762

Source: Anon., 1992b.

Trade in meat

Again, as in the case of shark fins, information on the chondrichthyan species involved in domestic production or international trade of meat is generally unavailable or extremely limited for most producer nations. The results of market research by TRAFFIC suggest that international trade in shark meat appears to include a significant volume of highly preferred food species such as the dogfishes and smooth-hounds, and preferred pelagic species such as the Shortfin Mako Shark and thresher sharks, although these species are also utilized for their fins, cartilage, liver oil, and other products. Although these are among the few species for which relatively high demand and value in domestic and international markets can be linked to targeted fisheries, it is not at all clear that other species are not traded in significant volumes. For example, despite the pre-eminence of Piked Dogfish in many European markets, EU markets for species other than dogfishes are increasing rapidly, with total imports from non-EU countries rising from 8946t in 1988, to 14 512t in 1994 (Fleming and Papageorgiou, 1996).

Owing to the relatively low value of the meat of most chondrichthyan species, its trade has not generally been considered to have led to severe depletion of stocks. In most cases, fisheries have exploited a range of products in addition to meat, including fins, liver oil, and hides. Indeed, historically, industries centered entirely on shark meat production have generally proven uneconomical, for example in Uruguay (Kreuzer and Ahmed, 1978) and in the USA (Rose, 1996d), and important directed chondrichthyan fisheries in countries such as Australia, Mexico, Taiwan, and the USA currently tend to exploit a variety of products.

The status of the Piked Dogfish, at least, however, is believed to have been negatively affected by overfishing in Europe, specifically in France, Norway, Ireland, and the UK (Fleming and Papageorgiou, 1996). In recent years, Piked Dogfish stocks off the Atlantic coast of the USA are believed to have been similarly impacted by directed fisheries that have intensified since the early 1990s to meet European demand (Rose, 1996d). The status of the large pelagic species, such as the Shortfin Mako Shark and Thresher Shark, is more difficult to evaluate given their wide distribution and paucity of information on stock size, structure, and movements. Thresher Shark stocks off the Pacific coast of the USA are believed to have been severely depleted as the result of a directed fishery in the 1980s, but the decline of the fishery has also been attributed to economic and regulatory factors (Rose, 1996d).

Trade in skins

Insufficient information is available from the majority of producer nations to determine the implications of trade in shark skins and leather for fisheries management and conservation. However, market information from Mexico suggests that the impact of use and trade of shark skins is extremely limited, and is dependent on the relatively close proximity and accessibility of specialized tanneries. In general, shark skin appears to be a relatively low value product that, when taken as a by-product of existing fisheries, contributes marginally to the overall value of the fish to the producer (Rose, 1996c).

Trade in shark liver oil

The production and trade of shark liver oil is also poorly documented. Demand for shark liver oil has clearly led to target fisheries in the past; the decline of liver oil fisheries for Tope Sharks off the Pacific coast of the USA in the 1940s is one of the best-documented cases of over-exploitation of a shark fishery in the world. Although shark liver oil production continues today at greatly reduced levels, several fisheries still specifically target deep-water shark species that may be vulnerable to localized overfishing, and in Europe, new fisheries for deep-water shark species are developing as new fishing grounds are exploited following the decline of traditional species. Little information on the impact of these fisheries is available, however. In Taiwan, fisheries for dogfishes and gulper sharks for the production of shark liver oil have declined significantly in recent years, but insufficient information is available on catch levels, fishing effort, stock abundance, and markets to be able to determine any causal relationship with liver oil utilization (Chen *et al.*, 1996).

Trade in shark cartilage

Conservationists have expressed growing concern that new markets for shark cartilage pose an additional source of pressure on shark stocks worldwide. Such concerns are typically based on two types of observation. First, the high retail prices of packaged pharmaceutical products containing cartilage and second, the volumes of shark cartilage purchased by certain processing plants, which are generally perceived to be extremely high: both are thought to contribute to over-exploitation in nearby fisheries. However, research for the present study suggests that although there is little basis for claims of the medical efficacy of cartilage, there is also little evidence that the use of cartilage is stimulating shark fisheries.

Retail prices for shark cartilage are high, in some cases reaching more than US$100 for a single bottle of capsules, but processors in the USA and Mexico report selling dried cartilage for approximately US$1.00 per lb (0.45kg), wet cartilage for less than US$1.00 (Rose, 1996a). According to Kreuzer and Ahmed (1978), shark cartilage accounts for an average of four per cent of total shark body weight, with a range of 3.0% (Tiger and Kitefin Sharks) to 9.4% (smooth-hounds). Thus, unit prices received by the fishermen are minimal, and the total value of the cartilage relative to meat and fins is extremely low. For example, if an average 23kg-shark yielded one kilogramme of cartilage, 1.2kg of fins, and some 10kg of fillets, prices to a USA-based harvester for these products would be US$2.00, US$25.00, and US$12.50, respectively.

Moreover, although the trade remains entirely undocumented, TRAFFIC market research and industry interviews suggest that cartilage processed by known manufacturers is often imported from several countries as well as purchased locally. For example, one highly publicized processing plant in Costa Rica is perceived to contribute to the over-exploitation of local fisheries, but in fact purchases raw cartilage from numerous sources worldwide for initial processing before shipping semi-processed cartilage to the USA. Casual observation of the operations of the plant, therefore, does not provide a basis for any assessment of the volume of supply obtained from local, or even national, or regional fisheries (Rose, 1996a). As with many other chondrichthyan products, trade in shark cartilage is complex, virtually undocumented, and poorly understood.

Conclusions

In many of the countries and regions reviewed during the course of the TRAFFIC Network study, chondrichthyan fisheries and trade provide an increasingly important contribution to total fisheries production and consumption, to cash earnings among coastal communities, to the fisheries processing sector, and to export earnings. According to the FAO, reported worldwide landings of sharks and related species reached 730 784t in 1994. Actual catches and landings are likely to have been much higher, a factor of poor reporting in directed commercial fisheries and subsistence fisheries, under-reporting or lack of reporting of discarded bycatch, and exclusion of recreational fisheries catches and landings from reported FAO data.

Chondrichthyan resources are valuable, in many cases much more valuable than previously documented uses and markets would suggest. The results of TRAFFIC's research indicate that a growing volume of chondrichthyan products - primarily meat and shark fins - from both targeted and incidental catches are traded worldwide. Although it is not possible to quantify actual harvests from each of these sources, it is clear that a significant proportion of products is derived from incidental catches in fisheries for other target species. A number of complex factors contribute to the enhanced role of chondrichthyans in world fisheries and trade, including development of gear, and gear changes, in offshore and distant-water fisheries; increasing regulation or declining availability of traditional fisheries species; increased demand for products such as meat, fins, and cartilage; and increased penetration of market networks for these products into new regions, such as Africa and South America.

Assessment of the management and conservation implications of growing chondrichthyan fisheries and trade remains a difficult challenge. Many chondrichthyan species are highly vulnerable to overexploitation, but ecologically sensitive species or those most vulnerable to a combination of targeted and incidental fisheries, habitat disturbance, and other factors are difficult to identify because of a notable lack of information on biology, life history, stock structure and movements, abundance, fisheries, and volume and species composition of catches and landings. Few countries have enacted management plans, so that chondrichthyan fisheries are characterized by poor reporting, limited research effort, and lack of restrictions on entry or fishing effort. Both domestic and international markets for chondrichthyan products also remain poorly documented, and the limited data available are difficult to interpret due to changes in volumes resulting from processing and the complex movements of the products in trade. These tasks are further complicated by significant local and regional variations in the dynamics of both fisheries and markets. In consequence, fisheries agencies are generally ill-equipped to recognize or respond to changes in fisheries and markets for these species.

Increasing world trade in products such as shark fins, fresh and frozen shark and skate wings, cartilage, and shark liver oil undoubtedly plays a significant role in increased chondrichthyan landings evident in many regions in recent years, and available production and trade data are useful in highlighting important markets and uses for these products. However, these data are currently subject to a number of reporting problems that severely limit the accuracy of reported volumes and values of chondrichthyan products in trade. In most cases, available production and trade data are not sufficiently precise to indicate the species and regions most affected by trade, and provide an inadequate basis for the development of specific management or regulatory measures.

Improved trade monitoring is clearly needed to assess the species composition of products in trade and to detect regional and worldwide trends in demand and supply. There is an even more pressing need, however, for improvements in basic fisheries management, research, and data collection. Improved reporting of the volume, species composition, and destination of catches and landings, for both directed fisheries and bycatch, will be essential not only for effective fisheries management, but also for needed ongoing assessments of domestic markets and international trade of chondrichthyans and their products.

RECOMMENDATIONS

The following recommendations address two specific issues that TRAFFIC deems essential for the conservation and management of sharks. These are the development and compilation of specific and consistent data to monitor the catch, landings, and trade of sharks; and the establishment of a scientifically-based global endeavour to ensure sustainable offtake of these species for the future.

Meeting future data needs

1. The FAO *Code of Conduct for Responsible Fisheries* (1995) notes in its Article 12.1 that "states should recognize that responsible fisheries require the availability of a sound scientific basis to assist fisheries managers and other interested parties in making decisions". This statement is of great relevance in relation to shark fisheries and the inadequacy or paucity of data necessary for adequate management.

Recommendation: All nations, particularly those that have expressed concern about the status and trade of sharks, should apply the principles and standards of the *Code of Conduct for Responsible Fisheries* that address fisheries research and data collection (Articles 7.4 and 12).

2. International bodies such as FAO, ICCAT, and ICES currently provide the most readily available sources of regional and global data on chondrichthyan catches, landings, production, and trade, but these data are extremely problematic as a result of inconsistent recording and reporting methods and owing to wide variations in the monitoring and reporting capabilities of the countries providing data.

Improved data collection and reporting depends in large part on increased national capacity to monitor chondrichthyan fisheries. However, international organizations, such as FAO, can assist this process by reviewing sources of error and bias in current reporting; developing and disseminating standardized guidelines for data collection and reporting; and, in consultation with other relevant fisheries and trade specialists, recommending species and species groups that should be reported separately in production and trade data.

Recommendation: International fisheries agencies including FAO, regional fisheries development agencies such as ICCAT and OLDEPESCA, and national fisheries agencies should initiate or improve the collection of taxa-specific data on shark fisheries, to species level wherever possible. They might compile such data using one or more of the following methods:

i) The compilation of catch and landing data at the genus or species level may be improved by adopting or adapting either the TRAFFIC list of commonly exploited sharks (see Annex 1 of this report) or the IUCN Shark Specialist Group's list of sharks that are both vulnerable to overexploitation and possibly subject to trade or by compiling a comparable list of some 30 to 40 species to target for improved data collection.

ii) As an alternative to genus- or species-specific data, the compilation of data at a higher taxonomic level could be initiated which is more easily achieved through the differentiation of external physical characteristics such as number of fins and gill slits.

iii) Nations or agencies lacking the capability to immediately initiate reporting at the level of species, genus, or order should initiate reporting as shark, ray, skate, or chimaera.

Recommendation: Once an initial species list is compiled and improved data collection initiated, FAO and other relevant fisheries agencies should actively review and periodically modify the list, by adding or eliminating species, so that species lists are specific to a geographic region, consist of sharks commonly fished in that region, and/or include species of concern to that region.

Recommendation: To assist in the compilation of data on catches and landings, the FAO should produce an expanded list of FAO species codes for national and international reporting.

Recommendation: All catch and landing data should be compiled by oceanic catch area, as largely defined by FAO or more strictly defined or limited by regional or national fisheries agencies.

Recommendation: Catch and landing data should be collected for commercial, subsistence, and recreational fisheries.

3. At the national level, identification of chondrichthyan species poses an especially pressing problem for both fisheries management and monitoring of markets and trade. Training in species identification for fishermen, personnel of fisheries management agencies, inspectors charged with enforcing health and sanitary codes, Customs officials, and others involved in reporting catches, landings, and trade may significantly improve the quality and content of fisheries and trade data. The FAO and other inter-governmental and international bodies can assist this process by contributing to the production and dissemination of species identification materials.

Recommendation: In order to assist fisheries agencies and fishermen in the compilation of species-specific catch and landing data, FAO should develop an elementary, user-friendly, and simply illustrated identification manual for commonly fished species. This identification guide can be adopted or modified by national and regional fisheries agencies for use by relevant agencies and in specific fisheries and/or fleets.

4. Significant improvements are needed in the general reporting of chondrichthyan catches and landings at the national level if related fisheries, markets, and trade are to be understood and effectively managed. The implementation of mandatory logbook reporting of the volume, species composition, and destination of catches and landings; mandatory or voluntary observer programmes; dockside monitoring programs; and fisheries processor surveys are among the many useful measures for improving data collection. Programmes such as these may contribute significantly not only to available information on chondrichthyan catches and landings,

but also to the availability of incidental market and other information needed to accurately interpret trends in fishing effort and in catches and landings.

Recommendation: General data collection efforts through logbook reporting, dockside monitoring programmes, processor surveys, and other related efforts should be initiated or improved in artisanal, subsistence, and recreational as well as large-scale commercial fisheries. Such monitoring programmes should be mandated for both domestic vessels fishing in national, foreign, and international waters, and foreign vessels operating in national waters or landing their catch in domestic ports. Resulting data should be published routinely or otherwise made available to researchers in order to assist current efforts to document and analyse trends in fisheries and stock abundance.

Recommendation: Documentation of chondrichthyan bycatch should be a priority for efforts to improve fisheries data collection and monitoring at the national, regional, and international levels.

5. In many cases, the uses and value of chondrichthyan resources remain largely undocumented not only in in national fisheries and production statistics, but also in Customs data. Important fishing, processing, and trading nations, particularly those nations that have been identified as exporters or re-exporters of chondrichthyan products, should consider the usefulness of monitoring chondrichthyan products in trade in order to anticipate any trade trends impacting fisheries and stocks within their jurisdictions.

Recommendation: In cooperation with national Customs authorities, national fisheries agencies should begin to report nationally or regionally important shark trade through pre-existing harmonized Customs codes for raw or semi-processed shark, shark fins, and shark oil.

Recommendation: National fisheries agencies should regularly obtain data thus collected in order to monitor trade and determine its effects, if any, on national shark catches and landings.

Recommendation: National fisheries agencies should systematically collect national trade and market information for sharks and related species by monitoring domestic domand and international trade to determine their relationship to trends in landings; conducting sample surveys of key fishery markets or auctions to note species availability and seasonality; determining the value, volume, product forms, and routes of domestic or international trade; and, based on research from experimental fishing cruises or vessel and market surveys, compiling or modifying region-specific or ocean-specific conversion ratios for translating the volume of landed and traded products to live or round weight.

Conservation measures

6. Once species-specific catch and landing information has been compiled and analysed by regional and national fisheries agencies, it will be possible for them to work together to identify a list of shark species commonly caught but vulnerable to over-exploitation and therefore deserving of management measures.

Recommendation: Regional and national fisheries agencies should develop economically feasible and sustainable management plans for shark fisheries vulnerable to over-exploitation.

7. The results of TRAFFIC research on chondrichthyan fisheries and trade repeatedly highlight the importance of chondrichthyan bycatch as a major contributing factor to rising world landings and trade of chondrichthyan species, and a critical issue in fisheries management, conservation, and trade monitoring.

Not only do incidental fisheries contribute a significant proportion of chondrichthyan landings and products in trade, but economically important species may be affected simultaneously by targeted fisheries, landings from incidental catches, and high rates of discard in other fisheries targeting more valuable species. Although distant water fleets are of particular concern owing to the sheer volume of bycatch, chondrichthyan bycatch is associated with most of the world's fisheries and gear types, including directed fisheries for specific chondrichthyan species or species groups.

Recommendation: Governmental and inter-governmental fisheries agencies should provide technical and, when possible, financial assistance for global research and information dissemination on modifications to gear and fishing methods that will reduce shark bycatch and bycatch mortality.

Recommendation: Whenever possible, fisheries agencies should attempt to ensure full utilization of shark catch, particularly for catches, bycatches, specific fisheries and gears associated with high rates of catch mortality.

8. According to FAO (Anon., 1991), "sharks grow and reproduce slowly [so that] the resource is fragile and can easily be overfished". The FAO has therefore recognized that "in the interests of sustainability, shark fisheries should be closely monitored to ensure that they are not overexploited" (Anon., 1991).

In the absence of any international, inter-governmental body with management authority over worldwide shark fisheries, and recognizing the relevance of international trade to the management and conservation of sharks, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1994 adopted Resolution Conf. 9.17, calling on Parties to the Convention and international fisheries organizations to improve the collection of data on shark fisheries and trade. Parties were further requested to provide available information regarding shark fisheries, management, and trade to the CITES Secretariat. This information will be compiled for further discussion at the next meeting of the Conference of the Parties (CoP10) in 1997.

Recommendation: In the absence of any international, inter-governmental agency with management oversight over shark fisheries, CITES should continue to monitor the work of FAO and other agencies in the implementation of Resolution Conf. 9.17, through and beyond CoP11.

Recommendation: A more formal method of monitoring can be instituted through the formation of a working group within CITES. CITES Parties should consider setting up a marine fisheries working group to review progress of the second phase of implementation of Resolution Conf. 9.17, and develop recommendations for measures needed to review and assess the status of sharks and other marine fisheries species that may be threatened by international trade.

ANNEX 1

Commonly fished chondrichthyan species*

HEXANCHIDAE	
Notorynchus cepedianus	Broadnose Sevengill Shark
SQUALIDAE	
Centrophorus spp.	gulper sharks
Squalus acanthias	Piked Dogfish
SQUATINIDAE	
Squatina spp.	angelsharks
ODONTASPIDAE	sand tiger sharks
Odontaspis ferox	Smalltooth Sand Tiger
ALOPIIDAE	
Alopias spp.	thresher sharks
Alopias vulpinus	Thresher Shark
Alopias pelagicus	Pelagic Thresher Shark
CETORHINIDAE	
Cetorhinus maximus	Basking Shark
LAMNIDAE	
Isurus spp.	mako sharks
Isurus paucus	Longfin Mako Shark
Isurus oxyrinchus	Shortfin Mako Shark
Lamna nasus	Porbeagle
SCYLIORHINIDAE	
Scyliorhinus canicula	Small-spotted Catshark
TRIAKIDAE	
Galeorhinus galeus	Tope Shark
Mustelus antarcticus	Gummy Shark
Mustelus lenticulatus	Spotted Estuary Smooth-hound
Mustelus spp.	smooth-hounds
CARCHARHINIDAE	
Carcharhinidae spp.	requiem sharks
Carcharhinidae albimarginatus	Silvertip Shark
Carcharhinidae amblyrhynchos	Grey Reef Shark
Carcharhinidae brachyurus	Copper Shark
Carcharhinidae brevipinna	Spinner Shark
Carcharhinidae falciformis	Silky Shark
Carcharhinidae leucas	Bull Shark
Carcharhinidae limbatus	Blacktip Shark
Carcharhinidae longimanus	Oceanic Whitetip shark
Carcharhinidae melanopterus	Blacktip Reef Shark
Carcharhinidae obscurus	Dusky Shark
Carcharhinidae plumbeus	Sandbar Shark

Carcharhinidae sorrah	Spot-tail Shark
Carcharhinidae taurus	Sand Tiger Shark
Galeocerdo cuvier	Tiger Shark
Prionace glauca	Blue Shark
Rhizoprionodon acutus	Milk Shark
Triaenodon obesus	Whitetip Reef Shark
SPHYRNIDAE	
Sphyrna spp.	hammerheads
Sphyrna mokarran	Great Hammerhead
Sphyrna lewini	Scalloped Hammerhead
Sphyrna zygaena	Smooth Hammerhead
RHYNCHOBATIDAE	
Rhynchobatus djiddenis	Giant Guitarfish
RAJIDAE	
Raja clavata	Thornback Ray
CALLORHINCHIDAE	
Callorhinchus spp.	elephantfish

* This list was developed on the basis of TRAFFIC Network research, and includes species frequently appearing in available information on worldwide shark fisheries. The list of commonly fished species is intended to guide preliminary efforts to improve species-specific reporting of catches and landings.

Inclusion in this list does not suggest that the species commonly occurs in international trade. Nor does it indicate that the species is vulnerable to, or threatened by, overexploitation. Indeed, many of the species listed here are included as a result of their broad geographic distributions.

GLOSSARY OF FISHING TERMS

Pelagic - (of marine life) belonging to the upper layers of the open sea, in contrast to *demersal*

Demersal - being, or living, near the sea bottom

Gillnet - a net of variable length and mesh size used to entangle fish by their gills.

Driftnet or *Drift gillnet* - a gill net suspended vertically from floats to a specific depth and left to drift freely, usually for catching mid-water and pelagic species of fish.

Dropline - a single line, with shorter lines ending in baited hooks attached, that is dropped vertically from the surface of the water. This gear type is used in deep water for bottom-dwelling fish.

Longline - a single line, with shorter lines ending in baited hooks attached, that is stretched horizontally or at an angle, usually for catching mid-water and pelagic species of fish.

Set net - a gillnet suspended vertically from floats at a fixed location.

Purse seine - a large net, typically used in commercial fisheries for tuna and related species, that encircles a school of fish and and is then closed using a purse-string mechanism.

Trawl net - a funnel-shaped fishing net towed behind a vessel, that is effective for catching fish on or near the sea floor.

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NOTES

[1] Chondrichthyans are subdivided into the elasmobranchii (sharks and rays) and the holocephali (chimaeras or elephantfish). The terms "elasmobranchs" and "chondrichthyans" are often used synonymously to refer to all cartilaginous fishes.

APPENDIX 1

Regional research into shark fisheries by the TRAFFIC Network is recorded in the following reports.

Barnett, R. (1996a). Shark fisheries and trade in east and southern Africa. In: Marshall, N.T. and Barnett, R. (eds). Shark fisheries and trade in the western Indian and southeast Atlantic Oceans. TRAFFIC East/Southern Africa.

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