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# Global fishery resources of tuna and tuna-like species

***Cover image:***
Design based on paintings by George Mattson published in *Tuna and billfish – fish without a country* by J. Joseph, W. Klawe and P. Murphy. La Jolla, United States of America, Inter-American Tropical Tuna Commission.1988.

# Global fishery resources of tuna and tuna-like species

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by
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**FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS**
Rome, 2007

# Preparation of this document

An earlier version of this paper was prepared for its presentation at the first Joint Meeting of Tuna Regional Fisheries Management Organizations, held in Kobe, Japan, 22–26 January 2007. The objective of this presentation was to provide background information about tuna and tuna-like species on the global scale, particularly on their fisheries, stock assessment and status, as a starting point for consideration at the Meeting. That earlier draft was subsequently revised in response to various suggestions and other comments received, resulting in the present document.

# Abstract


This paper reviews the state of fishery resources of tuna and tuna-like species on a global scale, concentrating on those most important commercially, i.e. the so-called principal market tuna species. They can be classified into tropical tunas (skipjack, yellowfin and bigeye) and temperate tunas (albacore and bluefin [Atlantic, Pacific and southern]). For tuna and tuna-like species, the document outlines:

- taxonomic and other basic biological information;
- the development and expansion of fisheries;
- trends of catches;
- institutional frameworks for regional cooperation in fisheries research, particularly stock assessment;
- procedures and input information for stock assessment; and
- the status of stocks.

It also discusses:

- potential improvements in knowledge of the status of stocks; and
- the outlook for this status and catches in the future.

There are still four or five of the 23 stocks of the principal market tunas that are only moderately exploited. These stocks are: i) albacore in the South Atlantic and the South Pacific (two stocks); and ii) skipjack in the Pacific (two stocks) and, possibly, in the Indian Ocean (which also may be about fully exploited).

Most stocks of the principal market tunas are nearly fully exploited (eight to ten of the 23 stocks). These stocks are: i) albacore in the Indian Ocean and the North Pacific (two stocks); ii) bigeye in the Atlantic and the Indian Ocean (two stocks); iii) Pacific bluefin; iv) yellowfin in all the oceans (four stocks), possibly with the exception of the western and central Pacific (also may be overexploited); and v) possibly, skipjack in the Indian Ocean (also may be moderately exploited).

A significant number of stocks are overexploited or depleted (five to six of the 23 stocks). Among these stocks, two are classified as depleted. These are Atlantic bluefin in the western Atlantic and southern bluefin. The stocks classified as overexploited are: i) albacore in the North Atlantic; ii) Atlantic bluefin in the eastern Atlantic and the Mediterranean Sea; iii) bigeye in the Pacific (perhaps two stocks); and, possibly iv) yellowfin in the western and central Pacific (which also may be about fully exploited).

Of the principal market species, the status of three of the 23 stocks is unknown; namely, albacore in the Mediterranean Sea and skipjack in the Atlantic (two stocks).



**Majkowski, J.**

Global fishery resources of tuna and tuna-like species.

*FAO Fisheries Technical Paper.* No. 483. Rome, FAO. 2007. 54p.

# Contents

# Acknowledgements

I am grateful to the staff and scientists of:

- the Commission for the Conservation of Southern Bluefin Tuna (CCSBT)
- the General Fisheries Commission for the Mediterranean (GFCM)
- the Indian Ocean Tuna Commission (IOTC)
- the Inter-American Tropical Tuna Commission (IATTC)
- the International Commission for the Conservation of Atlantic Tunas (ICCAT)
- the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC)
- the Secretariat of the Pacific Community (SPC)
- the Western and Central Pacific Fishery Commission (WCPFC) and
- various national institutions involved in tuna fisheries research and management

I should like to thank them for providing their tuna catch data and other information for the preparation of this paper as well as for previous papers prepared on tuna and tuna-like species over the many years that I have been working for FAO.

I should also like to express particular thanks to colleagues from the Fisheries Management and Conservation Service, Fisheries and Aquaculture Management Division, FAO Fisheries and Aquaculture Department: Fabio Carocci for the preparation of the figures and tables for this paper and Emanuela d'Antoni for the cover design.

# Executive summary

This paper reviews the state of fishery resources of tuna and tuna-like species on the global scale, concentrating on those most important commercially, i.e. the so-called principal market tuna species. They can be classified into tropical tunas (skipjack, yellowfin and bigeye) and temperate tunas (albacore and bluefin [Atlantic, Pacific and southern]).

For tuna and tuna-like species, the paper outlines:

- taxonomic and other basic biological information;
- the development and expansion of fisheries;
- trends of catches;
- institutional frameworks for regional cooperation in fisheries research, particularly stock assessment;
- procedures and input information for stock assessment; and
- the status of stocks.

It also discusses:

- potential improvements in knowledge of the status of stocks; and
- the outlook for this status and catches in the future.

Global annual catches of all tuna and tuna-like species tended to increase continuously with some fluctuations, reaching a maximum of about 9.5 million tonnes in 2003. Catches of the principal market tunas increased relatively steadily from less than 0.2 million tonnes in the early 1950s to the peak of 4.3 million tonnes in 2003, declining slightly in 2004. Atlantic, Pacific and southern bluefin contribute relatively little in terms of weight to the total catches of the principal market tunas, but their individual value is high because they are used for sashimi (raw fish regarded as a delicacy in Japan and increasingly in several other countries). The catch of these species peaked at about 150 000 tonnes in 1961, following a steep decline in the late 1960s as a result of declines in catches of southern bluefin. In 2004, the catch of the bluefin species was 79 000 tonnes.

In the early 1950s, the most catch (about 80 percent) was made in the Pacific. Between 1970 and 1978, the catches of the principal market tunas increased significantly because of the expansion of fisheries in the eastern Atlantic and the development of new offshore fishing grounds in the eastern Pacific. Between 1978 and 1984, many vessels moved to the western and central Pacific and the western Indian Ocean, developing new fisheries there. In the mid-1980s, catches of the principal tunas increased to 2.4 million tonnes. By 1994, they had increased to 3.4 million tonnes with better oceanographic conditions after the transfer of vessels. The development of fish aggregating devices (FADs) also contributed to these increases.

The global annual catches of skipjack and yellowfin tended to increase, reaching maximums of about 2.2 and 1.4 million tonnes in 2003, respectively. The global annual catch of bigeye also tended to increase continuously to a maximum of

493 000 tonnes in 2000, declining slightly from that level in subsequent years. The global catch of albacore increased from 1950 to the late 1960s, but has fluctuated without a clear trend since then with catches of about 220 000 tonnes in 2004.

Most of the tropical principal market tunas have reacted well to exploitation because of their high fecundity, wide geographic distribution, opportunistic behaviour and other population dynamics (such as a relatively short life span) that make them highly productive. Another factor is that skipjack and yellowfin are used mostly for canning, with lower prices than tuna used for sashimi such as bluefin and bigeye. Generally, with proper fisheries management, tropical species are capable of sustaining high yields. However, the possibilities of overexploitation and stock depletion should not be underestimated. On the whole, stocks of temperate species are less productive and may be more susceptible to overexploitation. The albacore used mainly for canning fetches much lower prices than bluefin, but higher than skipjack and yellowfin.

The following classification of the status of stocks is used throughout this paper.

- **N** *Not known* or significantly uncertain.
- **M** *Moderately exploited* (some limited potential for *sustainable* increases in catches).
- **F** *about Fully exploited* (fishing at about an optimal yield with no expected room for further *sustainable* increases in catches).
- **O** *Overexploited* (fishing above a level which is *sustainable* in a long term [with a risk of stock depletion/collapse] and no potential room for further sustainable increases in catches).
- **D** *Depleted* (catches well below historical maximum levels irrespective of fishing effort exerted).

In this classification, the most substantially overexploited stocks are distinguished by being classified as depleted.

There are still four or five of the 23 stocks of the principal market tunas that are only moderately exploited. These stocks are i) albacore in the South Atlantic and the South Pacific (two stocks); and ii) skipjack in the Pacific (two stocks) and, possibly, in the Indian Ocean (which also may be about fully exploited).

Most stocks of the principal market tunas are about fully exploited (eight to ten of the 23 stocks). These stocks are i) albacore in the Indian Ocean and the North Pacific (two stocks); ii) bigeye in the Atlantic and the Indian Ocean (two stocks); iii) Pacific bluefin; iv) yellowfin in all the oceans (four stocks), possibly with the exception of the western and central Pacific (also may be overexploited); and v) possibly, skipjack in the Indian Ocean (also may be moderately exploited).

A significant number of stocks are overexploited or depleted (five to six of the 23 stocks). Among these stocks, two are classified as depleted. These are Atlantic bluefin in the western Atlantic and southern bluefin. The stocks classified as overexploited are i) albacore in the North Atlantic; ii) Atlantic bluefin in the eastern Atlantic and the Mediterranean Sea; iii) bigeye in the Pacific (perhaps two stocks);

and, possibly iv) yellowfin in the western and central Pacific (which also may be about fully exploited).

Of the principal market species, the status of three of the 23 stocks is unknown. They are albacore in the Mediterranean Sea and skipjack in the Atlantic (two stocks).

If tuna fisheries continue to be profitable, the intensity of fishing may even increase as a result of fishing overcapacity unless it is effectively restrained by fisheries management measures. Such intensification would result in a significant deterioration in the status of stocks of tuna and tuna-like species. Even without intensification, the status of some stocks that are being overexploited is likely to deteriorate unless the exploitation is reduced. This deterioration could eventually lead to a reduction in catches.

The catches of the principal market tunas could be significantly increased in a sustainable way by more catches of skipjack in the Pacific (particularly in the western and central Pacific, despite the fact that their catches are greatest) and, possibly, in the Indian Ocean. However, this would need to be done without increasing the catches of other tuna species such as bigeye and yellowfin, which are currently caught together with skipjack. Increases in catches of bigeye and yellowfin are not desirable because they are about fully exploited or overexploited. Because of this, fishing techniques would have to be developed that would allow skipjack to be caught selectively without the other tuna species.

Albacore catches in the South Atlantic and South Pacific could also be increased in a sustainable way although the temperate species of albacore is not very productive. Catches of their stocks do not at present contribute greatly to global catches of the principal market tunas.

Stocks other than those mentioned above are about fully exploited, overexploited, depleted or their status is unknown. Therefore, their catches cannot be increased in a sustainable way, at least before recovery of overexploited and depleted stocks and before determining the status of stocks classified as unknown. In fact, catches from overexploited and depleted stocks may decrease at least in the short term, if additional management measures are not introduced to allow them to recover from overexploitation. Even without such measures, catches of overexploited and depleted stocks may decrease in a long term if they continue to be overexploited. Similarly, catches of about fully exploited stocks may eventually decrease, if they are overexploited.

# Introduction

## OBJECTIVE

This paper reviews the state of fishery resources of tuna and tuna-like species on the global scale. For these species, the paper outlines:

- taxonomic and other basic biological information;
- the development and expansion of fisheries;
- trends of catches;
- institutional frameworks for regional cooperation in fisheries research, particularly stock assessment;
- procedures and input information for stock assessment; and
- the status of stocks.

It also discusses:

- potential improvements in knowledge of the status of stocks; and
- the outlook for this status and catches in the future.

It concentrates on the commercially most important species of tuna and tuna-like species (i.e. the so-called principal market tuna species). These are albacore, bigeye, bluefin (Atlantic, Pacific and southern), skipjack and yellowfin.

## SOURCES OF CATCH DATA AND OTHER INFORMATION

Specifically for the tuna species that are most important commercially, two databases of FAO's Fisheries Global Information System (FIGIS) are used. They are:

- Global Tuna Nominal Catches (FAO, 2002) and
- Atlas of Tuna and Billfish Catches: Interactive Display (FAO, 2003).

The Atlas is used also to show the distribution of catches of most billfishes in addition to that of principal market tunas.

The above-mentioned databases combine catch data collected/collated by:

- the Commission for the Conservation of Southern Bluefin Tuna (CCSBT; http://www.ccsbt.org/)
- the Indian Ocean Tuna Commission (IOTC; http://www. iotc.org/)
- the Inter-American Tropical Tuna Commission (IATTC; http://www.iattc.org/)
- the International Commission for the Conservation of Atlantic Tunas
- (ICCAT; http://www. iccat.es/)
- International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC; http://isc.ac.affrc.go.jp/)
- the Secretariat of the Pacific Community (SPC; http://www.spc.org.nc/) and

- the Western and Central Pacific Fishery Commission (WCPFC; http://www.wcpfc.int/).

For tuna and tuna-like species other than the principal market tunas, data on nominal catches are not available from the Global Tuna Nominal Catches database (FAO, 2002) but are taken from the more general database entitled Global Production Statistics 1950–2004 of FIGIS, which has been created by FAO for fishes other than tuna and tuna-like species. These data have been obtained by FAO mainly from fishing countries and include their national statistics. However, for tuna and tuna-like species, in processing the data, FAO consulted the above-listed institutions, adjusting some data as appropriate. Most other information presented in this paper is obtained from the institutions listed earlier.

## TAXONOMIC AND OTHER BASIC BIOLOGICAL INFORMATION

The suborder Scombroidei is usually referred to as tuna and tuna-like species (Klawe, 1977; Collette and Nauen, 1983; Nakamura, 1985). It is composed of tunas (sometimes referred to as true tunas), billfishes and other tuna-like species (see Appendix I). It includes some of the largest and fastest fishes in the sea.

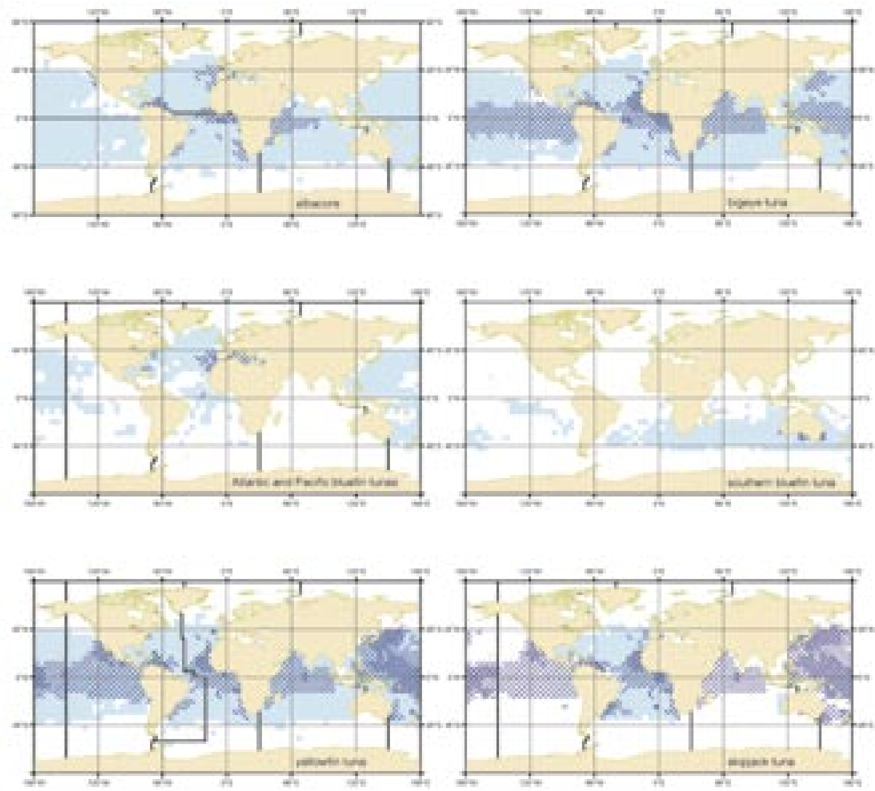
The tunas (*Thunnini*) include the most economically important species referred to as the principal market tunas because of their global economic importance and the intensive international trade for canning and sashimi. In fact, the anatomy of some tuna species seems to have been purposely designed for loining and canning. Tunas are subclassified into four genera (*Thunnus*, *Euthynnus*, *Katsuwonus* and *Auxis*) with 15 species all together.

From the genus *Thunnus*, the principal market tunas are albacore (*T. alalunga*), bigeye tuna (*T. obesus*), Atlantic bluefin tuna (*T. thynnus)*, Pacific bluefin tuna (*T. orientalis),* southern bluefin tuna (*T. maccoyii*) and yellowfin tuna (*T. albacares*). Skipjack tuna (*Katsuwonus pelamis*) is the seventh principal market tuna species. The superbly efficient metabolic system of tunas includes a circulatory system that allows them to retain or dissipate heat as required for peak biological performance and efficiency. As is evident from the geographic distribution of their catches (Figure 1), the principal market tunas are all oceanic, capable of long migrations or movements and constituting one or two stocks in each ocean. The exceptions are Atlantic and Pacific bluefins, which occur only in their eponymous oceans. Southern bluefin constitutes a single stock extending in the Atlantic, Indian and Pacific Oceans.

The principal market tunas are frequently divided into tropical (bigeye, skipjack and yellowfin) and temperate (albacore and bluefin). However, these generalities fail to describe precisely water temperature preferences in the case of bigeye, which is distributed throughout the tropics, but spends most time in the cooler waters near or within the thermocline, thus in more “temperate” waters like albacore when it ventures to lower latitudes.

Because of the economic situation in Japan in the past, prices of bluefin tuna, the species most valued for sashimi, although still high compared with other species, decreased. For a whole fish, a fisherman may receive from US$40 to

FIGURE 1
**Geographic areas where catches of principal tunas took place from 1994 to 2004**

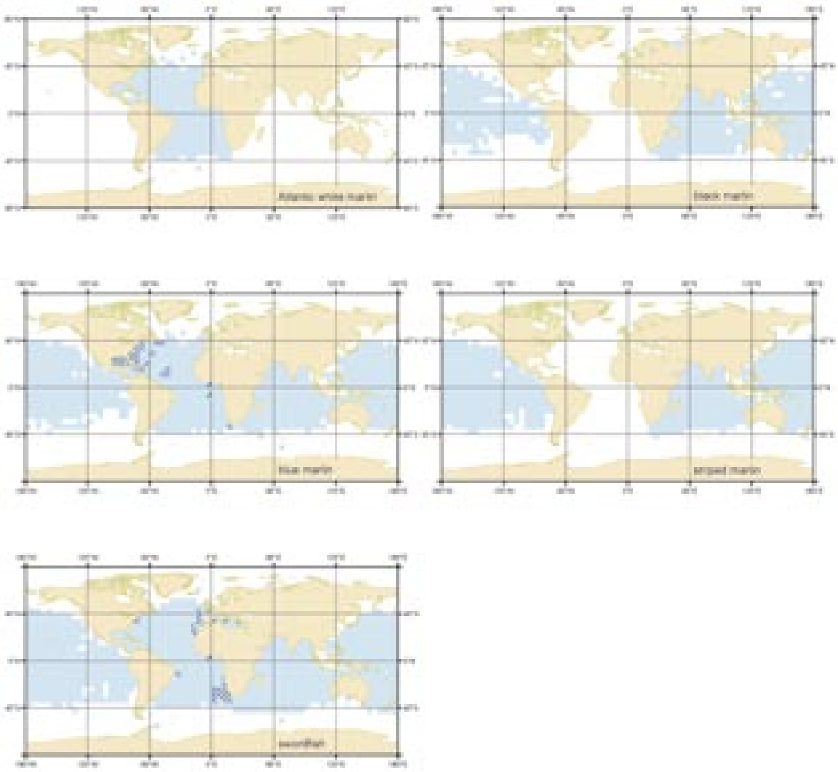


*Source*: FAO, 2003

US$50 per kg. Not so long ago, a fish of exceptional quality reached US$500 per kg and more recently has been sold for even more, but such prices referring to very few single fish do not reflect the situation on the market. Bluefin fattened at sea in enclosures (farms) is sold at generally lower prices, from US$12 to US$30 per kg. Bigeye is also well priced on sashimi markets. Although yellowfin is popular on these markets, prices are much lower. For canning, albacore (the tuna species first commercially canned) fetches the best prices because of its white meat, followed by yellowfin and skipjack. For the latter, fishermen are paid less than US$1 per kg. The relatively low prices of canning-quality fish are compensated for by very large catches, especially in the case of skipjack and yellowfin. Longtail tuna (*Thunnus tonggol*) is becoming increasingly important for canning and in substantial international trade. The consumption of tuna and tuna-like species in forms other than canned products and sashimi is increasing.

The tunas that are not the principal market species are more neritic, i.e. living in water masses over the continental shelf (see Appendix II). They include longtail

FIGURE 2
**Geographic areas where catches of billfishes took place from 1994 to 2004**



*Note*: For billfishes, for which these areas are not precisely known, see Appendix II.

*Source*: FAO, 2003

tuna, blackfin tuna (*T. atlanticus*), black skipjack (*Euthynnus lineatus*), kawakawa (*E. affinis*), little tunny (*E. alleteratus*), bullet tuna (*Auxis rochei*) and frigate tuna (*A. thazard*).

The billfishes (Istiophoridae) are composed of marlins (*Makaira* spp.), sailfish (*Istiophorus* spp.), spearfish (*Tetrapturus* spp.) and swordfish (*Xiphias gladius*, the only species in the genus). With the exception of two species (Mediterranean and roundscale spearfish), all billfishes have wide geographic distributions as is evident from the distribution of catches (Figure 2). Not all species occur in all oceans. Billfishes are mostly caught by longlines as bycatch, except for swordfish which is targeted in certain regions using longlines and harpoons. Billfishes are also caught in sport fisheries, where they are greatly valued. They are all excellent seafood.

Other important tuna-like species include slender tuna (*Allothunnus fallai*), butterfly kingfish (*Gasterochisma melampus*), wahoo (*Acanthocybium solandri*), bonitos (*Cybiosarda*, *Orcynopsis* and *Sarda*), Spanish and king mackerels, seerfish and sierra (*Scomberomorus* spp.). Their geographic distribution is given in Collette and Nauen (1983). These important species have significant potential especially for developing countries where they are mostly caught in artisanal and recreational fisheries. Slender tuna and butterfly kingfish (with a circumpolar distribution in the Southern Ocean) are now caught mainly as a bycatch of the Japanese longline fishery targeting southern bluefin tuna.

The 1982 UN Convention on the Law of the Sea classifies the principal market tunas, billfishes, blackfin tuna, bullet and frigate tuna, little tunny and kawakawa as highly migratory even though little tunny and kawakawa are mostly confined to the continental shelf and upper slope. Black skipjack is not classified as highly migratory, but it is probably more oceanic than little tunny and kawakawa.

# Fisheries: development and expansion

Tuna fisheries are among the oldest in the world with Phoenician trap fisheries (Ravier and Fromentin, 2001) for bluefin tuna occurring around 2000 BC. They are mentioned by Aristotle, Oppian and Pliny the Elder, and they are also recorded in excavations at prehistoric sites.

Until the second part of the twentieth century, fishing occurred mostly in coastal areas. In the Atlantic, it included purse seining for bluefin tuna off Norway; trolling for albacore in the Bay of Biscay; trap fishing near the Strait of Gibraltar and North African coast; swordfish fishing in the northwestern Atlantic and in the Mediterranean Sea; bigeye and skipjack fishing near islands; and artisanal fishing along the African coasts. In the Pacific, various artisanal fisheries operated near islands in tropical waters (albacore trolling off the West Coast of the United States of America, baitboat fishing for yellowfin and skipjack off the American coast, pole and line fishing for skipjack near Japan and many other fisheries for various tunas along the Japanese coasts). Off South America, coastal fisheries operated using baitboats and small seines. In the Indian Ocean, skipjack fishing off Sri Lanka, India and Maldives was carried out. Off Australia, longline fishing was carried out for southern bluefin tuna. Many other artisanal fisheries for tuna-like fishes existed in tropical or subtropical areas all over the world.

As a result of increasing demand for canned tuna, industrialized fisheries started during the 1940s and 1950s. They included Japanese longline and baitboat fishing in the Pacific and baitboat fishing off California along the Mexican coasts to Central America, while traditional fisheries continued their activities. After the Second World War, the fishing areas for the Japanese tuna fishery were limited to its coast until 1952. However, since then, fishing areas, particularly the longline ones, have expanded very rapidly. In the late 1950s, they reached as far as the Atlantic Ocean. Also in the late 1950s, some European pole and line fishing started off the African coasts from local harbours.

In the 1960s, Spanish and French boats with pole and line and purse seines started tuna fishing off West Africa. Japanese longliners also expanded their fishing area all over the world, mostly catching albacore and yellowfin for canning. In the middle of the 1960s, the Republic of Korea and Taiwan Province of China started large-scale longline fishing to export tuna for canning, learning the techniques from Japan. At the end of this decade, the Japanese longline industry developed an extremely cold storage system used for new frozen products for the sashimi market. Consequently, Japan switched the target species from yellowfin and albacore to bluefin and bigeye. The United States of America's pole and line fishing off Central and South America was almost completely replaced by purse seiners in the 1960s and purse seining of tuna with dolphins was developed.

In the 1970s, the purse seine fisheries of European countries developed quickly in the east tropical Atlantic and attained the first peak of their catches of yellowfin and skipjack. Purse seine fisheries developed further in the eastern tropical Pacific. A strict regulation for the reduction of mortality of dolphins caught with tuna fishing was implemented in this area. Consequently, the United States of America's flag vessels started changing their flags to other Central and South American countries. Some fishing effort was also shifted to the central and western Pacific where no dolphin fishing occurred.

After the development of extremely cold storage, some longliners gradually changed their target from yellowfin (for canning) to bigeye (for sashimi). This shift was first seen among Japanese longliners, but it gradually expanded to the fleets from the Republic of Korea and Taiwan Province of China. To catch bigeye, which has a much deeper habitat than that of tropical tunas, longlines were set deeper and deeper. This change in fishing strategy implies changes in fishing areas, leading to modifications in target and bycatch species.

In the 1980s, a new purse seine fishery started in the western Indian Ocean and many French seiners from the eastern Atlantic moved there. In the Pacific Ocean, the purse seine fishery expanded its fishing area, particularly in the south, central and western Pacific. Purse seine fishing efficiency increased with modern equipment such as bird radar and the use of helicopters. During the 1990s, many new countries entered into large-scale industrial fishing, mostly purse seining (e.g. Mexico, Venezuela and Brazil). Small-scale longline fishing operations by coastal countries in various areas (e.g. Mediterranean countries, the Philippines and Indonesia) also started. The Japanese longline fleet began to reduce its size in the 1980s. At the same time, Taiwan Province of China longliners and others flying flags of convenience increased rapidly.

Particularly in the 1980s, management regulatory measures for tuna fisheries were introduced by tuna fishery bodies, which also affected fishing patterns and country shares of catches. In the 1990s, more management measures were introduced, resulting in an increase in illegal, unreported and unregulated (IUU) fishing. IUU fishing became a hazard for the proper management of fish resources. In general, the tuna fishing capacity increased extensively during the 1990s. Recent increases in catches sometimes caused oversupply to the market, particularly for skipjack because of the large purse seine catches.

Starting in the 1980s and increasingly in the 1990s, many coastal states started new tuna fishing by chartering boats with flags of convenience. This occurred in all oceans. Some of these chartered vessels changed flags to the coastal states and this tendency will possibly be intensified in the near future. Partially because of the development of these new coastal fisheries, the fishing effort by traditional longline countries started to decline.

Purse seiners started fishing around FADs in the Atlantic in the early 1990s, and this method expanded to the Indian and Pacific Oceans. FAD fishing is less selective for fish species and size. The fishing efficiency, size of fish taken, species composition and incidental catch changed drastically with the adoption of this new practice.

Tuna farming started in the 1990s. This new industry resulted in a better price being paid to fishers and an increasing demand for specific sizes and species. Through the farming/fattening process, the relatively small tunas taken by purse seiners, which used to be sold only for canning, can now be used for the sashimi market. To date, bluefin tuna is the main species used in farming, but it is extending to bigeye and yellowfin tuna. The countries involved in bluefin farming include Australia, Japan, Mexico and several Mediterranean countries (particularly Croatia, Italy, Malta, Morocco, Spain and Turkey).

At present, on an industrial scale, tuna and tuna-like species are mainly caught with purse seines, longline and pole and line over wide areas in oceans (Figures 1 and 2). Of these fishing gears, the most catch in terms of weight is taken by purse seiners. In the Pacific, about 70 percent of the catch of principal market tunas is taken by purse seiners, 10 percent by pole and line and 8 percent by longlines. In the Indian Ocean, these values are 45, 15 and 20 percent and in the Atlantic, 55, 21 and 22 percent, respectively. Other gears used are troll lines, handlines, driftnets, traps and harpoons.

Industrial tuna fisheries are extremely dynamic and fleets, especially distant-water fishing fleets, can react very quickly to changes in stock size or market conditions. For example, as already mentioned, in the early 1980s, because of low catch rates and problems with access to fishing grounds, many French and Spanish purse seiners from the Atlantic moved to the Indian Ocean, contributing to the doubling of Indian Ocean catches. Some of these vessels have now moved back to the Atlantic. Similarly, because of unfavourable oceanographic conditions (El Niño), the United States of America's purse seiners moved from the eastern Pacific to the western part of the ocean in the early 1980s.

The purse seine and pole and line are used to catch fish close to the surface (e.g. skipjack and relatively small individuals of yellowfin, albacore and bluefin). Longlines are used for fish at greater depths (e.g. large individuals of bluefin, bigeye, yellowfin, albacore and billfishes). Most purse seine and pole and line catches are canned. Longline catches with the exception of those of albacore are mainly sold on the sashimi market to be consumed raw, traditionally in Japan, but now also in other countries. The use of pole and line and large-scale longlining has been generally declining, while purse seining is increasingly used, resulting in greater catches of skipjack, small to medium yellowfin and small bigeye, while catches of large yellowfin and the other principal market tunas have remained relatively stable.

Small-scale longlining for high-quality fish for the sashimi market is increasingly being used by Taiwan Province of China and mainland China as well as other developing countries. This contributes to a general trend of rapidly increasing importance of coastal developing countries (including island countries of the Indian and Pacific Oceans) in tuna fishing. This increasing importance results from the purchase of purse seiners and from the intensification of artisanal fisheries. Catches from these fisheries may still be underestimated despite the fact that the rate of non-reporting of catches in developing countries is being reduced.

For each stock of principal market tunas, Appendix III lists the most important fishing countries. Further information on tuna fisheries can be found in Bayliff, Leiva Moreno and Majkowski (2005) and in Miyake, Miyabe and Nakano (2004).

# Catches: trends

With the exception of the last part, this chapter concentrates on principal market tunas. The relationship between catches of these species and those of all tuna and tuna-like species is presented in Figure 3. The latter catches tend to increase continuously with some fluctuations, reaching their maximum of about 9.5 million tonnes in 2003.

## PRINCIPAL MARKET TUNAS

### Historical evolution

The global production of the principal market tunas increased relatively steadily from less than 0.2 million tonnes in the early 1950s to a peak of 4.3 million tonnes in 2003, declining slightly in 2004 (Figure 3). In the early 1950s, most catch (about 80 percent) was taken in the Pacific. Between 1970 and 1978, catches increased significantly as a result of the expansion of fisheries in the eastern Atlantic and the development of new offshore fishing grounds in the eastern Pacific. Between 1978 and 1984, many vessels moved to the western Pacific and the western Indian Ocean, developing new fisheries there. In the mid-1980s, catches of the principal

FIGURE 3

**Annual catches of all tuna and tuna-like species, principal tunas, skipjack and yellowfin**

('000 tonnes)

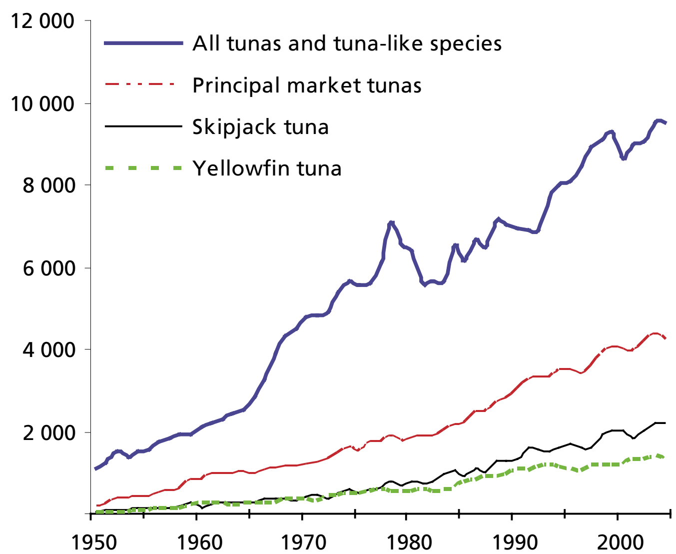


FIGURE 4
**Catches of principal market tunas in the Pacific**
('000 tonnes)

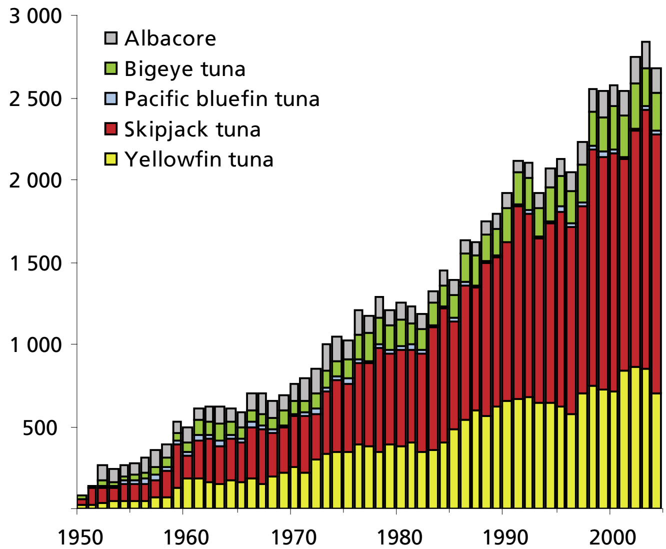
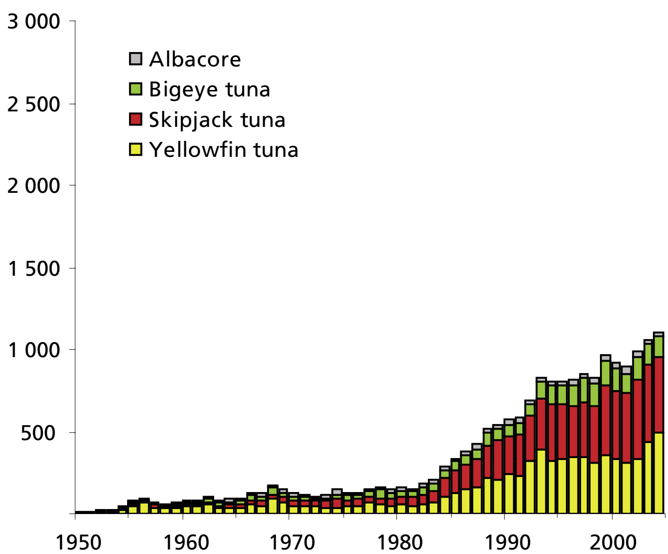



FIGURE 5
**Catches of principal market tunas in the Indian Ocean**
('000 tonnes)



tunas increased to 2.4 million tonnes. By 1994, they had increased to 3.4 million tonnes with better oceanographic conditions after the transfer of vessels. The development of FAD fishing also contributed to these increases.

## By species

Skipjack, which is used mostly for canning, accounts for the greatest proportion of the world catches of tuna (Figure 3). Catches tended to increase over the entire period of its exploitation. In 2003, the skipjack catch was about 2.2 million tonnes (the highest on record), representing about half of all the principal market tuna landed. In the early 1980s, catches of skipjack increased steadily as a result of expansion of fishing effort into the tropical western and central Pacific (Figure 4) and the western Indian Ocean (Figure 5). These increases continued in the following years. The development of purse seine fisheries on FADs in the 1990s contributed to further increases in catches of tropical tuna species including skipjack. In the Atlantic, catches of skipjack peaked at 0.24 million tonnes in 1991, decreasing to 0.19 million tonnes in 2004 (Figure 6) and thus contributing relatively little to the global catches of the species.

Yellowfin is commercially the second most important species of tuna by weight. Most yellowfin is used for canning, but more and more of the catches are being sold in fresh fish markets (and also as frozen fish). Similarly as with skipjack,

FIGURE 6
**Catches of principal market tunas in the Atlantic**
('000 tonnes)

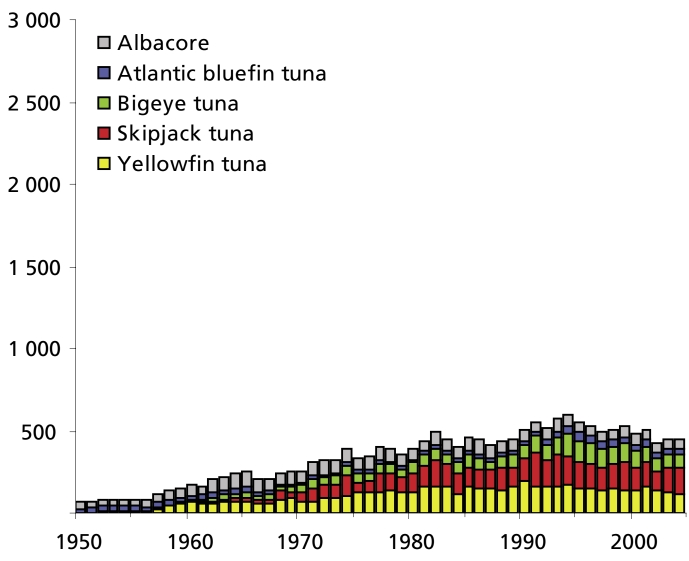
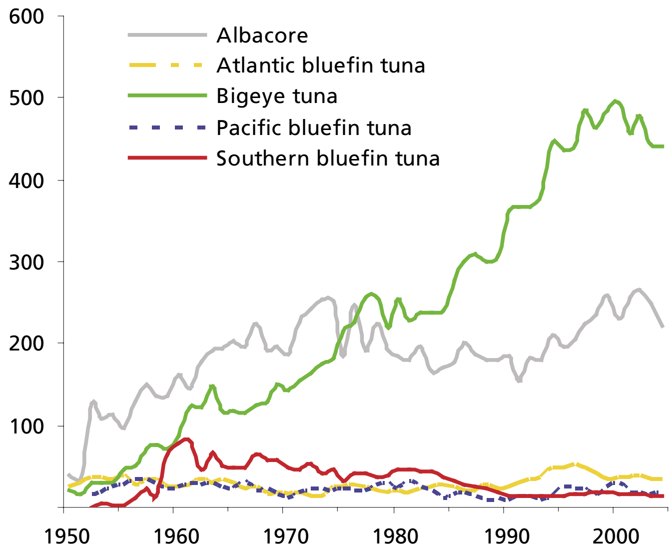


FIGURE 7
**Annual catches of principal tunas other than skipjack and yellowfin**
('000 tonnes)




for the same reasons, catches of yellowfin have tended to increase up to now, reaching 1.3 million tonnes in 2004 (Figure 3). Catches in the Atlantic peaked at 0.19 million tonnes in 1990 and then tended to decrease to 0.12 million tonnes in 2004 (Figure 6). Catches from the Indian Ocean increased to 0.49 million tonnes in 2004 (Figure 5). Catches of yellowfin from the Pacific reached a peak at 0.86 million tonnes in 2002, decreasing to 0.70 million tonnes in 2004 (Figure 4).

Bigeye, the third most important species in terms of landed weight (Figure 7) is similar in appearance to yellowfin. However, unlike yellowfin, bigeye tunas are primarily creatures of the deep, spending most of their lives in cold waters below the upper mixed layer of the ocean where they used to be traditionally captured mainly by longline gear. Their high fat content (for insulation from the cold water) makes them desirable for the Japanese sashimi market. The rapid and substantial increase in catches in the mid-1970s resulted from modifications of longline gear which enabled it to be used in much deeper water than previously. However, more recently the longline catches of large bigeye tunas have been declining, while purse seine catches of smaller bigeye, particularly in association with FADs, increased rapidly in the 1990s, resulting in continuous large increases of total catches for the species to a maximum of 493 000 tonnes in 2000, declining slightly from that level in subsequent years. The increases of bigeye purse seine catches around FADs resulted in complications for fisheries management and allocations among participants in the fisheries harvesting bigeye.

World production of albacore, used mostly for canning, increased from 1950 to the late 1960s. It has fluctuated without a clear trend since then with catches of 220 000 tonnes in 2004 (Figure 7). During the 1980s and early 1990s, driftnet fisheries made large catches of small albacore on the high seas in the southwestern and northeastern Pacific. Even with the termination of these fisheries, the total albacore catch in the Pacific significantly increased from the level before 2001, peaking at 172 000 tonnes in 2002 (Figure 4).

Atlantic, Pacific and southern bluefin contribute relatively little in terms of volume to the total catches of principal market tunas (Figure 7), but their individual value is high because of their use for sashimi. The catch of these species peaked at about 150 000 tonnes in 1961, following a steep decline in the late 1960s as a result of decreased catches of southern bluefin.

Catches of Atlantic bluefin tended to decline from the early 1950s to the early 1970s. During the next decade and a half, catches fluctuated without trend. In the early 1990s, reported catches increased rapidly to 53 000 tonnes in 1996 probably as a result of improved reporting in the Mediterranean Sea. Catches declined after 1996 and have stabilized at about 35 000 tonnes in the last period. The catch reported in 2004 (34 500 tonnes) was slightly over the total allowable catch (TAC) of 32 000 tonnes, but scientists at the International Commission for the Conservation of Atlantic Tunas (ICCAT) estimated it to be about 50 000 tonnes.

The catch of Pacific bluefin peaked at 32 000 tonnes in 1966 and 1981. The smallest catch was 8 000 tonnes in the early 1990s. Catches have fluctuated upwards since then, in the order of 29 000 tonnes in 2000, but decreasing to 22 000 tonnes in 2004.

Catches of southern bluefin increased steeply from 800 tonnes in 1952 to 81 000 tonnes in 1961. They fluctuated without a trend between 41 000 tonnes and 66 000 tonnes until 1974. Catches of the species decreased steeply and steadily from 45 000 tonnes in 1980 to 13 700 tonnes in 1991. The reported catches have remained between 13 000 tonnes and 20 000 tonnes since then, with 13 500 tonnes reported in 2004. Recently, a possibility of substantial under-reporting of southern bluefin catches over the last ten to 20 years was identified. Catches from individual stocks of the principal market tunas are shown and discussed in the context of the status of these stocks (see the Status of Stocks chapter).

## By ocean

Historically, the largest proportion of principal market tunas has always been taken from the Pacific Ocean (Figure 8). Between 1998 and 2002, the annual catch of these species in the ocean remained quite stable at about 2.5 million tonnes. This represents approximately 65 percent of global annual catch of the principal market tunas. Skipjack and yellowfin contribute about 86 percent of the total catch in the Pacific.

Until the mid-1980s, catches of the principal market species in the Atlantic and the Mediterranean Sea were greater than those in the Indian Ocean but around the mid-1980s, the Atlantic catches became smaller than those in the Indian Ocean.

FIGURE 8
**Catches of principal market tunas by ocean**
('000 tonnes)

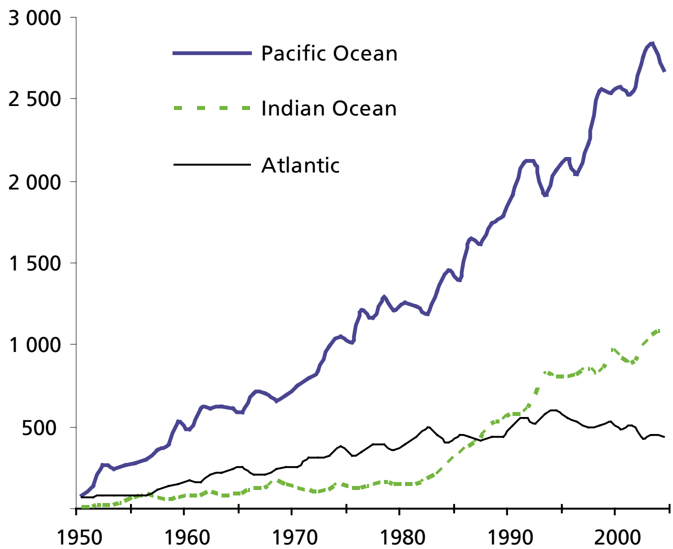
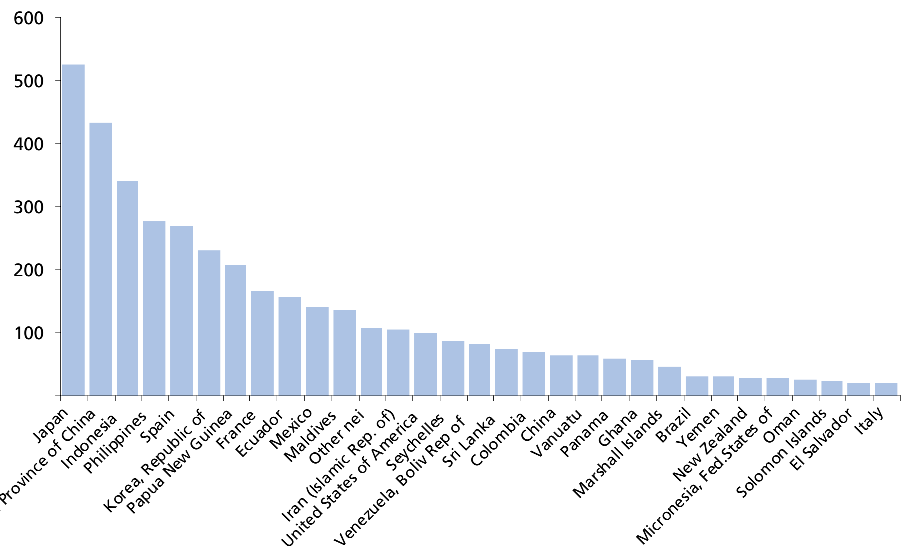



FIGURE 9
**Catches in 2004 by principal fishing country**
('000 tonnes)



The transfer of some vessels from the Atlantic to the Indian Ocean contributed to this change. Catches in the Atlantic continued to increase until 1994 when the maximum annual catch of 0.63 million tonnes was taken, representing almost 18 percent of global landings of the principal market tunas. In 2004, Atlantic landings were 428 000 tonnes. Bigeye, skipjack and yellowfin contribute about 70 percent of the total catches of principal market species there.

Prior to the 1980s, the catch from the Indian Ocean accounted for less than about 8 percent of world production of the principal market tunas. As a result of the expansion of tuna fishing operations in the ocean, catches of skipjack and yellowfin increased rapidly in the 1980s. Consequently, catches of the principal market tunas in the Indian Ocean surpassed those in the Atlantic Ocean, accounting for about 26 percent of global landings of the principal market tunas in 2004 (i.e. around 1.1 million tonnes). At present, skipjack and yellowfin contribute about 86 percent of the total catches of the principal market tunas from the Indian Ocean.

### By country/entity

The principal market tuna catches of Japan and Taiwan Province of China are now the largest (more than 0.5 and 0.4 million tonnes caught in 2004, respectively) of all countries (Figure 9). Other important tuna fishing countries include Indonesia (341 948 tonnes), the Philippines (278 000 tonnes), Spain (268 585 tonnes), Republic of Korea (231 320 tonnes), Papua New Guinea (206 678 tonnes), France (165 767 tonnes), Ecuador (157 293 tonnes), Mexico (141 871 tonnes), Maldives (135 919 tonnes), Islamic Republic of Iran (105 247 tonnes), United States of America (99 917 tonnes), Seychelles (87 990 tonnes), Bolivarian Republic of Venezuela (81 432 tonnes), Sri Lanka (73 910 tonnes), Colombia (69 068 tonnes), China (64 410 tonnes), Vanuatu (63 439 tonnes), Panama (59 291 tonnes) and Ghana (55 681 tonnes).

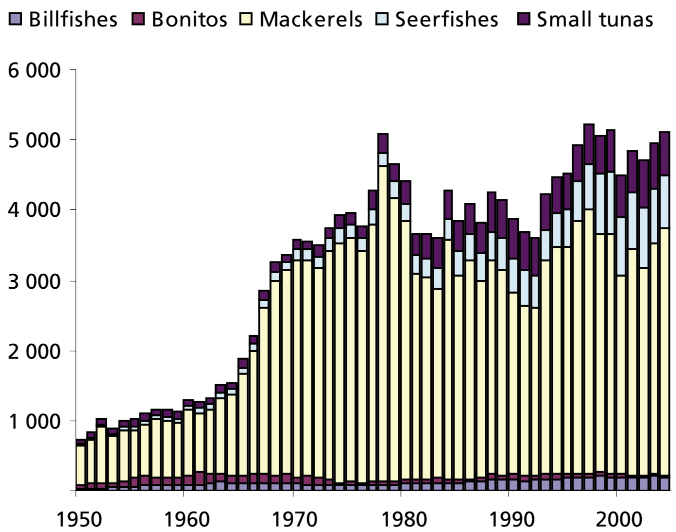
Particularly off Southeast Asia, in both the Indian and Pacific Oceans, tuna fisheries are growing, including the artisanal sector catching mostly small tunas, skipjack and yellowfin. This sector's growth has also been significant in the entire Indian Ocean. Further information on fishing countries/entities is given in Appendix III.

### Other tuna and tuna-like species

The catches of tuna and tuna-like species other than the principal market tunas also significantly increased from about 0.5 million tonnes in the early 1970s to nearly 5.2 million tonnes in 2004, fluctuating significantly since the late 1980s. Historical trends of catches of these species divided into billfishes, bonitos, mackerels, seerfishes and small tunas (tunas other than the principal market tunas) are presented in Figure 10.

Less than 10 percent of these catches are composed of billfishes, taken mainly in the Pacific and Atlantic. In terms of weight (catches in 2004), the most important species of tunas and tuna-like species other than the principal market

FIGURE 10
**Catches of billfishes, bonitos, mackerels, seerfishes and smll tunas (other than the principal market tunas)**
('000 tonnes)




tunas are chub mackerel (2 017 276 tonnes), Atlantic mackerel (708 710 tonnes), Indian mackerel not specified (498 124 tonnes), Japanese Spanish mackerel (427 990 tonnes), frigate and bullet tunas (295 385 tonnes), Indian mackerel (218 676 tonnes), narrow-barred Spanish mackerel (196 483 tonnes), longtail tuna (143 329 tonnes), kawakawa (133 903 tonnes) and swordfish (109 622 tonnes).

# Institutional frameworks for international collaboration in fisheries research

## REGIONAL FRAMEWORKS

Countries/entities fishing tuna and tuna-like species cooperate in fisheries research (including stock assessment) within several international frameworks (FAO, 1994; Marashi, 1996; Beckett 1998), particularly:

- the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), established in 1993;
- the General Fisheries Commission for the Mediterranean (GFCM), established in 1952;
- the Indian Ocean Tuna Commission (IOTC), established in 1996;
- the Inter-American Tropical Tuna Commission (IATTC), established in 1949 (for the eastern Pacific east of 150° west longitude);
- the International Commission for the Conservation of Atlantic Tunas (ICCAT), established in 1969;
- the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC), established in 1995;
- the Secretariat of the South Pacific Community (SPC), established in 1947 (tuna-related activities since the mid-1970s); and
- the Western and Central Pacific Fisheries Commission (WCPFC), established in 2004.

With the exception of ISC and SPC, the above-mentioned institutions are the Regional Fishery Management Organization (RFMO) and therefore, they also have conservation and fisheries management responsibilities.

IATTC is the oldest tuna RFMO, while WCPFC is the youngest. Experiences of those RFMOs created before the establishment of Article 64 of the United Nations Convention on the Law of the Sea (UNCLOS) were used in formulating the Article, which mandates states to cooperate directly through appropriate organizations to ensure the conservation of highly migratory species.

GFCM deals with all fish species including tuna and tuna-like species in the Mediterranean Sea. CCSBT deals with only one target species (southern bluefin tuna) on a global scale, while all the other tuna RFMOs deal with the principal market tuna species, billfishes and other tuna-like species in their specific areas of competence. They also deal with the associated bycatch species to some extent.

In addition to their responsibilities in conservation and fisheries management, CCSBT, GFCM, IATTC, ICCAT, IOTC and WCPFC facilitate and/or coordinate the data collection/collation, processing and dissemination, stock assessment and other fisheries research in their areas of competence. IATTC, which has a significant research capacity, carries out intensive research, while the roles of CCSBT, GFCM, ICCAT, IOTC and WCPFC in research are mostly limited to the coordination of activities of their member countries/entities. All these organizations regularly carry out or facilitate stock assessments of tuna and tuna-like species in their areas of competence, results of which are reviewed at various scientific meetings (mostly of scientific committees and their working groups).

A significant number of countries fishing for tuna in the Mediterranean Sea (which is included in the area of competence of ICCAT) originally were not members of ICCAT, but of GFCM only. Therefore, ICCAT collaborates closely with GFCM regarding tuna and tuna-like species. The latter body endorses and implements all the management measures introduced by ICCAT for the Mediterranean Sea.

IOTC and GFCM are fishery bodies of the Food and Agriculture Organization of the United Nations (FAO). Before the creation of IOTC, the FAO/United Nations Development Programme (UNDP) Indo-Pacific Tuna Programme (IPTP) coordinated and carried out tuna research in the Indian Ocean and in the Pacific off Southeast Asia.

SPC, and more specifically its Oceanic Fisheries Programme (OFP), has a significant research capacity in the stock assessment of tuna and tuna-like species. It has been carrying out research required for the actual assessment of stocks of the principal market tuna species and billfishes in the western and central Pacific. Before the creation of the Scientific Committee (SC) of WCPFC in 2005, the results of this research were reviewed at meetings of its Standing Committee on Tuna and Billfish (SCTB). That function of SCTB has been replaced by that of the SC of WCPFC, but SPC continues to carry out stock assessments of the principal market tuna species and billfishes in the western and central Pacific.

ISC relies on the capacities of its member countries/entities in fisheries research on North Pacific albacore, marlins and swordfish, Pacific bluefin and the associated bycatch species. The collaboration between ISC and the Northern Committee of WCPFC is being formally established.

## GLOBAL COOPERATION

Cooperation in tuna fisheries research extends beyond the scale of single oceans for various reasons. As mentioned before, industrial tuna fleets are highly mobile and capable of moving between oceans. The principal market tunas are intensively traded on the global scale. In addition, many tuna fisheries research, conservation and management problems are similar in all oceans. Therefore, there is a need for exchange of information, cooperation and collaboration on the global scale.

Consequently, for a long time, representatives of the tuna RFMOs and SPC have participated, as observers, in important technical meetings on tuna and tuna-like species outside their areas of competence. Since relatively recently, usually once a year, representatives of secretariats of the tuna RFMOs, Pacific Islands Forum Fisheries Agency (FFA) and SPC have organized short meetings in conjunction with other prominent global fisheries meetings to discuss matters of mutual interest. They have also created the Network of Tuna Agencies and Programs. More recently, the tuna RFMOs have created a joint Web site (http://www.tuna-org.org/) to share their information.

An important example of global collaboration including tuna and tuna-like species is the formulation, in 1995, of the Agreement for the Implementation of the Provisions of the UN Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (sometimes referred to as the Fish Stocks Agreement). The United Nations facilitated the conclusion of this Agreement and FAO actively assisted, from a technical point of view, in reaching the Agreement (Doulman, 1995; Mahon 1996).

FAO has been involved in the consideration of many other global issues involving tuna and tuna-like species. One of these issues is bioeconomic interactions among fisheries, which need to be scientifically addressed for the resolution of fisheries management problems. Coordinated effort in this direction was initiated by FAO's Trust Fund project: "Cooperative Research on Interactions of Pacific Tuna Fisheries" (Shomura, Majkowski and Langi, 1993a, 1993b; Shomura, Majkowski and Harman, 1995, 1996). With the completion of the project, this effort is continued by regional and national institutions.

In March 2000, FAO coorganized, jointly with CCSBT, IATTC, ICCAT, IOTC and SPC, a global Expert Consultation on Implications of the Precautionary Approach for Tuna Biological and Technological Research in Thailand (FAO, 2001).

Another issue is that tuna fleets on the global scale have a greater capacity to catch tuna than is required for their sustainable exploitation. For many tuna fishing fleets, there is insufficient control of their capacity, fishing effort and catches. All tuna RFMOs recognize the seriousness of the overcapacity problem. As a result of such concerns (Joseph, 2003), FAO formulated and implemented a technical, multidisciplinary Trust Fund project on the "Management of Tuna Fishing Capacity: Conservation and Socio-economics". Its objectives are to provide necessary information and identify, consider and resolve technical problems associated with the management of tuna fishing capacity on a global scale, taking into account conservation and socio-economic issues. The Technical Advisory Committee (TAC) for the project is composed of experts affiliated with CCSBT, FFA, IATTC, ICCAT, INFOFISH (http://www. infofish.org/), IOTC, SPC, Japan's National Research Institute of Far Seas Fisheries (NRIFSF) and international associations of tuna longliners and purse seiners (Organization for the Promotion of Responsible Tuna Fisheries [OPRT] and the World Tuna Purse Seine Organization [WTPO]). The project's activities involved global studies, meetings of the TAC (Rome, Italy, 14 to 16 April 2004 and Madrid, Spain, 15 to

18 March 2005) and the Methodological Workshop on the Management of Tuna Fishing Capacity (La Jolla, California, United States of America, 8 to 12 May 2006).

Moreover, FAO collates data on nominal catches of all fish species including tunas and, separately, specifically of principal market tunas (see the Sources of catch data and other information in the Introduction). The first data set for all species is based mainly on official national statistics; it does not distinguish among different fishing gears and stocks. The second data set specifically for the principal tunas is able to do this, since it is based mainly on statistics of international organizations involved in tuna fisheries research (FAO, 2002). Both sets can be accessed from the Web page of FAO's Fisheries Global Information System (FIGIS). FAO also collates data on the geographic distribution of catches of tunas and billfishes on a global scale. These data and information on tuna resources, fisheries and their management are incorporated in FIGIS.

# Stock assessment: procedures and input information

Stock assessments are based on the concept of stocks and are carried out on these stocks, i.e. genetically or physically identifiable unique groups of fish that are "isolated" and managed as units: they reproduce and respond to fishing as single units of population with identifiable population parameters such as growth and mortality rates and unique biomass and spawning aggregations.

Assessments of the status of stocks of tuna and tuna-like species are carried out using both simple and sophisticated mathematical and/or statistical models, accounting for general biological knowledge of the stocks. The fairly recent major advances in computing technologies mean that complex models for stock assessment can be adopted for tuna and tuna-like species. They may be able to account better for inherent uncertainties in knowledge and in input data or test the sensitivity of results to these uncertainties. In the light of the extent of uncertainties, this is not to say that complex models are always better than simple ones, which still continue to be used.

Input data for stock assessment models or procedures may include:

- fisheries data such as those on:
  - total catches in number or weight of the fish caught from stocks, their size, age and geographic distribution, and
  - fishing effort
- data from tagging and recapture of fish, and
- data on oceanographic conditions.

It is not practical to carry out research surveys to estimate the abundance of those tuna and tuna-like species with a wide distribution. Therefore, data on catches and fishing effort and those from tagging provide the only means of estimating this abundance with the aid of stock assessment models or procedures.

Unfortunately, tagging programmes are extremely expensive and require cooperation by fishers to obtain and return information on recapture of tagged fish. Consequently, substantial tagging programmes have been carried out only occasionally.

International institutions and countries fishing tuna have devoted a great deal of effort to collecting relevant data. Yet in spite of this, the quality of the data is not sufficient even for some of the principal market tuna species. The introduction of management measures for tuna fisheries results unfortunately in deterioration. The presence of observers on board fishing vessels usually improves the quality of data, but programmes need to involve a significant number of vessels, if not all of them, and that is why they are so expensive.

There are many problems involved in obtaining indexes of tuna abundance from data on catches and fishing effort, mainly caused by difficulties in accounting for the considerable advances in fishing technology and for changes in oceanographic conditions.

# Status of stocks

## CLASSIFICATION

The following classification of the status of stocks is used throughout this paper.

- **N** *Not known* or significantly uncertain.
- **M** *Moderately exploited* (some limited potential for *sustainable* increases in catches).
- **F** *about Fully exploited* (fishing at about an optimal yield with no expected room for further *sustainable* increases in catches).
- **O** *Overexploited* (fishing above a level which is *sustainable* in the long term [with a risk of stock depletion/collapse] and no potential room for further sustainable increases in catches).
- **D** *Depleted* (catches well below historical maximum levels irrespective of fishing effort exerted).

In this classification, most substantially overexploited stocks are distinguished by being classified as depleted. For stocks where it is unknown whether their status is, for example, moderately or about fully exploited, M-F is given. Similarly, F-O is given for stocks where it is uncertain whether they are about fully or overexploited.

This classification is used by FAO in its regular reviews on the state of world marine fishery resources (FAO, 2005). In November 2005, the classification (Maguire *et al.*, 2006) was also used in a technical document provided to the UN Division for Ocean Affairs and the Law of the Sea (DOALOS) as one of FAO's contributions to the Report of the UN Secretary-General to the Conference on the Agreement for the Implementation of the Provisions of the UN Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, which was held in New York from 22 to 26 May 2006.

Although these definitions do not explicitly mention maximum sustainable yields (MSYs) and the associated levels of stock biomass and fishing mortality, the stocks of the species considered in this chapter could be similarly classified by explicitly using the concept of MSY. In particular, the actual levels of stock biomass and fishing mortality can be classified with regard to the levels associated with MSY (De Leiva Moreno and Majkowski, 2005). Such a two-dimensional classification gives precise information on the status of stocks, but it may prove complex for a non-technical audience to comprehend. For example, it could be said that a stock is *not overexploited* (biomass greater than that associated with MSY), but it is *being overexploited* (fishing mortality greater than that associated with MSY).

For earlier reviews of the global status of tuna and tuna-like species, see Allen (2002); De Leiva Moreno and Majkowski (2005); Hinton (in press); Joseph (1998, 2000, 2004); Maguire *et al.* (2006); and Majkowski (2005).

## PRINCIPAL MARKET TUNAS

Knowledge and data on the principal market tunas are generally much better than those for other tuna and tuna-like species. The former have been studied for many

**Catches and state of stocks of the principal market tuna species**

| Species | Stock/area | Catch ('000 tonnes) 2000 | 2001 | 2002 | 2003 | 2004 | State of exploitation |
|---|---|---|---|---|---|---|---|
| Albacore (*T. alalunga*) | Atlantic: Med. Sea | 6 | 5 | 6 | 8 | 5 | N |
| | Atlantic: North | 34 | 25 | 23 | 26 | 25 | O |
| | Atlantic: South | 29 | 35 | 32 | 28 | 23 | M |
| | Indian Ocean | 38 | 41 | 33 | 25 | 23 | F |
| | Pacific: North | 84 | 98 | 109 | 100 | 92 | F |
| | Pacific: South | 40 | 53 | 63 | 62 | 56 | M |
| | **Total** | **231** | **257** | **266** | **249** | **224** | |
| Atlantic bluefin tuna (*T. thynnus*) | Atlantic: eastern and Mediterranean Sea | 34 | 35 | 35 | 32 | 32 | O |
| | Atlantic: western | 3 | 3 | 3 | 2 | 2 | D |
| | **Total** | **37** | **38** | **38** | **34** | **34** | |
| Bigeye tuna (T. obesus) | Atlantic | 103 | 96 | 76 | 83 | 76 | F |
| | Indian Ocean | 128 | 115 | 135 | 124 | 126 | F |
| | Pacific: eastern | 142 | 130 | 132 | 114 | 108 | O |
| | Pacific: west. & cent. | 120 | 117 | 134 | 122 | 129 | O |
| | **Total** | **493** | **458** | **477** | **443** | **439** | |
| Pacific bluefin tuna (*T. orientalis*) | Pacific | **29** | **17** | **17** | **16** | **22** | F |
| Skipjack tuna (*K. pelamis*) | Atlantic: eastern | 111 | 118 | 93 | 124 | 133 | N |
| | Atlantic: western | 29 | 31 | 22 | 24 | 27 | N |
| | Indian Ocean | 422 | 426 | 489 | 474 | 457 | M-F |
| | Pacific: eastern | 282 | 416 | 439 | 406 | 288 | M |
| | Pacific: west. & cent. | 1 237 | 1 136 | 1 284 | 1 295 | 1 370 | M |
| | **Total** | **2 081** | **2 127** | **2 327** | **2 323** | **2 275** | |
| Southern bluefin tuna (*T. maccoyii*) | Southern Ocean | **15** | **16** | **15** | **14** | **13** | D |
| Yellowfin tuna (*T. albacares*) | Atlantic | 134 | 160 | 139 | 125 | 120 | F |
| | Indian Ocean | 330 | 310 | 332 | 437 | 494 | F |
| | Pacific: eastern | 282 | 416 | 439 | 406 | 288 | F |
| | Pacific: west. & cent. | 433 | 427 | 419 | 447 | 413 | F-O |
| | **Total** | **1 179** | **1 313** | **1 329** | **1 415** | **1 315** | |
| **Total** | | **4 065** | **4 226** | **4 469** | **4 494** | **4 322** | |

years and more research effort has been devoted to them because of their economic importance. However, even for these species, significant uncertainties exist in basic biological knowledge and data. For example, relatively recent research indicates that the life span of southern bluefin tuna, one of the best studied species, may be considerably longer than previously believed. For Atlantic bluefin, another well-studied species, officially reported catches may be significantly smaller than those actually taken, according to information from a trade-based statistical programme (Miyake, 1998) recently introduced by ICCAT. Additional research is needed to further advance biological knowledge of stocks.

However, despite uncertainties in knowledge and input data for stock assessment of the principal market tunas, scientists are usually able to reach some generally valid conclusions on the status of those stocks for which knowledge and data are reasonable.

Information on recent catches and the status of stocks of the principal market tunas is summarized in the table above. The catch estimates in the table were obtained from the FIGIS database Global Tuna Nominal Catches (FAO, 2002), in the second half of 2006. Using the classification described above, a status was assigned to each stock using the information available from reports of scientific meetings of CCSBT, IATTC, ICCAT, IOTC, ISC and WCPFC (see the chapter on Institutional frameworks for international collaboration in fisheries research). This information is available on the Web sites of these institutions.

Most tropical principal market tunas have reacted well to exploitation because of their high fecundity, wide geographic distribution, opportunistic behaviour and other population dynamics (such as a relatively short life span) that make them highly productive. These species include skipjack, yellowfin and bigeye. Another factor is that the first two species are used mostly for canning, with lower prices than those used for sashimi such as bluefin (the temperate species preferred) and bigeye. Generally, with proper fisheries management, tropical species are capable of sustaining high yields. However, the possibilities of overexploitation and stock depletion should not be underestimated.

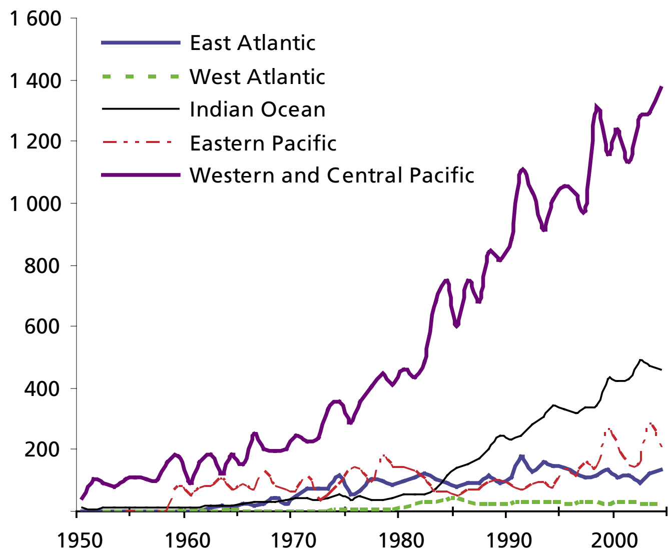
Bluefin and albacore are both temperate species; but albacore that is used mainly for canning fetches much lower prices than bluefin, although higher than skipjack and yellowfin. Generally, stocks of temperate species are less productive and may be more susceptible to overexploitation.

## Skipjack

Among the principal market tunas, the tropical species of skipjack, which yields the largest catch of these species, is in a healthy state. It is only moderately exploited, possibly with the exception of: i) the Indian Ocean, where it is uncertain whether it is moderately or about fully exploited; and ii) the Atlantic, where its status is significantly uncertain. In the eastern Atlantic, but probably not in its western part, skipjack may be about fully exploited.

The status of skipjack is generally consistent with catches, tending to increase further, with the exception of those in the Atlantic (see Figure 11).

FIGURE 11
**Annual catches of skipjack by stock**
('000 tonnes)




## Yellowfin

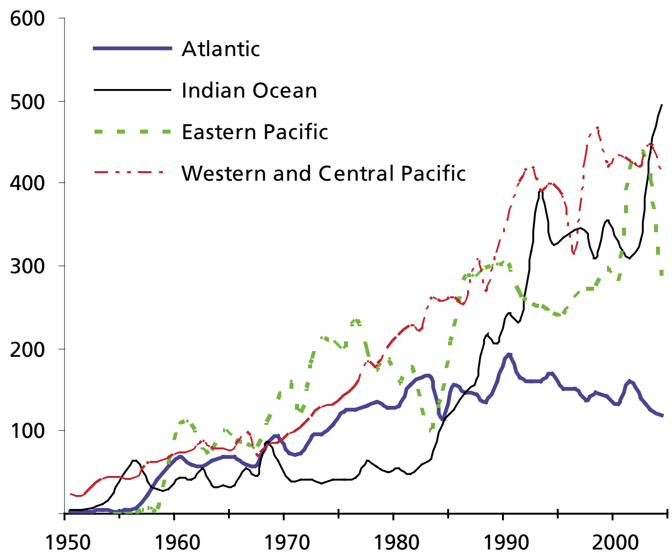
With the possible exception of the western and central Pacific, stocks of yellowfin, another tropical species, are about fully exploited. In the western and central Pacific, there may be overexploitation but this is not certain.

With the exception of the Indian Ocean, catches of yellowfin decreased in the last few years (see Figure 12). However, these changes may not be indicative of the status of their stocks, but rather of a high variability of recruitment and availability of yellowfin for fisheries. Catches seem to be determined mainly by environmental conditions rather than the intensity of past exploitation, at least with the present intensity of fishing similarly as it is for skipjack. In the Atlantic, the decline in catches of yellowfin may reflect decreases in fishing intensity.

## Bigeye

There is increasing concern about the status of bigeye. In the Atlantic and Indian Oceans, bigeye are about fully exploited. In the Pacific, it is not clear whether there is one stock or two, in the eastern part, and the western and central part. Therefore, as alternatives, one or two stocks are assumed in the assessment. However, each of the two assumptions leads to the conclusion of overexploitation. In addition to contributing to overfishing, the increasing purse seine catches of small bigeye in all oceans may negatively affect the longline catches of large bigeye, which fetch much higher prices.

FIGURE 12
**Annual catches of yellowfin by stock**
('000 tonnes)




For all stocks, catches are now smaller than their maximum, reached fairly recently (see Figure 13). In the Pacific and the Indian Ocean, these declines may be only temporary. In the Atlantic, the decline has been considerable.

## Albacore

Stocks of the temperate species of albacore are moderately exploited in the South Pacific and the South Atlantic, about fully exploited in the Indian Ocean and in the North Pacific and overexploited in the North Atlantic. The status of albacore in the Mediterranean Sea is unknown.

Catches of albacore with the exception of those in the North Atlantic, the Mediterranean Sea and possibly the South Pacific seem to fluctuate without any clear trend (see Figures 14 and 15). The North Atlantic catches have generally been declining since the mid-1960s. Mediterranean catches of albacore are tending to increase. In the South Pacific, the albacore catch recently reached its absolute maximum and then slightly declined, peaking previously at lower values in the early 1970s and late 1980s.

## Bluefin

The temperate species of bluefin, most sought after for sashimi, is overexploited, if not depleted, except for Pacific bluefin, which is about fully exploited. The yield per recruit for the Pacific stock could be increased if catches of small bluefin taken

FIGURE 13
**Annual catches of bigeye tuna by stock**
('000 tonnes)

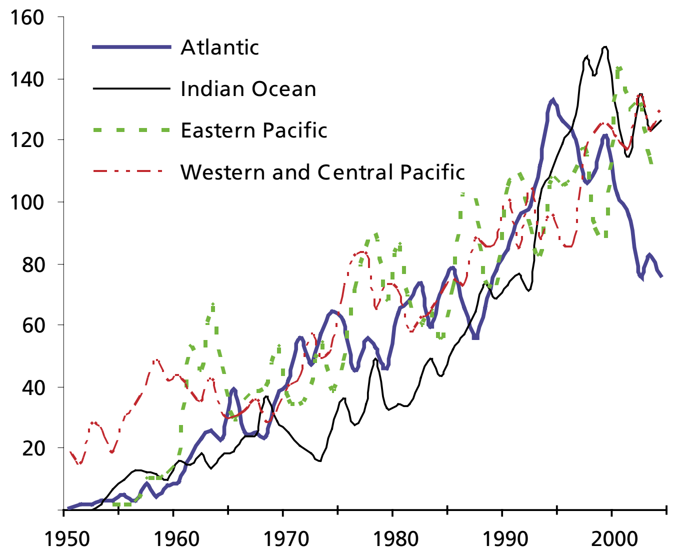



FIGURE 14
**Annual catches of albacore in the Atlantic and Mediterranean by stock**
('000 tonnes)

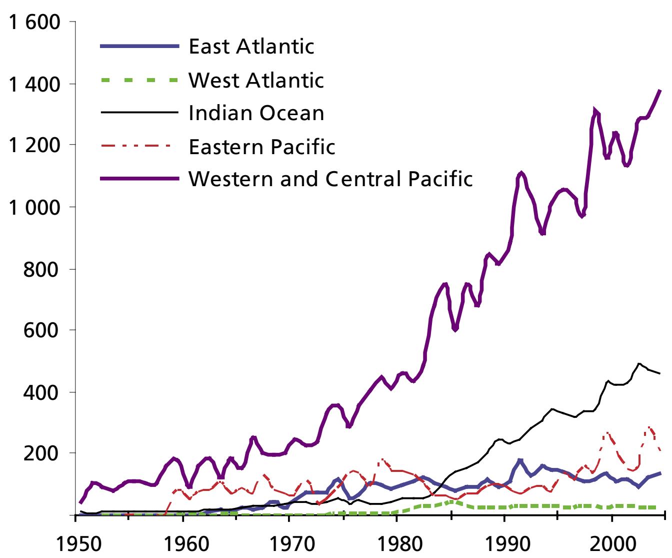
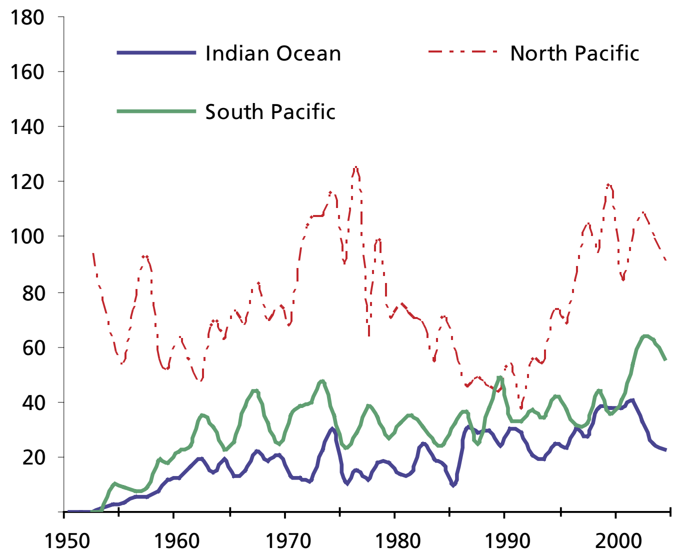


FIGURE 15
**Annual catches of albacore in the Indian Ocean and Pacific by stock**
('000 tonnes)




by trolling and purse seining were to be reduced. The western Atlantic bluefin stock is depleted as is the southern bluefin.

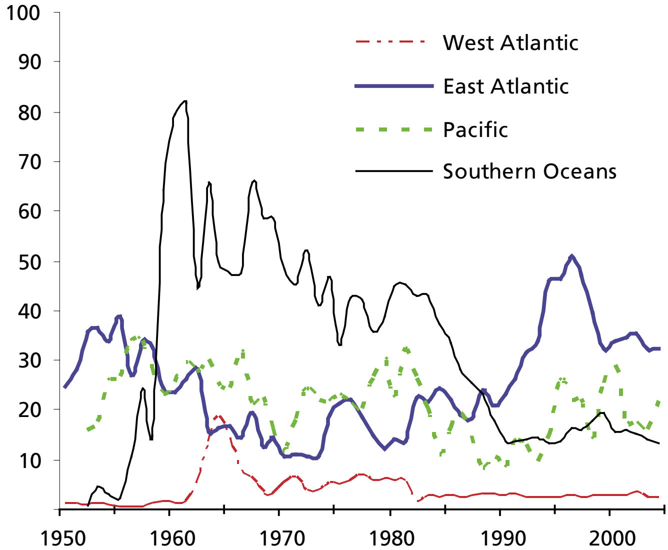
For depleted stocks, present catches are much smaller than their historical maximum (see Figure 16). The present catch of Atlantic bluefin in the east Atlantic and Mediterranean Sea may be much higher than that officially reported, which is close to the total allowable catch (TAC). According to ICCAT scientists, it may be close to its maximum. The catch of Pacific bluefin has been recently fluctuating around a level significantly lower than the maximum reached in the mid-1960s and 1980s.

## Summary

There are still at least four of the 23 stocks of the principal market tunas that are moderately exploited. This number may be five, in fact, if the stock classified as M-F (unknown whether the stock is moderately or about fully exploited) is included. Stocks moderately exploited are i) albacore in the South Atlantic and the South Pacific (two stocks); and ii) skipjack in the Pacific (two stocks) and, perhaps, in the Indian Ocean (also possibly about fully exploited).

Most stocks of principal market tunas are about fully exploited (at least eight of the 23 stocks, but possibly ten of the 23, if the stocks classified as M-F and F-O are included). These stocks are i) albacore in the Indian Ocean and the North Pacific (two stocks); ii) bigeye in the Atlantic and the Indian Ocean (two stocks); iii) Pacific

FIGURE 16
**Annual catches of bluefin by stock**
('000 tonnes)




bluefin; iv) yellowfin in all the oceans (four stocks), perhaps with the exception of that in the western and central Pacific (also possibly overexploited); and perhaps (v) skipjack in the Indian Ocean (also possibly moderately exploited).

A significant number of stocks are overexploited or depleted (at least five of the 23 stocks, but possibly six, if the stock classified as F-O is included). Of these stocks, only two are classified as depleted. The latter are Atlantic bluefin in the western Atlantic and southern bluefin. Stocks classified as overexploited are i) albacore in the North Atlantic; ii) Atlantic bluefin in the eastern Atlantic and the Mediterranean Sea; iii) bigeye in the Pacific (possibly two stocks) and perhaps iv) yellowfin in the western and central Pacific (also possibly fully exploited).

Of the principal market species, the status of three of the 23 stocks is unknown. These are albacore in the Mediterranean Sea and skipjack in the Atlantic (two stocks).

## OTHER TUNA AND TUNA-LIKE SPECIES

The status of many tunas other than principal market species and tuna-like species is highly uncertain or simply unknown. Therefore, there is concern over the intensification of their exploitation.

Nevertheless, because of commercial exploitation, more is known about swordfish than other billfishes. In the northeastern Pacific, swordfish is moderately exploited. In the North Atlantic and southeastern Pacific, it is about fully exploited. In the Indian Ocean, catches of swordfish are above MSY and consequently they are not sustainable in a long term, but the stock has not been reduced below the levels associated with MSY. The South Atlantic stock seems to be in a healthy state, but it is not known whether catches higher than those at present would be sustainable. The status of remaining stocks is unknown or significantly uncertain (i.e. in the Mediterranean Sea and the central, northwestern and southwestern Pacific).

Significant uncertainties about the status of many billfishes represent a serious conservation problem even though, with the exception of swordfish, most of them are not the main targets of commercial fisheries. In the Atlantic, blue and white marlins appear to be overexploited. Blue marlin is about fully exploited in the Pacific. The striped marlin is only moderately exploited in the eastern Pacific and about fully exploited in the western and central Pacific.

The status of the tuna and tuna-like species that are not principal market tunas and billfishes is generally unknown or little known. Little attention is generally given to these species by international institutions involved in fisheries research on tuna and tuna-like species even though some institutions such as ICCAT and IOTC have permanent working groups on small or neritic tunas, respectively. For most of these species, biological knowledge and catch and fishing effort data are insufficient to carry out stock assessments. Consequently, further basic biological research and data collection are necessary before their status can be assessed.

# Discussion

## POTENTIAL IMPROVEMENTS IN KNOWLEDGE OF THE STATUS OF STOCKS

As outlined in the last chapter, the status of tuna and tuna-like species other than the principal market tunas and some billfishes is unknown. With a few exceptions (longtail tuna), these species do not have the same global commercial importance as the principal market tunas. Most of the species cannot be adequately assessed because data on catches, characteristics (e.g. their length and/or age distribution) and fishing effort are not adequately known, if at all. Furthermore, there is no sufficient basic biological information on their stock structure, growth rates, natural mortality and reproduction. To overcome this problem, fishing countries and secretariats of tuna RFMOs need to make further commitments, allocate more funds and/or assign an additional research capacity since the countries fishing the species are frequently developing countries without sufficient research capacity and expertise. Because many of the species have localized coastal distributions, research and data collection generally may not need to be carried out on an ocean scale, but more locally.

With the exception of swordfish, which is a target of commercial fisheries, the status of many species of billfishes is also unknown or uncertain. These are caught mainly as a bycatch of longline fisheries, but they are also a target of sport or game fishing. Because of the nature of catches, their magnitude is uncertain and may not be as representative of stocks as in the case of catches of the principal market tunas. The uncertainties in stock status are also caused by insufficient basic biological information, including stock structure. However, contrary to the mostly coastal or neritic species, their wide distribution in oceans requires research effort on the individual ocean scale.

As is evident from the previous chapter, knowledge of the status of principal market tunas could be improved. Improvements would necessitate better data on catches, their characteristics and fishing effort and better basic biological knowledge of the species. Unfortunately, without closer monitoring of fishing operations and catches (e.g. through observer programmes), fisheries management measures (which are being introduced for many fisheries) tend to result in a deterioration of data on catches and their characteristics. Therefore, these measures necessitate greater attention to maintaining the quality of data on catches and their characteristics even for those fisheries that had quality data before the introduction of the measures.

More well-designed large-scale tagging programmes would enhance knowledge of the status of tuna and tuna-like species, providing basic biological information (including that on stock structure, migration, growth and natural mortality) and input data for complex methods of stock assessment. Such methods have already been developed, but cannot be applied for some stocks because data on recaptures of tagged fish are inadequate. Such programmes should be repeated from time to time to update information and include specific experiments. Unfortunately, however, they are extremely expensive.

Further development and testing of methods for stock assessment of tuna and tuna-like species are important to improve knowledge of stock status. Particularly for tuna and tuna-like species other than the principal market tunas, methods without stringent requirements for input data and biological information are needed. For the principal market tunas, more complex methods that give their biology, environmental influences and the effect of fishing in greater detail are required. Nevertheless, simple methods should also be applied because in some cases they may be effective.

Tuna and tuna-like species are a part of pelagic ecosystems, which mutually affect each other. Most current methods of stock assessment of tuna and tuna-like species do not properly account for these effects, which change over time (e.g. natural mortality that is dependent on the abundance of predators, or fish growth rate dependent on the availability of food). The United Nations Fish Stocks Agreement necessitates the application of the concept of ecosystem management. The application of the ecosystem approach to fisheries management requires significant additional knowledge, such as that on the functioning of the ecosystems with tuna and tuna-like species. Obtaining this knowledge may require intensive, large-scale, multidisciplinary, well-designed and well-coordinated programmes, which may be expensive.

Tuna fisheries catch not only the target species but also bycatch species in the same pelagic ecosystems, which affects the stocks of these species. Bycatches and discards are generally small (Alverson *et al.*, 1994; Bailey, Williams and Itano, 1994; Joseph, 1994; Hall, 1996, 1998; IATTC, 1998). However, they include species of dolphins, turtles, seabirds and sharks, which is of concern. There is already some improvement in the collection of data on bycatches, but more research is necessary to determine the status of stocks of bycatch species.

Reducing bycatches and discards will require cooperative effort on the part of the tuna industry, governments and governmental and non-governmental organizations (NGOs). The most publicized programme for the protection of bycatch species in tuna fisheries has been the dolphin programme in the eastern Pacific. By taking joint action, governments and the industry have reduced the mortality of these animals from very high levels to those that are biologically insignificant and approaching zero.

Efforts continue to reduce bycatches of sea turtles and seabirds in longline and artisanal fisheries. In the latter, for example, IATTC has a programme in place to reduce sea turtle mortality through the use of circle hooks. These programmes are critical as fishing effort increases in small-scale artisanal longline fisheries. In the future, greater utilization of bycatch species may be expected. Fishing may also become more selective through gear modifications and changes in the operation of vessels (including fishing areas and seasons).

Without additional research capacity, significant progress in obtaining better knowledge of tuna and tuna-like species and of the ecosystems that they inhabit is unlikely to be achieved. The precautionary approach incorporated in the Fish Stocks Agreement and in the Code of Conduct calls on states to be more cautious where information is uncertain, unreliable or inadequate (FAO, 1996; Majkowski, 1998). Within this context, the absence of adequate scientific information should not be used as an excuse for postponing or failing to take fisheries management measures.

## OUTLOOK FOR STOCK STATUS IN THE FUTURE

The future status of tuna and tuna-like species will depend on:

- the future intensity of fishing and
- the response of stocks to future exploitation.

The response of stocks to future exploitation cannot be accurately predicted, particularly because of i) levels of biomass much lower than those in the past; ii) exploitation rates much higher than those in the past; and iii) exploitation patterns different from those of the past. The response depends on the so-called stock recruitment relationships that are uncertain to a significant extent, if not unknown. With parental biomass at very low levels, future recruitment to fisheries may be more dependent (also negatively) on environmental conditions than at high levels. In other words, at such low parental biomass levels, the status of stocks may deteriorate much more rapidly than expected.

The future intensity of fishing of tuna and tuna-like species will be determined by:

- the profitability of the fisheries directed at these species, and
- the effectiveness of management of these fisheries.

The profitability of fisheries is determined by the prices of the species and the cost of fishing. Prices are affected by the demand for fish products and the supply of fish. The cost of fishing depends on the density or abundance of fish at sea (i.e. the status of stocks). In the past, insufficient demand for some tuna species such as skipjack and to some extent, yellowfin, caused a decline in prices, making fishing for these species unprofitable. Further consideration of both fishing profitability and fisheries management is beyond the scope of this paper, but information may be found elsewhere.

However, with good profitability in fisheries, the intensity of fishing may even increase as a result of fishing overcapacity unless it is effectively restrained by fisheries management measures. Such intensification would result in a significant deterioration in the status of stocks of tuna and tuna-like species. Even without this intensification, the status of some stocks that are being overexploited is likely to deteriorate unless the exploitation is reduced. This deterioration in status could eventually lead to a reduction in catches.

## OUTLOOK FOR FUTURE CATCHES

At present, skipjack contributes the most to catches of the principal market tunas. Catches could be significantly increased, in a sustainable way, by further increasing catches of this species in the Pacific (particularly in the western and central Pacific) and, possibly, in the Indian Ocean. However, this would need to be done without increasing the catches of other tuna species such as bigeye and yellowfin, which are currently caught together with skipjack. Increases in catches of bigeye and yellowfin are not desirable because they are about fully exploited or overexploited. Because of this, fishing techniques would have to be developed that would allow skipjack to be caught selectively without the other tuna species.

Albacore catches in the South Atlantic and South Pacific could also be increased in a sustainable way although the temperate species of albacore is not very productive. Catches of stocks do not at present contribute greatly to global catches of the principal market tunas. Therefore, it is unlikely that sustainable increases of albacore catches would significantly increase the global catch of these tunas. As the other stocks of albacore are about fully exploited or overexploited, it is not expected that their catches will increase in a sustainable way.

The stocks of the principal market tunas other than those mentioned above are about fully exploited, overexploited, depleted or their status is unknown. Therefore, their catches cannot be increased in a sustainable way, at least before recovery of overexploited and depleted stocks and before determining the status of stocks classified as unknown.

In fact, for the overexploited and depleted stocks of i) albacore in the North Atlantic; ii) bigeye in the Pacific; iii) bluefin, with the exception of Pacific bluefin; and possibly, iv) yellowfin in the western Pacific, catches may decrease, at least in the short term, if additional management measures are not introduced to allow their recovery from overexploitation.

Even without these measures, catches of the overexploited and depleted stocks may decrease in the long term if they continue to be overexploited. Similarly, catches of the about fully exploited stocks may eventually decrease, if they are overexploited.

The overall yield from tuna and tuna-like species depends on the combination of the fishing techniques used and the fishing effort. The various fishing methods have differing effectiveness and selectivity characteristics when targeting various age groups. Improvements in yield might be achieved for some stocks by protecting small or immature fish and targeting older age groups (e.g. albacore and yellowfin in the Atlantic and bigeye and northern and southern bluefin in other oceans). Problems occur with compliance with present size regulations (e.g. within the framework of ICCAT, especially for Atlantic bluefin in the Mediterranean Sea and in the eastern Atlantic), resulting in a lower yield per recruit. The intensification of fishing around FADs also raises concerns because it tends to result in large catches of small fish. In the eastern Atlantic, for example, the problem has become so acute that the industry (French and Spanish purse seiners) is placing self-imposed controls on the use of FADs. However, in general, the protection of small fish may not necessarily result in increases in local yield from an area with intense emigration. In addition, protecting smaller individuals of species with high natural mortality such as skipjack may not always give noticeable results from a conservation point of view.

Considering future catches of each species of the principal market tunas separately, at present the above-mentioned problems do not allow catches of skipjack to be increased despite only moderate intensity of exploitation in some areas. With the current level of fishing effort, catches of skipjack are likely to remain in their present range, but fluctuating greatly because of a high variability of recruitment and the availability of skipjack for fisheries. Therefore, skipjack catches are determined mainly by environmental conditions rather than the intensity of past exploitation.

Because of its full exploitation or possible overexploitation (in the western and central Pacific), there is no potential for increasing catches of yellowfin in a sustainable way. After skipjack, yellowfish contributes most to catches of the principal market tunas. As with skipjack, future catches of yellowfin are likely to show significant variability for similar reasons as for skipjack.

Globally, there is no potential for increasing catches of bigeye. In fact, in the short term, catches of bigeye may decrease, if management measures limit or cut back catches of the species in the Pacific to allow its recovery from overexploitation.

As mentioned above, it is unlikely that catches of albacore will increase significantly, if at all.

Because of the overexploitation or depletion of bluefin, except Pacific bluefin (about fully exploited), their catches cannot be increased in a sustainable way. As already mentioned, their combined catch may decrease, at least in the short term, if additional management measures are introduced to allow their recovery from overexploitation.

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## APPENDIX I

# Classification of tuna and tuna-like species[1]

| Family: Scombridae; subfamily: Scombrinae | | | | |
|---|---|---|---|---|
| **Scientific name** | **Common names** | | | **FAO code** |
| | **English** | **French** | **Spanish** | |
| *Tribe: Thunnini* | **Tunas** | **Thons** | **Atún** | |
| *Thunnus alalunga* | Albacore | Germon | Atún blanco | ALB |
| *Thunnus albacares* | Yellowfin tuna | Albacore | Rabil | YFT |
| *Thunnus atlanticus* | Blackfin tuna | Thon à nageoires noires | Atún aleta negra | BLF |
| *Thunnus maccoyii* | Southern bluefin tuna | Thon rouge du Sud | Atún del Sur | SBF |
| *Thunnus obesus* | Bigeye tuna | Thon obèse | Patudo | BET |
| *Thunnus thynnus* | Atlantic bluefin tuna | Thon rouge | Atún | BFT |
| *Thunnus orientalis* | Pacific bluefin tuna | Thon bleu du Pacifique | Atún aleta azul del Pacífico | PBF |
| *Thunnus tonggol* | Longtail tuna | Thon mignon | Atún tongol | LOT |
| *Katsuwonus pelamis* | Skipjack tuna | Listao | Listado | SKJ |
| *Euthynnus affinis* | Kawakawa | Thonine orientale | Bacoreta oriental | KAW |
| *Euthynnus alleteratus* | Little tunny | Thonine commune | Bacoreta | LTA |
| *Euthynnus lineatus* | Black skipjack | Thonine noire | Barrilete negro | BKJ |
| *Auxis rochei* | Bullet tuna | Bonitou | Melvera | BLT |
| *Auxis thazard* | Frigate tuna | Auxide | Melva | FRI |
| *Tribe: Sardini* | **Bonitos** | **Bonites** | **Bonitos** | |
| *Allothunnus fallai* | Slender tuna | Thon élégant | Atún lanzón | SLT |
| *Cybiosarda elegans* | Leaping bonito | Bonite à dos tacheté | Bonito saltador | LEB |
| *Gymnosarda unicolor* | Dogtooth tuna | Bonite à gros yeux | Tasarte ojón | DOT |
| *Orcynopsis unicolor* | Plain bonito | Palomette | Tasarte | BOP |
| *Sarda australis* | Australian bonito | Bonite bagnard | Bonito austral | BAU |
| *Sarda chiliensis* | Eastern Pacific bonito | Bonite du Pac. oriental | Bonito del Pac. oriental | BEP |
| *Sarda orientalis* | Indo-Pacific bonito | Bonite orientale | Bonito mono | BIP |
| *Sarda sarda* | Atlantic bonito | Bonite à dos rayé | Bonito atlántico | BON |
| *Tribe: Scomberomorini* | **Seerfishes** | **Thazards** | **Carites** | |
| *Acanthocybium solandri* | Wahoo | Thazard-bâtard | Peto | WAH |
| *Scomberomorus brasiliensis* | Serra Spanish mackerel | Thazard serra | Serra | BRS |
| *Scomberomorus cavalla* | King mackerel | Thazard barre | Carite lucio | KGM |
| *Scomberomorus commerson* | Narrow-barred king mack. | Thazard rayé | Carite estriado | COM |
| *Scomberomorus concolor* | Monterey Spanish mackerel | Thazard Monterey | Carite de Monterey | MOS |
| *Scomberomorus guttatus* | Indo-Pacific king mackerel | Thazard ponctué | Carite del Indo-Pacifico | GUT |
| *Scomberomorus koreanus* | Korean seerfish | Thazard coréen | Carite coreano | KOS |
| *Scomberomorus lineolatus* | Streaked seerfish | Thazard cirrus | Carite rayado | STS |
| *Scomberomorus maculatus* | Atlantic Spanish mackerel | Thazard atlantique | Carite atlántico | SSM |
| *Scomberomorus multiradius* | Papuan seerfish | Thazard papou | Carite papuense | PAP |
| *Scomberomorus munroi* | Australian spotted mackerel | Thazard australien | Carite australiano | ASM |
| *Scomberomorus niphonius* | Japanese Spanish mackerel | Thazard oriental | Carite oriental | NPH |
| *Scomberomorus plurilineatus* | Kanadi kingfish | Thazard Kanadi | Carite canadí | KAK |
| *Scomberomorus queenslandicus* | Queensland school mackerel | Thazard de Queensland | Carite de Queensland | QUM |
| *Scomberomorus regalis* | Cero | Thazard franc | Carite chinigua | CER |
| *Scomberomorus semifasciatus* | Broad-barred king mackerel | Thazard tigre | Carite tigre | BBM |
| *Scomberomorus sierra* | Pacific sierra | Thazard sierra | Carite sierra | SIE |
| *Scomberomorus sinensis* | Chinese seerfish | Thazard nébuleux | Carite indochino | CHY |
| *Scomberomorus tritor* | West African Spanish mackerel | Thazard blanc | Carite lusitánico | MAW |
| *Tribe: Scombrini* | **Mackerel** | **Maquereaux** | **Caballa** | |
| *Rastrelliger brachysoma* | Short mackerel | Maquereau trapu | Caballa rechoncha | RAB |
| *Rastrelliger faughni* | Island mackerel | Maquereau des îles | Caballa isleña | RAF |
| *Rastrelliger kanagurta* | Indian mackerel | Maquereau des Indes | Caballa de la India | RAG |
| *Scomber australasicus* | Spotted chub mackerel | Maquereau tacheté | Caballa pintoja | MAA |
| *Scomber japonicus* | Chub mackerel | Maquereau espagnol | Estorino | MAS |
| *Scomber scombrus* | Atlantic mackerel | Maquereau commun | Caballa del Atlántico | MAC |
| *Grammatorcynus bicarinatus* | Shark mackerel | Thazard requin | Carite cazón | SHM |
| *Grammatorcynus bilineatus* | Double-lined mackerel | Thazard-kusara | Carite cazón pintado | DBM |

[1] Modified from Collette and Nauen, 1983 and Nakamura, 1985.

| Family: Scombridae; subfamily: Gasterochismatinae | | | | |
|---|---|---|---|---|
| **Scientific name** | **Common names** | | | **FAO code** |
| | **English** | **French** | **Spanish** | |
| *Gasterochisma melampus* | Butterfly kingfish | Thon papillon | Atún chauchera | BUK |

| Family: Xiphidae | | | | |
|---|---|---|---|---|
| **Scientific name** | **Common names** | | | **FAO code** |
| | **English** | **French** | **Spanish** | |
| *Xiphias gladius* | Swordfish | Espadon | Pez espada | SWO |

| Family: Istiophoridae | | | | |
|---|---|---|---|---|
| **Scientific name** | **Common names** | | | **FAO code** |
| | **English** | **French** | **Spanish** | |
| *Istiophorus albicans* | Atlantic sailfish | Voilier de l'Atantique | Pez vela del Atlántico | SAI |
| *Istiophorus platypterus* | Indo-Pacific sailfish | Voilier de l'Indo-Pacifique | Pez vela del Indo-Pacífico | SFA |
| *Makaira indica* | Black marlin | Makaire noir | Aguja negra | BLM |
| *Makaira nigricans* | Blue marlin | Makaire bleu | Aguja azul | BUM |
| *Tetrapterus albidus* | Atlantic white marlin | Makaire blanc de l'Atlantique | Aguja blanca del Atlántico | WHM |
| *Tetrapterus angustirostris* | Shortbill spearfish | Makaire à rostre court | Marlín trompa corta | SSP |
| *Tetrapterus audax* | Striped marlin | Marlin rayé | Marlín rayado | MLS |
| *Tetrapterus belone* | Mediterranean spearfish | Marlin de la Méditerranée | Marlín del Mediterráneo | MSP |
| *Tetrapterus georgei* | Roundscale spearfish | Makaire épée | Marlín peto | RSP |
| *Tetrapterus pfluegeri* | Longbill spearfish | Makaire bécune | Aguja picuda | SPF |

FIGURE A.1

**Classification of Scombrids (Collette and Nauen, 1983) – at present, the number of *Thunnus* species has increased from seven (in the Figure) to eight because of the distinction of Pacific bluefin tuna as a separate species from Atlantic bluefin tuna**

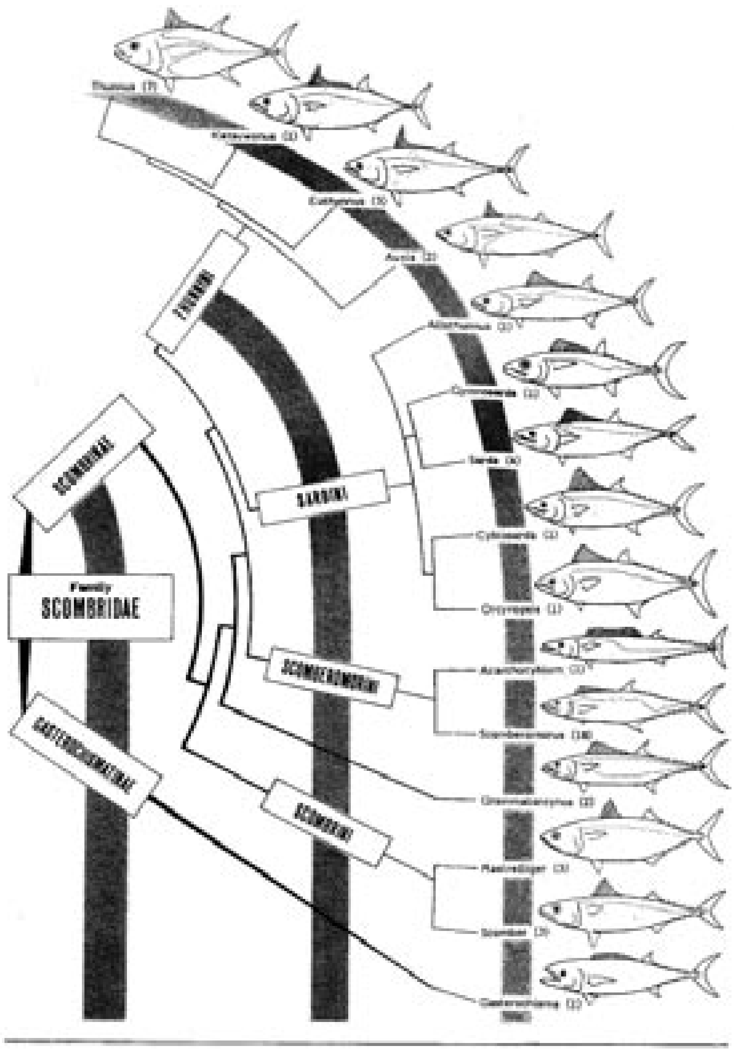
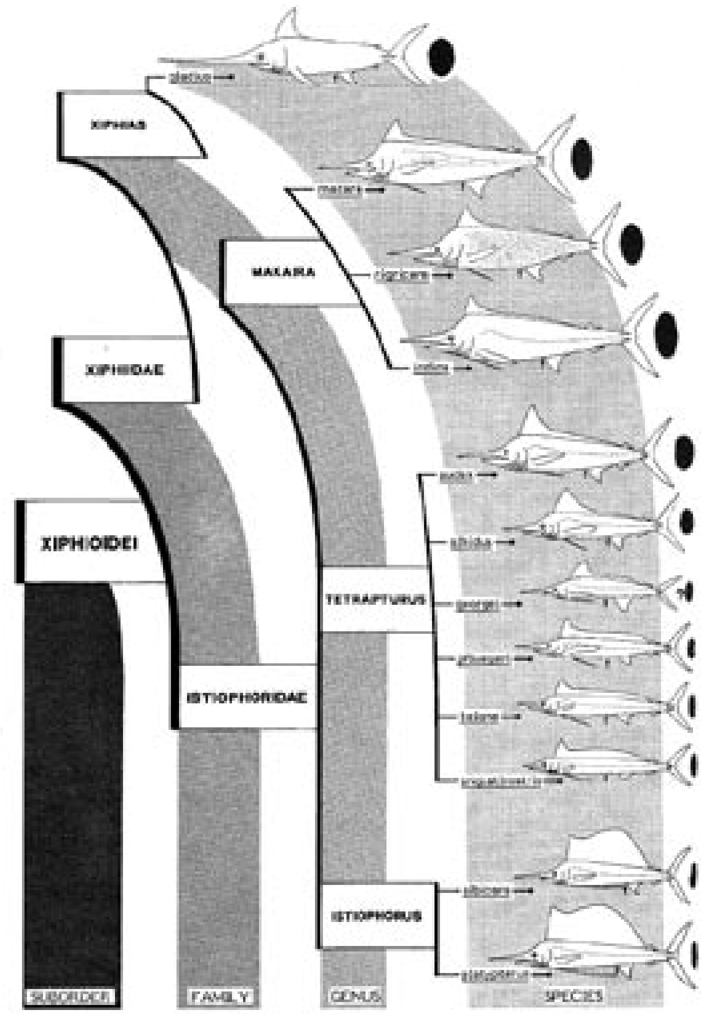
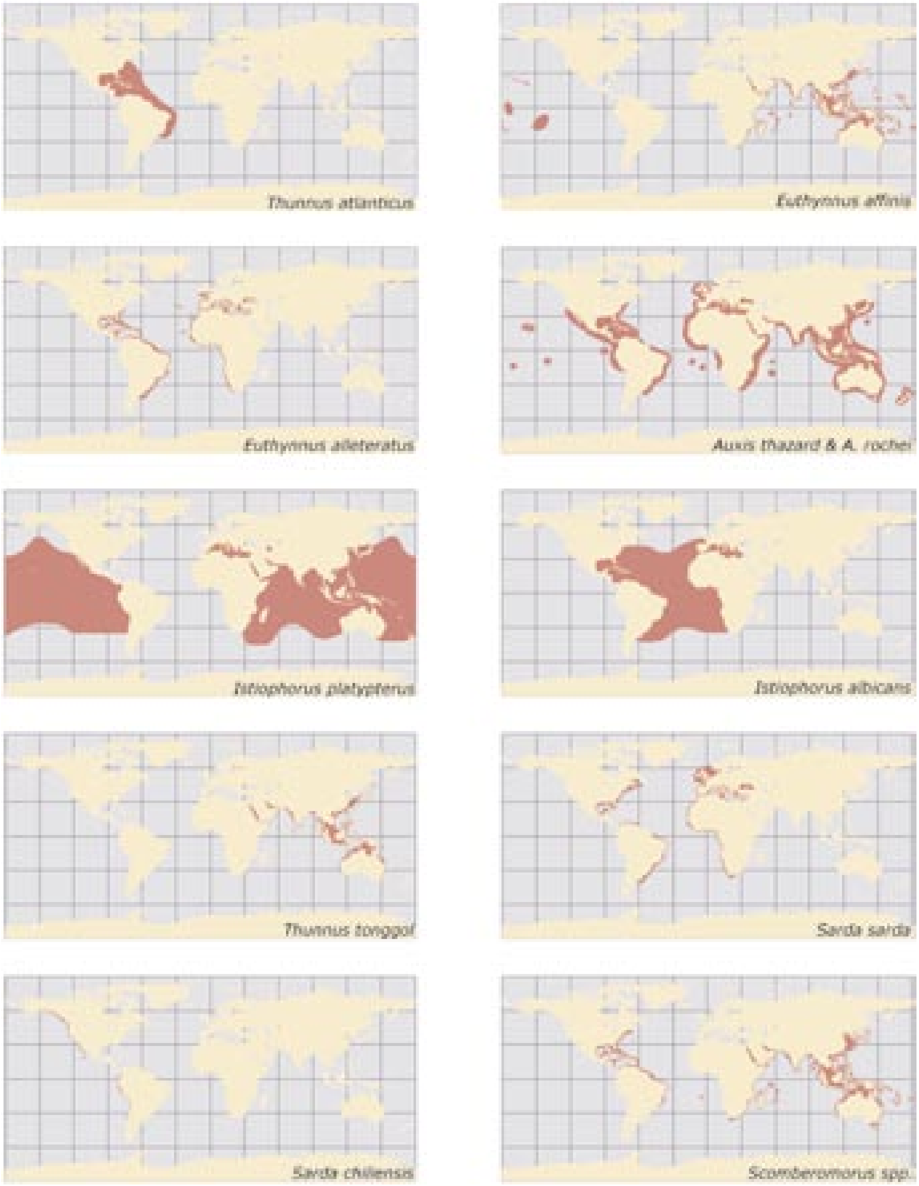


FIGURE A.2
**Classification of billfishes (Nakamura, 1985)**



APPENDIX II

# Distribution of billfishes and some small tunas for which there are no detailed data on geographic distribution of catches




*Note*: maps adapted from Collette and Nauen , 1983 and Nakamura, 1985.

## APPENDIX III

# Catches of principal market tunas in 2004 by stock, fishing gear and country (tonnes)[1]

| Species | Ocean | Gear | Most important countries (catches in tonnes) | Total (all countries) |
|---|---|---|---|---|
| Albacore | Indian Ocean | Longline | Taiwan Province of China (12 451), Indonesia (4 419), Japan (3 690), France (359), Republic of Korea (350), Thailand (195), Seychelles (67), China (62), Spain (53), Australia (53) | 22 366 |
| | | Other gears | France (72), South Africa (1), Australia (1) | 74 |
| | | Purse seine | France (77), Spain (76), Seychelles (59), Islamic Republic of Iran (11) | 243 |
| | | Troll line | Australia | 6 |
| | Atlantic: North | Longline | Taiwan Province of China (4 278), Japan (1 169), Portugal (287), United States of America (120), Bolivarian Republic of Venezuela (116), France (92), Saint Vincent and the Grenadines (82), China (32), Grenada (25), Canada (23) | 6 224 |
| | | Other gears | France (2 427), United States of America (525), Ireland (172), Morocco (120), Canada (4), Portugal (2) | 3 250 |
| | | Pole and line | Spain (7 893), Portugal (225), France (11) | 8 129 |
| | | Purse seine | Bolivarian Republic of Venezuela (341), France (7) | 348 |
| | | Troll line | Spain (7 477), Saint Vincent and the Grenadines (7), Ireland (3) | 7 487 |
| | Atlantic: South | Longline | Taiwan Province of China (13 288), Japan (468), Brazil (284), Namibia (250), Uruguay (120), China (112), Spain (82), South Africa (53), Republic of Korea (37) | 14 694 |
| | | Other gears | South Africa (297), Brazil (2) | 299 |
| | | Pole and line | South Africa (4 153), Namibia (3 079), Brazil (235), Portugal (9) | 7 476 |
| | Mediterranean Sea | Longline | Italy (1 554), Greece (427), Cyprus (243), Spain (109), Malta (10) | 2 343 |
| | | Other gears | Italy (2 116), Spain (29), Greece (20), Cyprus (12) | 2 177 |
| | | Purse seine | Greece | 326 |
| | Pacific: South | Longline | Taiwan Province of China (13 307), Fiji (11 290), China (6 222), Japan (4 798), American Samoa (2 462), French Polynesia (2 164), Papua New Guinea (1 640), Cook Islands (1 630), New Caledonia (1 468), New Zealand (1 360) | 46 341 |
| | | Other gears | Australia (50), New Zealand (9) | 59 |
| | | Pole and line | French Polynesia (71), Japan (7) | 78 |
| | | Troll line | New Zealand (4 113), United States of America (960), Canada (63), Australia (3) | 5 139 |
| | Pacific: North | Longline | Taiwan Province of China (9 988), Vanuatu (2 554), Japan (2 204), French Polynesia (1 802), China (1 180), Republic of Korea (783), Belize (296), Chile (8), United States of America (8) | 18 831 |
| | | Other gears | United States of America (1 518), Japan (126) | 1 644 |
| | | Pole and line | Japan (32 255), United States of America (252) | 32 507 |

[1] *Source*: FAO, 2003.

| Species | Ocean | Gear | **Most important countries** (catches in tonnes) | Total (all countries) |
|---|---|---|---|---|
| | | Purse seine | Japan (14 400), Mexico (208), United States of America (2) | 14 610 |
| | | Troll line | United States of America (25 436), Canada (15 352), Cook Islands (99) | 40 887 |
| Bigeye tuna | Indian Ocean | Longline | Taiwan Province of China (56 918), Japan (10 908), Indonesia (10 906), China (8 321), Seychelles (6 958), Republic of Korea (2 466), Philippines (923), Spain (421), Maldives (175) | 101 855 |
| | | Other gears | Sri Lanka (233), Comoros (21), France (6) | 260 |
| | | Pole and line | Maldives | 1 015 |
| | | Purse seine | Spain (8 634), France (5 813), Seychelles (4 395), Japan (524), Islamic Republic of Iran (178) | 22 586 |
| | | Troll line | Comoros | 14 |
| | Atlantic | Longline | Taiwan Province of China (17 717), Japan (15 203), China (6 556), Philippines (1 855), Brazil (1 377), Republic of Korea (629), Spain (416), United States of America (308), Bolivarian Republic of Venezuela (278), South Africa (221) | 44 560 |
| | | Other gears | Morocco (929), Spain (114), United States of America (105), Brazil (74), Canada (8), Cape Verde (1) | 1 231 |
| | | Pole and line | Ghana (4 983), Spain (3 778), Portugal (3 161), France (587), Senegal (548), Bolivarian Republic of Venezuela (171), South Africa (48), Namibia (44), Brazil (42) | 13 559 |
| | | Purse seine | Spain (3 943), France (2 339), Ghana (1 961), Netherlands Antilles (1 822), Panama (1 521), Bolivarian Republic of Venezuela (611) | 13 388 |
| | Pacific: western and central | Longline | Japan (26 112), Taiwan Province of China (21 734), Republic of Korea (17 941), China (8 965), United States of America (4 181), Fiji (1 254), Australia (784), Indonesia (641), Federated States of Micronesia (520), French Polynesia (495) | 82 627 |
| | | Other gears | Philippines (8 440), Indonesia (6 956), Japan (35), Australia (23), French Polynesia (2), Taiwan Province of China (1) | 15 457 |
| | | Pole and line | Indonesia (944), Japan (865) | 1 809 |
| | | Purse seine | United States of America (5 031), Japan (4 579), Philippines (4 540), Papua New Guinea (3 749), Solomon Islands (2 069), Republic of Korea (1 892), Marshall Islands (962), Spain (842), Indonesia (794), Taiwan Province of China (730) | 25 188 |
| | | Troll line | United States of America (521), Japan (126) | 647 |
| Pacific bluefin tuna | Pacific | Longline | Taiwan Province of China (1 714), Japan (1 311), United States of America (1) | 3 026 |
| | | Other gears | Japan (1 611), United States of America (44) | 1 655 |
| | | Pole and line | Japan | 237 |
| | | Purse seine | Mexico (8 880), Japan (6 340), Republic of Korea (636) | 15 856 |
| | | Troll line | Japan (921), Mexico (11) | 932 |
| Skipjack tuna | Indian Ocean | Longline | Indonesia (439), Taiwan Province of China (46), Maldives (8), Japan (4), Spain (4) | 530 |
| | | Other gears | Sri Lanka (62 276), Islamic Republic of Iran (53 564), Indonesia (48 723), Pakistan (3 318), India (384), Oman (149), France (109), Maldives (75), Comoros (69), Jordan (45) | 168 712 |
| | | Pole and line | Maldives (104 542), India (4 000) | 108 542 |
| | | Purse seine | Spain (64 393), France (37 972), Seychelles (29 960), Islamic Republic of Iran (10 719), Indonesia (3 665), Japan (1 459), Australia (30) | 170 749 |
| | | Troll line | Maldives (5 124), Comoros (3 131), France (471), Mauritius (8) | 8 734 |
| | Atlantic: west | Longline | Saint Vincent and the Grenadines (166), Portugal (29), Taiwan Province of China (14), Mexico (9), Brazil (1) | 219 |
| | | Other gears | United States of America | 100 |
| | | Pole and line | Brazil (23 036), Bolivarian Republic of Venezuela (501) | 23 537 |

| Species | Ocean | Gear | **Most important countries** (catches in tonnes) | Total (all countries) |
|---|---|---|---|---|
| | | Purse seine | Bolivarian Republic of Venezuela | 2 769 |
| | | Troll line | Saint Lucia (137), Saint Vincent and the Grenadines (85), Dominica (30), Grenada (21) | 273 |
| | Pacific: western and central | Longline | Taiwan Province of China (3 237), Philippines (982), American Samoa (225), Japan (140), United States of America (130), French Polynesia (65), Cook Islands (41), Samoa (39), Fiji (24), China (6) | 4 889 |
| | | Other gears | Philippines (62 621), Indonesia (31 609), Taiwan Province of China (1 339), Kiribati (940), Japan (866), French Polynesia (435) | 97 810 |
| | | Pole and line | Japan (122 158), Indonesia (115 181), Solomon Islands (6 625), French Polynesia (511), United States of America (436), Fiji (431), Australia (11) | 245 353 |
| | | Purse seine | Taiwan Province of China (181 524), Papua New Guinea (175 201), Japan (173 587), Republic of Korea (152 126), Philippines (106 828), United States of America (47 896), Vanuatu (44 809), Marshall Islands (42 078), Federal States of Micronesia (22 998), New Zealand (20 289) | 967 336 |
| | | Troll line | Japan (6 376), United States of America (94), Guam (73), Northern Mariana Islands (66), Fiji (54), American Samoa (9) | 6 672 |
| | Atlantic: east | Longline | Morocco (269), Taiwan Province of China (29), Italy (19), Spain (6) | 323 |
| | | Other gears | Côte d'Ivoire (559), Cape Verde (307), Morocco (98), Spain (25), Portugal (18), Italy (15), Ireland (14), Senegal (10) | 1 046 |
| | | Pole and line | Ghana (24 632), Portugal (8 459), Spain (7 206), France (1 752), Senegal (1 261), Saint Helena (63), Cape Verde (57), South Africa (2) | 45 011 |
| | | Purse seine | Spain (31 514), France (20 127), Ghana (8 968), Netherlands Antilles (8 708), Panama (7 126), Morocco (442), Greece (99), Cape Verde (7) | 86 549 |
| Southern bluefin tuna | Southern Ocean | Longline | Japan (5 846), Taiwan Province of China (1 298), Indonesia (676), New Zealand (391), Australia (228), Republic of Korea (131), Philippines (80) | 8 651 |
| | | Purse seine | Australia | 4 834 |
| | | Troll line | New Zealand | 1 |
| Yellowfin tuna | Indian Ocean | Longline | Taiwan Province of China (49 793), Indonesia (16 528), Japan (16 159), Republic of Korea (4 068), Seychelles (4 047), China (3 781), Philippines (2 004), Islamic Republic of Iran (733), Malaysia (592) | 101 615 |
| | | Other gears | Islamic Republic of Iran (39 692), Yemen (31 268), Sri Lanka (29 721), Oman (24 310), Pakistan (2 944), Comoros (1 654), Indonesia (1 158), India (1 040), United Republic of Tanzania (650), France (395) | 132 832 |
| | | Pole and line | Maldives (14 423), India (444) | 14 867 |
| | | Purse seine | Spain (80 811), France (63 521), Seychelles (48 797), Islamic Republic of Iran (13 145), Indonesia (1 279), Japan (327) | 231 791 |
| | | Troll line | Maldives (6 488), Comoros (4 246), France (292), Mauritius (100), Kenya (80), Australia (1) | 11 207 |
| | Atlantic | Longline | Taiwan Province of China (5 824), Japan (5 457), Saint Vincent and the Grenadines (4 227), United States of America (2 488), Brazil (1 966), China (1 305), Mexico (1 208), Republic of Korea (984), Bolivarian Republic of Venezuela (558), Grenada (460) | 24 477 |
| | | Other gears | United States of America (4 012), Brazil (2 147), Côte d'Ivoire (565), Latvia (334), Cape Verde (284), South Africa (242), Dominican Republic (226), Morocco (95), Bermuda (82), Colombia (46) | 8 033 |
| | | Pole and line | Ghana (9 944), Brazil (2 839), Bolivarian Republic of Venezuela (203), Cape Verde (1 379), Spain (1 292), Senegal (668), France (585), South Africa (139), Angola (34) | 19 496 |

| Species | Ocean | Gear | **Most important countries** (catches in tonnes) | Total (all countries) |
|---|---|---|---|---|
| | | Purse seine | France (23 364), Spain (20 086), Ghana (5 193), Netherlands Antilles (4 161), Bolivarian Republic of Venezuela (3 185), Panama (1 887), Cape Verde (233), Brazil (32) | 61 848 |
| | | Troll line | Saint Lucia (152), Dominica (81), Saint Vincent and the Grenadines (24) | 257 |
| | Pacific: western and central | Longline | Taiwan Province of China (21 588), Japan (12 888), Republic of Korea (10 058), Indonesia (6 810), Fiji (4 164), China (3 358), Philippines (2 579), Papua New Guinea (2 526), Australia (1 948), French Polynesia (1 042) | 66 961 |
| | | Other gears | Philippines (86 643), Indonesia (63 993), Japan (2 841), Kiribati (1 120), French Polynesia (211), Taiwan Province of China (155), Australia (11) | 154 974 |
| | | Pole and line | Indonesia (8 499), Japan (2 963), Solomon Islands (257), French Polynesia (69), Fiji (44), United States of America (23) | 11 855 |
| | | Purse seine | Philippines (33 636), Republic of Korea (29 472), Papua New Guinea (23 166), Japan (22 713), Taiwan Province of China (15 968), United States of America (14 492), Solomon Islands (7 208), Indonesia (7 143), Marshall Islands (3 632), Vanuatu (3 334) | 160 764 |
| | | Troll line | Japan (2 524), United States of America (695), Guam (46), Fiji (41), Northern Mariana Islands (12), American Samoa (3) | 3 321 |

This paper reviews the state of fishery resources of tuna and tuna-like species on a global scale, focusing on those most important commercially, i.e. the so-called principal market tuna species. These are classified as tropical tunas (skipjack, yellowfin and bigeye) and temperate tunas (albacore and bluefin [Atlantic, Pacific and southern]). For each tuna and tuna-like species, the document provides: taxonomic and other basic biological information; the development and expansion of the fishery; catch trends; institutional frameworks for regional cooperation in fisheries research, particularly stock assessment; procedures and input information for stock assessment; the status of the stocks; potential improvements in knowledge of the status of the stocks; and the future outlook for this status and catches.

ISBN 978-92-5-105806-0 ISSN 0429-9345

9 789251 058060

TC/M/A1291E/1/08.07/1300