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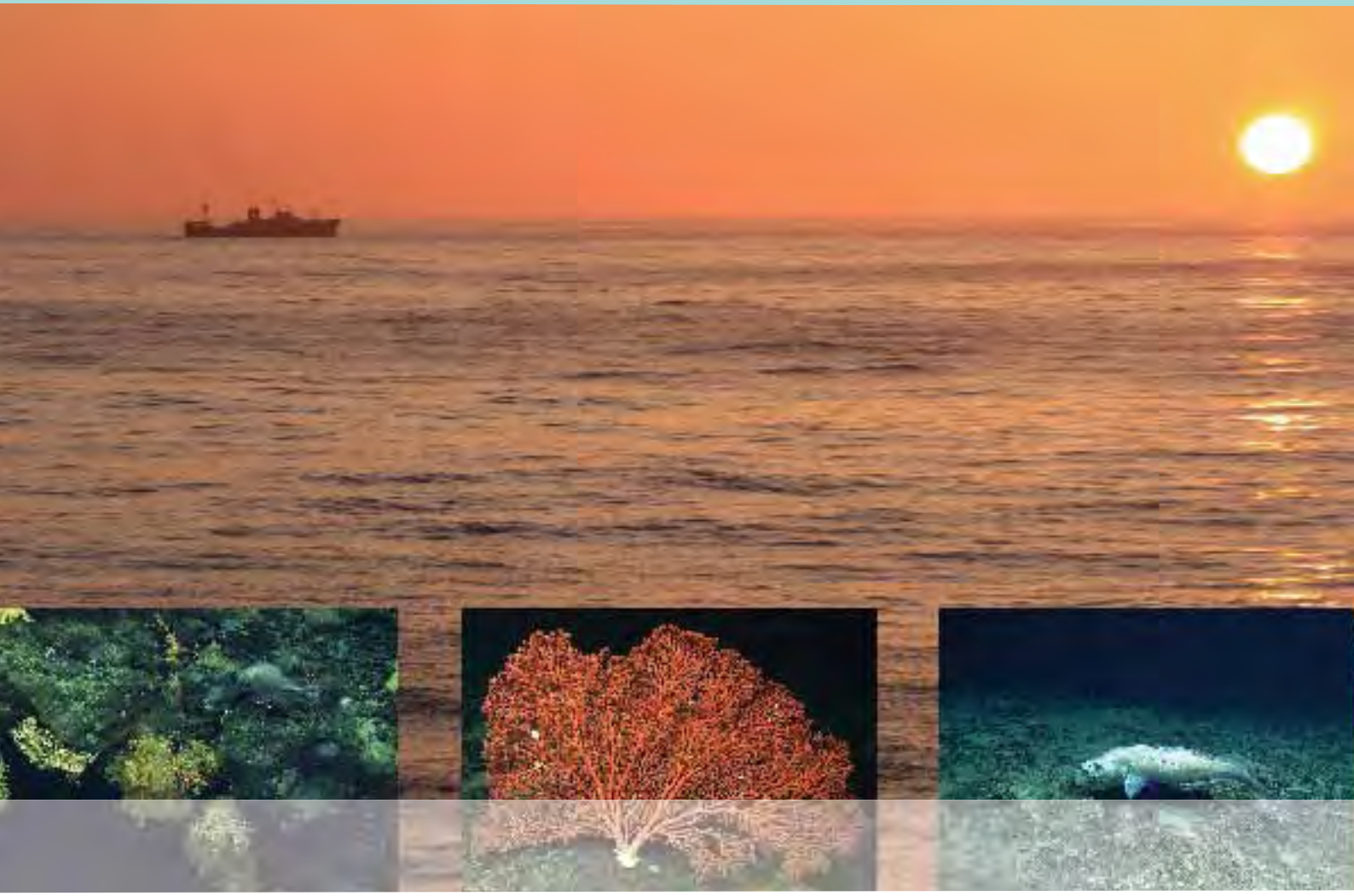
Worldwide review of bottom fisheries in the high seas



Cover photos:
Background: Image of vessel courtesy of Tarvo Roose.
Left to right: Oreo dory (*Neocyttus helgae*) with Lophelia and *Acanthogorgia* spp.,
gorgonian fan (*Paragorgia* spp.) and morid cod (*Lepidion guentheri*). Images courtesy of Peter Auster
and the Deep Atlantic Stepping Stones Science Party, the Institute for Exploration (IFE),
University of Rhode Island - Institute for Archaeological Oceanography (URI-IAO)
and the National Oceanic and Atmospheric Administration (NOAA).

Worldwide review of bottom fisheries in the high seas

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Preparation of this document

This document, the *Worldwide review of bottom fisheries in the high seas*, was prepared in response to the request by the twenty-sixth session of the Food and Agriculture Organization of the United Nations (FAO) Committee on Fisheries (COFI), the subsequent consideration of the issue of bottom fisheries in the high seas by the United Nations General Assembly (UNGA) in its Resolution 61/105 on Sustainable Fisheries adopted in December 2006, and the twenty-seventh session of COFI in 2007. It is intended to provide states and other interested parties with a summary of the current status of high seas bottom fisheries worldwide based on the best information available, including responses to an FAO questionnaire sent to high seas fishing states, the European Community and relevant regional fisheries management organizations. It also highlights gaps in the available information to effectively assess the extent to which these fisheries are managed, consistent with the FAO *International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (as adopted on 29 August 2008) and the approach agreed by the UNGA in Resolution 61/105.

Reviews of bottom fisheries in the high seas were carried out in the following nine regions: the North East and North West Atlantic, the Mediterranean, the South East and South West Atlantic, the North and South Pacific, the Indian Ocean and the Southern Ocean. Fisheries are described in terms of fleets, catch and effort, and main species caught, with due consideration being given to the location of fishing activities.

These reviews were prepared based on a range of information collected through a desktop study, a questionnaire and numerous contacts with fisheries managers and researchers. The questionnaire was addressed in January 2007 to 40 countries and the EC – the flag states of vessels identified as potentially involved in high seas bottom fishing in recent years (from 2003 to 2006). A modified version of the questionnaire was also addressed to regional organizations with a mandate to manage high seas bottom fisheries. The objective of the questionnaire was to assist in identifying the main high-seas bottom fisheries, and to assess the importance of these fisheries in terms of number of vessels, catch and fishing effort during the period covered by the review.

Funding for the preparation of this document was generously provided by the Government of Japan through the "Promotion of sustainable fisheries: support for the Plan of Implementation of the World Summit on Sustainable Development" project (GCP/INT/942/JPN).

Contribution by states and regional fisheries management organizations that provided substantial information for this review is noted with appreciation.

All FAO maps presented in this review were created by Fabio Carocci, Fisheries Management and Conservation Service, Fisheries and Aquaculture Department, FAO. Other contributors and reviewers are acknowledged in the individual regional chapters.

This document was revised and updated on the basis of new information provided by FAO Members, pursuant to the request made the Committee on Fisheries (COFI) at its twenty-eighth session in March 2009.

Abstract

The *Worldwide review of bottom fisheries in the high seas* provides states and other interested parties with a summary of the current status of high seas bottom fisheries worldwide based on the best information available, including responses to an FAO questionnaire sent to high seas fishing states, the European Community and relevant regional fisheries management organizations. It contains reviews of bottom fisheries in the high seas in the following regions: the North East and North West Atlantic, the Mediterranean, the South East and South West Atlantic, the North and South Pacific, the Indian Ocean and the Southern Ocean. Fisheries are described in terms of fleets, catch and effort, and main species caught, with due consideration being given to the location of fishing activities.

This document was prepared in response to the request by the FAO Committee on Fisheries (COFI) and related consideration of the issue of bottom fisheries on the high seas by the United Nations General Assembly in Resolution 61/105 on Sustainable Fisheries adopted in December 2006. It also aims at assisting in the implementation of the *FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* by providing background information and highlighting gaps in the available data.

According to the findings of this review, 285 vessels were active in the high seas bottom fisheries worldwide in 2006. The total catch of this fleet has been estimated to about 250 000 tonnes valued at EUR 450 million (landed value). For various reasons discussed in the report, these are to be considered minimal estimates.

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Contents

Introduction

This report, the *Worldwide review of bottom fisheries in the high seas*, was prepared in response to the request by the twenty-sixth session of the Food and Agriculture Organization of the United Nations (FAO) Committee on Fisheries (COFI), the subsequent consideration of the issue of bottom fisheries on the high seas by the United Nations General Assembly (UNGA) in its Resolution 61/105 on Sustainable Fisheries adopted in December 2006, and the twenty-seventh session of COFI in 2007. It is intended to provide states and other interested parties with a summary of the current status of high seas bottom fisheries worldwide, based on the best information available, including responses to an FAO questionnaire[1] sent to high seas fishing states and relevant regional fisheries management organizations (RFMOs). It also highlights gaps in the available information to assess effectively the extent to which these fisheries are managed in conformity with the approach agreed by UNGA in Resolution 61/105, and the *FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (adopted on 29 August 2008).

POLICY BACKGROUND

The management of bottom fisheries and the protection of ecosystems in the high seas have been high on the priority list of the international community, and have been discussed at fora ranging from the UNGA to high level meetings organized by FAO and the Convention on Biological Diversity, to many conferences and workshops organized by specialised inter-governmental and non-governmental organizations (IGOs and NGOs).

The issue of high seas bottom fisheries and their impacts on vulnerable marine ecosystems (VMEs) has been the subject of extensive negotiation by UNGA over the course of the past several years. Resolution 61/105 on Sustainable Fisheries, adopted by UNGA in December 2006, calls on flag states and RFMOs to take action immediately, both individually and through RFMOs/Arrangements, to manage fish stocks sustainably and protect VMEs, including seamounts, hydrothermal vents and cold-water corals, from destructive fishing practices. Furthermore, the Resolution calls on states and RFMOs/Arrangements to manage bottom fisheries on the high seas through assessing the impacts of individual bottom fishing activities; by preventing significant adverse impacts on VMEs, closing areas of the high seas to bottom fishing where VMEs are known or likely to occur, unless fisheries in these areas can be managed to prevent significant adverse impacts; and ensuring the long-term sustainability of deep-sea fish stocks.[2]

The approach outlined in the Resolution is broadly consistent with currently accepted international principles and standards for the management of fisheries on the high seas in conformity with international law as reflected in the United Nations Convention on the Law of the Sea of 10 December 1982 as well those established in international instruments such as the 1995 UN Agreement for the Implementation of the Provisions of the United Nations Convention on the Law

[1] The 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire: see Appendix A).

[2] United Nations General Assembly Resolution 61/105. Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations 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, and related instruments, paras 80–91.

of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (the Fish Stocks Agreement) and the FAO Code of Conduct for Responsible Fisheries. Among the most relevant provisions of these instruments are those that call on states to prevent overfishing; assess the impacts of fishing on associated and dependent species and species belonging to the same ecosystem; minimize impacts on associated and dependent species and ensure their conservation; protect habitats of particular concern; and apply the precautionary approach widely to protect and preserve fish stocks and the marine environment.In addition, UNGA called on FAO to enhance data collection and dissemination; promote information exchange and increase knowledge on bottom fishing activities; and collect and disseminate information on fisheries-related issues, including the protection of VMEs from the impacts of fishing.

FAO is actively involved in issues related to the management of bottom fisheries in the high seas and in the conservation of marine resources and habitats, consistent with the Code of Conduct for Responsible Fisheries, as well as in the protection of VMEs and marine biodiversity. The *FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* were developed in response to the concern expressed by states and organizations regarding the sustainable utilization of marine resources in bottom fisheries in the high seas and the protection of VMEs. This report initiates efforts to enhance knowledge on bottom fisheries in the high seas. This information is vital for the FAO Guidelines since it provides an initial overview of the status of fisheries in these areas, which is important for the understanding and implementation of the Guidelines and other relevant international instruments, as well as providing background information for management decisions to support the above-mentioned instruments.

DEFINITION

The FAO Fisheries Glossary defines a fishery as "an activity leading to the harvesting of fish, within the boundaries of a defined area. The fishery concept fundamentally gathers indication of human fishing activity, including from economic, management, biological/environmental and technological viewpoints".

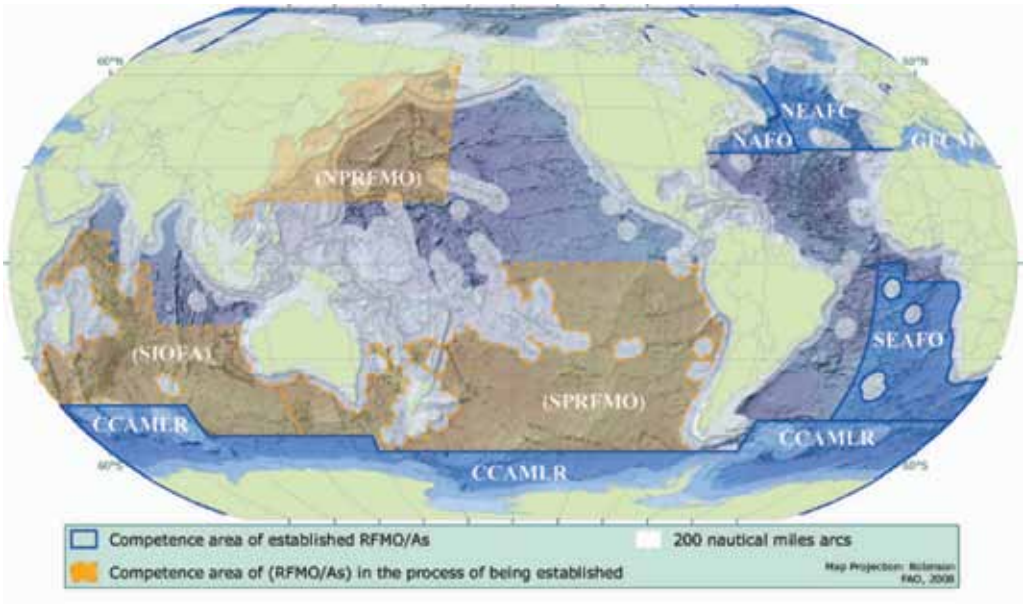
For the purpose of this review, the multidisciplinary viewpoint considered in identifying the different fisheries encompasses four main criteria:

- jurisdictional – high seas;
- geographic/topographic – the location and characteristics of the fishing ground;
- biological – the species or group of species targeted; and
- technological – the fishing gear used to harvest the resources.

Therefore, the definition of a fishery adopted here is an activity leading to the harvesting of fish, conducted by vessels using the same type of fishing gear and targeting the same species or group of species on a specific fishing ground. As considered in the scope of the review detailed in the next section, the fishing ground of each fishery inventoried is located, at least partially, in the high seas. It is usually characterized by a specific topographic feature (e.g. seamounts, banks, ridge and slope of the continental shelf).

SCOPE

The fisheries that are the subject of this review are those occurring in areas beyond national jurisdictions and conducted using fishing gears that either contact or are likely to contact the sea floor during the course of the fishing operation. These fisheries typically target demersal and benthic species. Many, but not all, of the species targeted or incidentally caught in these fisheries are long-lived, slow growing or late maturing species that can sustain only low exploitation rates. Fishing depth has not been considered as a primary criterion, although most of the fisheries considered in the review are conducted at depths below 200 metres (m), on continental slopes or isolated oceanic topographic structures such as seamounts, ridge systems and banks.



MAP 1
Global high seas areas and coverage of relevant RFMOs

Some fisheries that do not fulfil these characteristics have also been included, where appropriate. For example, the report cites some fisheries conducted with deep-sea pelagic gears that may or are likely to have occasional contact with the sea floor, fisheries targeting species mainly distributed in shallow waters, but where bycatch includes deep-sea species, or fisheries with a fishing ground mainly located within national jurisdictions, but somewhat overlapping the high seas.

METHODOLOGY

Regional approach

This report has been split into regional reviews. The limits of the different regions correspond to the Convention Areas of existing RFMOs with the legal competence to manage these fisheries. Where no RFMO exists, ongoing regional arrangements or negotiations for the establishment of such RFMOs have been considered for the breakdown of the review by region, as well as regions where there are gaps in the management regime for high seas bottom fisheries.

It includes four regional reviews in the Atlantic Ocean: North East Atlantic, North West Atlantic, South East Atlantic and South West Atlantic. No review was undertaken for the Eastern and Western Central Atlantic regions as little information was available regarding high seas bottom fishing grounds in these two regions. The information found regarding fisheries in these areas includes the activity of two deep-sea trawlers in FAO Area 34, reported by the Cook Islands in their answer to the FAO Questionnaire. In addition, two high seas deep-sea fishing grounds overlap the Western Central Atlantic (FAO Statistical Area 31) and the Eastern Central Atlantic (FAO Statistical Area 34) and have been mentioned in the respective regional reviews: the South Azores area in the North East Atlantic and the Corner Rise Seamounts complex in the North West Atlantic. These two fishing grounds seem to be the main fishing grounds in the Central Atlantic (Clark *et al.*, 2007)[3].

[3] Clark, M.R., Vinnichenko, V.I., Gordon, J.D.M, Beck-Bulat, G.Z., Kukharev, N.N. & Kakora, A.F. 2007. Large-scale distant-water trawl fisheries on seamounts. Chapter 17. *In* Pitcher, T.J., Morato, T., Hart, P.J.B., Clark, M.R., Haggan, N. & Santos, R.S. (eds). *Seamounts: ecology, fisheries and conservation*. Fish and Aquatic Resources Series. Oxford, United Kingdom, Blackwell.

A specific regional review has been prepared for the Mediterranean. Considering the general absence of 200 nautical miles national jurisdictions in this region, many of the bottom fisheries operating beyond the territorial waters can be considered as high seas fisheries. Therefore, the scope of the Mediterranean review has been reduced to the high seas bottom fisheries targeting resources outside the continental shelf, at depths greater than 400 m.

In the Pacific Ocean, two reviews are presented: the North and South Pacific Ocean. A single review covers the Indian Ocean, and the last regional review concerns the Southern Ocean.

Temporal coverage

The primary objective of this report is to present the "current picture" of high seas bottom fisheries. In general, data related to the period 2003–2006 have been reported. Where no information was available for that period, information related to previous periods was considered. In addition, each regional review includes a brief summary on the history of high seas deep-sea resources in the region.

THE QUESTIONNAIRE

The identification of documents describing the high seas bottom fisheries in each region was a preliminary task for the review. Following a desktop study, a questionnaire (as mentioned above, see Appendix A) was developed and addressed in January 2007 to 40 countries (see Appendix B), the flag states of vessels identified as potentially involved in high seas bottom fishing in recent years (from 2003 to 2006). Because of the specific case of the Mediterranean Sea, the questionnaire was not sent to the countries with a bottom fishing fleet exclusively fishing in that region. The regional review for the Mediterranean Sea was undertaken through a desktop study.

The objective of the questionnaire was to assist in identifying the main high seas bottom fisheries, and to assess the importance of these fisheries in terms of number of vessels, catch and fishing effort during the period covered by the review. The following information was requested:

- the list of fishing vessels involved in high seas bottom fisheries;
- the number of vessels and total gross tonnage by type of vessel and reporting year;
- the number of vessels by vessel type, main fishing ground and reporting year;
- the total catch by main fishing ground, with the percentage captured in the high seas for fishing grounds corresponding to straddling stocks;
- the catch by main species, with the percentage captured in the high seas for fishing grounds corresponding to straddling stocks;
- the number of fishing days by main fishing ground, with the percentage captured in the high seas for fishing grounds corresponding to straddling stocks; and
- the number of fishing days by type of fishing gear, with the percentage captured in the high seas for fishing grounds corresponding to straddling stocks.

Some of the countries to which the questionnaire was sent did not reply. Four countries replied with no mention of a fleet active in high seas bottom fisheries. Some countries did not reply officially to the questionnaire, but some information was obtained through direct contact with staff of the national fisheries administration or with scientists.

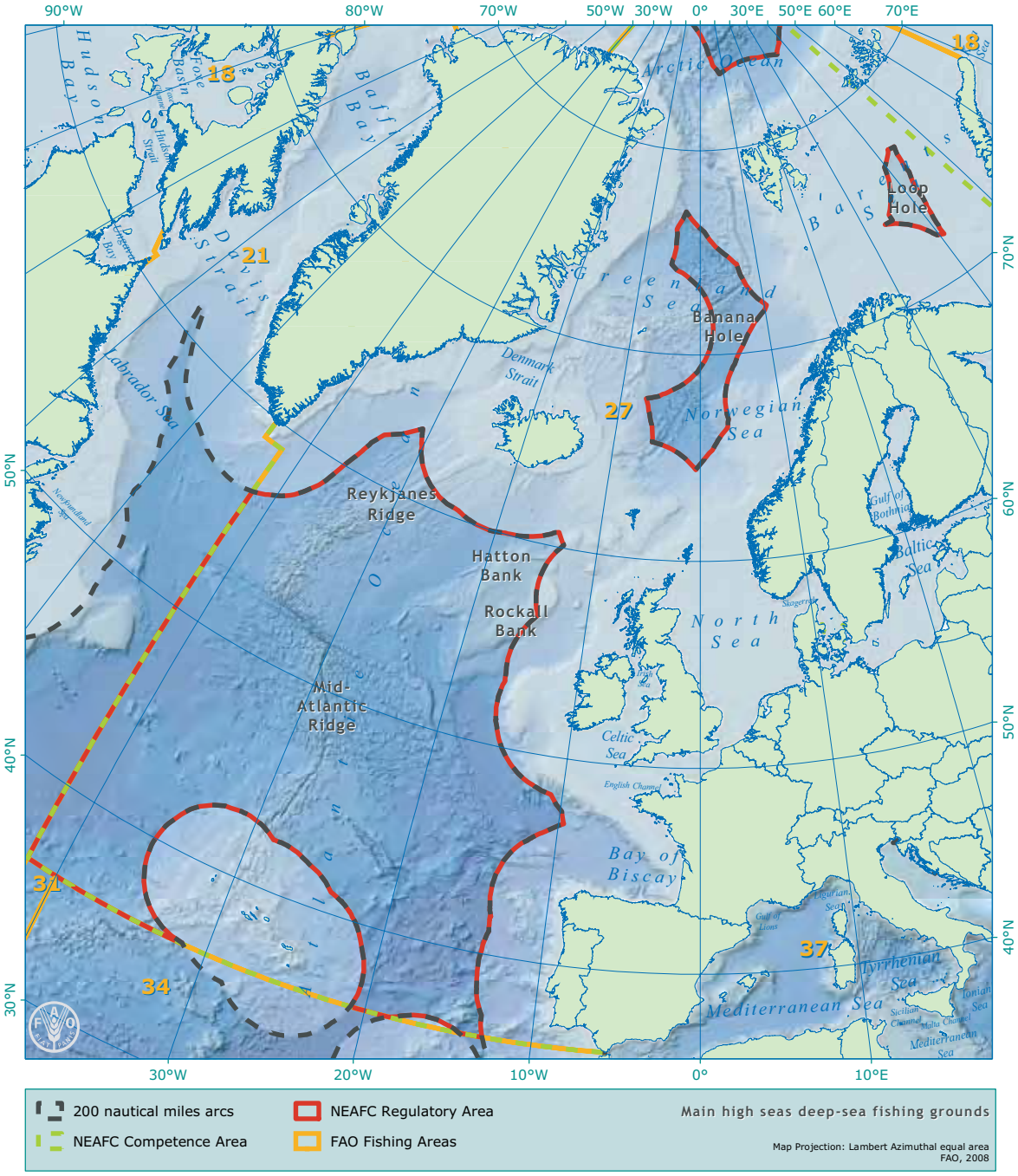
A modified version of the questionnaire was also addressed to regional organizations/institutions with a mandate to manage high seas bottom fisheries:

- North East Atlantic Fisheries Commission (NEAFC)
- Northwest Atlantic Fisheries Organization (NAFO)
- South East Atlantic Fisheries Organisation (SEAFO)

- Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)
- EU – Directorate-General for Maritime Affairs and Fisheries (DG MARE) (former DG FISH)

Additional information was obtained from direct contact with national authorities, secretariats of regional organizations and deep-sea fisheries experts.

THE ATLANTIC OCEAN AND ADJACENT SEAS



MAP 1
High seas deep-sea fishing grounds in the North East Atlantic Ocean

North East Atlantic Ocean

FAO Statistical Area 27

GEOGRAPHIC DESCRIPTION OF THE REGION

The North East Atlantic region (FAO Statistical Area 27) is limited to the north by the Arctic Ocean and to the south by the 36°N parallel, which corresponds to the southern point of the Iberian Peninsula. It covers all of the maritime area between the European continent and Greenland. Important geological features in the high seas of this region include the Mid-Atlantic Ridge (MAR), the Reykjanes Ridge, Hatton Bank and Rockall Bank. The western limit south of Greenland is the 42°W meridian, separating the North East Atlantic from the North West Atlantic (Map 1).

The North East Atlantic region is divided into fishing areas for statistical purposes. These areas have been established within the framework of the Food and Agriculture Organization of the United Nations (FAO) Coordinating Working Party on Fishery Statistics (CWP) in collaboration with interested parties in the region, including the International Council for the Exploration of the Sea (ICES) and the North East Atlantic Fisheries Commission (NEAFC). These areas are referenced in this review as ICES Areas (as seen in Maps 2 and 3).

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

NEAFC is the competent regional organization for fisheries management in the region. Its Area of Competence (see Map 1) covers FAO Statistical Area 27. The high seas area of the North East Atlantic is called the NEAFC "Regulatory Area". There are four sections of the NEAFC Regulatory Area, the largest being the main location for deep-sea high seas fisheries (see Map 1). A second section is in the Barents Sea, where a portion of international waters between the Norwegian and Russian exclusive economic zones (EEZs) is known as the "Loophole". The shared demersal fisheries in this area are managed by the Joint Norwegian-Russian Fisheries Commission established in 1976 to manage cod, haddock and capelin fisheries in the Barents Sea, although other pelagic and shrimp fisheries are managed by NEAFC. Another of the sections of high seas is known as the "Banana Hole" and lies beyond the Faroese, Icelandic, Greenland and Norwegian jurisdictions and the Svalbard Protection Zone. Finally, an area north of Greenland, Svalbard and Franz Josef Land towards the North Pole is also part of the NEAFC Regulatory Area.

The NEAFC contracting parties are the European Union (EU), Denmark in respect of Faroe Islands and Greenland, Iceland, Norway and the Russian Federation. Belize, Canada, the Cook Islands, Japan and New Zealand have the status of cooperating non-contracting parties.

The list of deep-sea species regulated by NEAFC includes 49 species. In 2002, NEAFC established a working group on deep-sea species which last met in June 2006. NEAFC receives scientific advice from ICES. The two main working groups of ICES dealing with deep-sea fisheries are the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), and the ICES-Northwest Atlantic Fisheries Organization (NAFO) Joint Working Group on Deep Water Ecology (WGDEC). Other ICES working groups of relevance include the Arctic Fisheries Working Group (AFWG), the North-Western Working Group (NWWG), the Working Group on Elasmobranch

Fishes (WGEF), the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS), the Study Group on Cold Water Corals (dissolved from 2005), and the Working Group on Ecosystem Effects of Fishing Activities (WGECO).

The NEAFC Permanent Committee on Management and Science (PECMAS) is responsible for the formulation of requests for scientific advice submitted to ICES, the reviewing of management measure proposals submitted by contracting parties, and for the provision of new developments or information on science, technology and management tools to the Secretariat.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

There is a long history of exploitation of deep-sea species in the North East Atlantic beginning with the black scabbardfish (*Aphanopus carbo*) fishery around the Madeira Islands dating at least from the late nineteenth century (Martins and Ferreira, 1995). The more recent history of deep-sea fisheries in the international waters of the North East Atlantic was initiated by the former Union of Soviet Socialist Republics (USSR) in 1973, when aggregations of roundnose grenadier (*Coryphaenoides rupestris*) over the northern part of the MAR were discovered. Initial catches peaked at about 30 000 tonnes per annum and the fishery continued with varying intensity until the early 1990s. (Troyanovsky and Lisovsky, 1995) This fishery was mainly conducted using pelagic trawls, but also with bottom gear (Clark *et al.*, 2007).

A longline fishery also developed on the Reykjanes Ridge in the 1990s, targeting golden redfish (giant redfish) (*Sebastes marinus*) (Hareide *et al.*, 2001) and tusk (*Brosme brosme*). This fishery ceased in 1997 and was then resumed in 2005–2006. More to the south on the MAR, an alfonsino (*Beryx splendens* and *B. decadactylus*) commercial fishery in international waters was conducted at the end of the 1970s, but since then has been sporadic (ICES, 2007b).

Deep-sea species were also exploited by the former USSR in the early 1970s around the continental margins in areas such as Bill Bailey, Lousy, Hatton and Rockall Banks (Vinnichenko, 2000). These fisheries virtually ceased when coastal states, particularly Iceland, Faroe Islands and the United Kingdom, declared EEZs in the mid-1970s. In 1997, the United Kingdom reduced its exclusive fishery zone around Rockall Bank from 200 to 12 nautical miles, and thereafter bottom trawl and longline fisheries in the high seas were established by a number of countries, including Spain, Norway, Faroe Islands and the Russian Federation (Gordon, 2007). Most of these fisheries targeted deep-sea species such as roundnose grenadier, black scabbardfish, deep-sea sharks, blue ling (*Molva dypterygia*) and Greenland halibut (*Reinhardtius hippoglossoides*). On the shallower parts of the Rockall Bank, the Russian fleet resumed fishing for haddock (*Melanogrammus aeglefinus*). Apart from trawling, longline and gillnet fisheries also took place in this area.

A fishery for blue ling, on the MAR and west of the United Kingdom, was developed by German trawlers in the 1970s and French trawlers in the mid- to late 1970s. At that time, species such as roundnose grenadier, black scabbardfish and deep-sea sharks were discarded (Charuau *et al.*, 1995; Large *et al.*, 2003).

French and Faroese trawlers developed an orange roughy (*Hoplostethus atlanticus*) fishery in the early 1990s. The fishing grounds were mainly located in waters under national jurisdiction, on seamounts such as the Hebrides Seamounts and along the continental margin. Some fishing grounds were also located in international waters on the MAR (Thomsen, 1998) or on the Hatton and Rockall Banks. Maximum catches occurred in the mid-1990s but have declined since then (Clark *et al.*, 2007).

In the early 1990s, a fishery for Northeast Arctic cod (*Gadus morhua*) developed in the Barents Sea. Even if not a true deep-sea species, this fishery is an important

bottom fishery in the area. During the peak years around 1994, 7 percent of the catch of cod in the Barents Sea was considered to be caught in the Loophole (see Map 1), international waters spanning some 62 400 square kilometres (km²). By 1995, around 80 trawlers from Iceland, the main fishing nation in that area, were fishing in the Loophole. Vessels from the European Community, Greenland and Faroe Islands were also involved in the fishery. By 1998, high seas catches in these fisheries were down to little more than 2 000 tonnes as the cod stock shifted south. (Stokke, 2002)

TABLE 1
Main species of high seas deep-sea fisheries in the North East Atlantic

Common name	Scientific name	Vulnerability
Main target species – trawl fisheries		
Baird's slickhead (Baird's smoothhead)	*Alepocephalus bairdii*	
Black scabbardfish	*Aphanopus carbo*	4.0
Alfonsino	*Beryx splendens* and *B. decadactylus*	4.7
Blue ling	*Molva dypterygia*	4.0
Leafscale gulper shark	*Centrophorus squamosus*	1.5
Haddock	*Melanogrammus aeglefinus*	
Beaked redfish	*Sebastes mentella*	2.6
Orange roughy	*Hoplostethus atlanticus*	
Portuguese dogfish	*Centroscymnus coelolepis*	1.5
Roundnose grenadier	*Coryphaenoides rupestris*	2.4
Main target species – longline fisheries		
Greenland halibut	*Reinhardtius hippoglossoides*	3.2
Deep-sea sharks		
Ling	*Molva molva*	4.0
Tusk	*Brosme brosme*	3.8
Golden redfish (giant redfish)	*Sebastes marinus*	
Main target species – gillnet fisheries		
Hake	*Merluccius merluccius*	
Monkfish	*Lophius piscatorius* and *L. budegassa*	
Deep-sea sharks		
Deep-water red (or king) crab	*Geryon* spp.	
Other species		
Cardinal fishes	*Epigonus* spp.	
Greater forkbeard	*Phycis blennoides*	
Blackspot seabream	*Pagellus bogaraveo*	
Blackbelly rosefish (bluemouth)	*Helicolenus dactylopterus*	
Forkbeards nei	*Phycis* spp.	
Rabbit fish	Chimaeridae (mainly *Hydrolagus mirabilis* or *Chimaera monstrosa*)	
Roughhead grenadier	*Macrourus berglax*	
Roughsnout grenadier	*Trachyrincus scabrus*	

Current fisheries

The main commercial deep-sea species targeted in the high seas of the North East Atlantic are listed in Table 1 (see also Figure 1). Many of these species are long-lived, slow growing, have low fecundity and mature at a late age. On the basis of these and other characteristics, the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP) graded the main target species on a scale of one to five in terms of vulnerability (five being least vulnerable) (ICES, 2001). These values are shown in Table 1 but should be treated as indicative.

In recent years, the main high seas deep-sea fishing grounds in the North East Atlantic have been the Hatton and Rockall Banks, the Reykjanes Ridge and the MAR (see Map 2). In the northern part, there is also some deep-sea fishing in the two high seas "holes" known respectively as the Loophole in the Barents Sea and the Banana Hole in the Norwegian Sea, although there are no bottom fisheries in the latter. Sporadic fishing also occurs on some seamounts and other banks along the continental slopes and on both sides of the MAR.

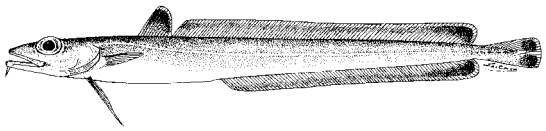
Hatton and Rockall Banks

This fishing ground for deep-sea species is mainly located in the high seas (ICES Subareas XIIb and VIb1). It is surrounded from the north to the southeast by the EEZs

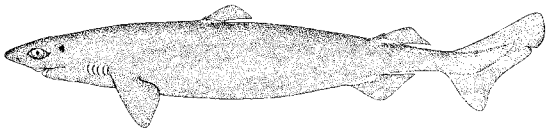
FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the North East Atlantic

Roundnose grenadier (*Coryphaenoides rupestris*)

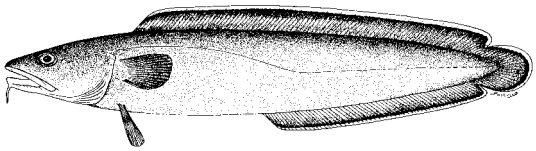
Blue ling (*Molva dypterygia*)



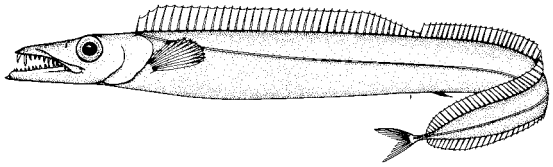
Portuguese dogfish (*Centroscymnus coelolepis*)



Tusk (*Brosme brosme*)



Black scabbardfish (*Aphanopus carbo*)



Source: FAO.

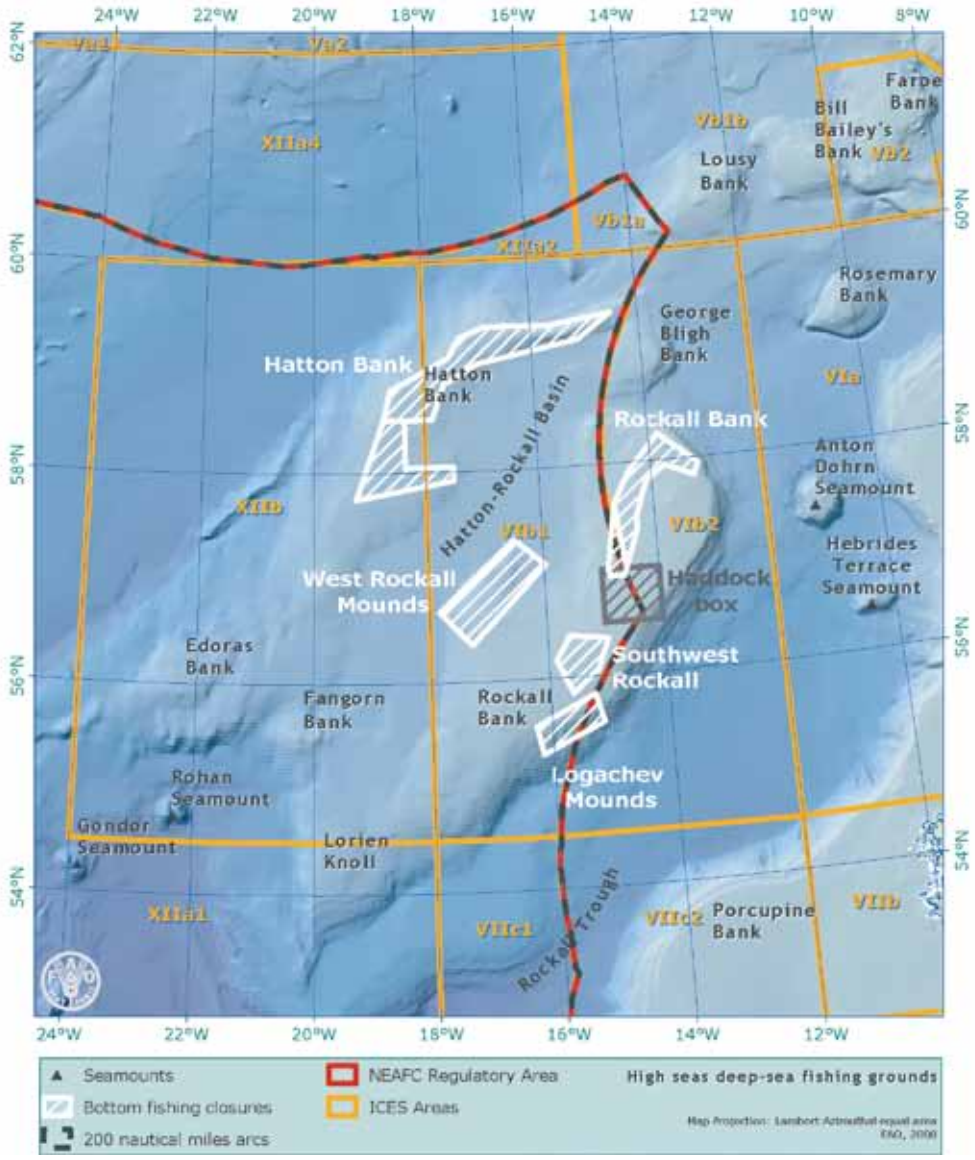
of four countries: Iceland, Faroe Islands, the United Kingdom and Ireland. Part of the Rockall Bank is in the United Kingdom and Ireland's EEZs (ICES Subarea VIb2). In the north, a chain of banks links the Rockall Bank to the Faroe Plateau: Georges Bligh, Lousy and Bill Bailey's Banks.

Part of the south slope of Lousy Bank is in international waters. On the eastern side, the Rockall Trough separates this international fishing ground from the slopes of the continental shelf. In the north, west of Bill Bailey's Bank, the Wyville-Thomson Ridge separates the Rockall Trough from the Faroe-Shetland Channel and is a barrier between the colder bottom waters of the Arctic and the warmer waters of the North Atlantic. To the south of the Rockall Bank, the Lorien Knoll is located in ICES Subarea XIIa1. Hatton Bank is deeper (minimum depth around 600 metres [m]) than Rockall Bank (rises up to the surface). The south of this fishing ground is limited by the abyssal plain.

Multispecies deep-sea bottom trawl fishery

A multispecies deep-sea bottom trawl fishery has been conducted for many years on the slopes of the Hatton and Rockall Banks. The target species are mainly roundnose grenadier, Baird's slickhead (*Alepocephalus bairdii*), black scabbardfish, leafscale gulper shark (*Centrophorus squamosus*) and Portuguese dogfish (*Centroscymnus coelolepis*). The latter two shark species are collectively referred to as siki sharks. Common bycatch consists of blue ling and greater forkbeard (*Phycis blennoides*). The fishing depth is between 800 and 1 600 m.

This fishery is dominated by the Spanish freezer trawl fleet, fishing mainly on the western part of the Hatton Bank, with increased effort on Baird's slickhead in recent years. The Spanish fleet consisted of 25 to 28 vessels fishing a total of approximately



MAP 2
Hatton and Rockall Banks deep-sea fishing grounds

1 500 days per year in the early part of the decade, but may have declined in recent years. Five vessels of the Spanish fleet work exclusively on this fishing ground, whereas the others also fish in the NAFO area and in the Irminger Sea. These latter vessels fish on Hatton Bank at the beginning or at the end of their fishing trip to their other fishing grounds in the North Atlantic (De Cardenas, 2007).

French deep-sea trawlers mainly operate within the European Community's EEZs, but some of them also fish in the high seas of the Hatton and Rockall Bank area, although there has been a decrease of activity in recent years. In 2005, 11 French trawlers (P. Lorance, personal communication, 2007) caught a total of 713 tonnes of roundnose grenadier (see Table 2) in this area, representing 16 percent of the total French catch of this species in the North East Atlantic. In 2006, the French catch of roundnose grenadier in the high seas of Hatton and Rockall Banks decreased to 184 tonnes, representing around 6 percent of the total French catch of this species in the North East Atlantic. Other species caught by French trawlers in the high seas include blue ling (1 percent of the total French catch of this species was caught in the high seas for 2005 and 6 percent in 2006), orange roughy (24 percent caught in the high seas for 2005 and 25 percent in 2006), and black scabbardfish (2 percent caught in the

TABLE 2
Indicative annual fishing effort and catches in the Hatton and Rockall Banks multispecies bottom trawl fishery for the period 2003–2006

Flag state	Number of vessels	Number of fishing days	Catch (tonnes)					
			Roundnose grenadier			Baird's slickhead		
France	11[7] (2005)	/	XIIb	Vb1a/ VIb1a	Year	/		
			85[4]	99[4]	2006			
			508[4]	205[4]	2005			
			1 707[4]	704[4]	2004			
Spain	29[4] (2006)	1 500[3] (2003, 2004)	XIIb		Year	/		
	26[3] (2003, 2004)		4 194		2005[4]			
			8 423		2004[4]			
United Kingdom (Scotland)	XII	VIb	Year	/	XII–VI int.		Year	0[2] (2003–2006)
	0[2]	4[2]	2006		0[2]		2006	
	1[2]	7[2]	2005		9[2]		2005	
	2[2]	10[2]	2004		4.5[2]		2004	
	2[2]	19[2]	2003		1.85[2]		2003	
Russian Federation	XIIb	VIb	Year	XIIb	VIb	Year	XIIb	VIb	Year	XIIb	VIb	Year
	0[2, 6]	0[2, 6]	2006	0[6]	0[6]	2006	0[6]	0[6]	2006	0[6]	0[6]	2006
	1[2, 6]	1[2, 6]	2005	4[6]	11[6]	2005	9.6[6]	70.8[6]	2005	2.3[6]	12.6[6]	2005
	1[2, 6]	1[2, 6]	2004	2[6]	10[6]	2004	15[6]	77[6]	2004	3[6]	15[6]	2004
Poland	1 or 2[8] (2001–2004)	/	XII	VIb	Year	XII	VIb	Year				
			21[5]	13[5]	2004	0[5]	0[5]	2004				
			32[5]	452[5]	2003	6[5]	113[5]	2003				
Lithuania	1[1] (2006)	/	XII	VI	Year	XII	VI	Year				
			6	112	2006	11	317	2006				
			13[5]	92[5]	2005	69[5]	668[5]	2005				
			120[5]	961[5]	2004	21[5]	525[5]	2004				
			31[5]	939[5]	2003	13[5]	229[5]	2003				
Estonia	1[2] (2001–2006)	XII / VIb	Year	XII	VIb	Year	XII	VIb	Year			
		52[2]	2006	27[2]	34[2]	2006	75.7[2]	82.4[2]	2006			
		111[2]	2005	20[5]	80[5]	2005	/		2005			

/ = Unknown.
Sources:
[1] Response from EU DG FISH to FAO Questionnaire.
[2] Returned questionnaires to FAO by respective country.
[3] ICES, 2005a.
[4] ICES, 2007b.
[5] ICES, 2007a.
[6] Vinnichenko, Khlivnoy and Akhtarina, 2005; Vinnichenko and Bokhanov, 2006; Vinnichenko, 2007.
[7] P. Lorance. personal communication, 2007.
[8] NEAFC catch statistics.

high seas in 2005 and 5 percent in 2006). It has also been reported that French trawlers have been discarding species such as Baird's slickhead (N.-R. Hareide, personal communication, 2008).

The United Kingdom (Scotland) had four bottom trawlers in 2006 targeting mainly monkfish (*Lophius piscatorius* and *L. budegassa*) at shallower depths (as deep as 800 m) on Rockall Bank, with bycatch of deep-sea species including ling (*Molva molva*), blue ling and siki sharks. Some of these vessels may fish deeper, targeting deep-sea species such as roundnose grenadier, black scabbardfish and siki sharks (ICES, 2007b). In its answer to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A), the United Kingdom indicated several vessels were engaged in deep-sea trawl fishing in the high seas of ICES Area XII (two vessels in 2003 and 2004, one in 2005), which is presumed, with some uncertainty, to have taken place on Hatton Bank (ICES Area XIIb), as part of the activity of the UK of the trawlers fishing on Rockall Bank.

Other countries such as Poland (until 2004), Lithuania, Estonia and the Russian Federation also participate in this fishery, but with a limited number of vessels (Table 2).

Multispecies deep-sea longline fishery

This fishery operates over a wide bathymetric range, from 200 to 1 700 m, which has a significant influence on individual catch profiles. For example, at greater depths the species composition will, to a large extent, be dominated by deep-sea sharks and Greenland halibut. At shallower depths (200–600 m) on Rockall Bank, ling and tusk comprise the majority of the landings. Other species targeted include greater forkbeard, skates and blue ling.

Norwegian vessels are involved in this fishery, but the number of vessels declined from 17 in 2001 to three in 2006. The main targeted species are Greenland halibut in ICES Area XII and tusk and ling in ICES Area VI. One to four Russian longliners have participated on a seasonal basis in the fishery in recent years, targeting mainly sharks on the Hatton deep-sea slopes (700–1 700 m) and other species in shallower waters. The fishing effort of these longliners is around 17 000 hooks per fishing day (Vinnichenko *et al.,* 2005; Vinnichenko and Bokhanov, 2006; Vinnichenko, 2007). France also reports activity of one longliner targeting deep-sea species in the high seas of the North East Atlantic during 2003 and 2004. For a summary of the annual fishing effort in this fishery, see Table 3.

TABLE 3
Indicative annual fishing effort in the Hatton and Rockall Banks multispecies longline fishery for the period 2003–2006

Flag state	Number of vessels			Fishing days		
	Hatton	Rockall	Year	Hatton	Rockall	Year
Russian Federation	1[1, 3]	1[1, 3]	2006	48[1]	21[1]	2006
	1[3] or 2[1]	4[1, 3]	2005	33[1]	131[1]	2005
	1[1, 3]	1[1, 3]	2004	40[1]	49[1]	2004
France	1[3]		2003/ 2004	/		
Norway*	3[3]		2006	/		2006
	2		2005	37		2005
	4[2]		2004	172[2]		2004
	12[2]		2003	292[2]		2003

/ = Unknown.
* Part of this fishing activity is on the Mid-Atlantic Ridge.
Sources:
[1] Vinnichenko *et al.*, 2005; Vinnichenko and Bokhanov, 2006; Vinnichenko, 2007.
[2] ICES, 2005a.
[3] Returned questionnaires to FAO by respective country.

Bottom trawl fishery for haddock

Although haddock is not a deep-sea species, this fishery is important to note in this review as it is conducted with bottom gear and has bycatch of deep-sea species including rabbit fish (Chimaeridae), ling, blue ling, roundnose grenadier, tusk, beaked redfish (*Sebastes mentella*) and blackbelly rosefish (bluemouth) (*Helicolenus dactylopterus*). The fishing ground is located on the shallow plateau area of Rockall Bank (200-400 m). It is partially in the international waters, but overlaps the EEZs of Ireland and the United Kingdom. In order to protect haddock stocks NEAFC, in 2004, closed an area (the Haddock Box) to fishing by all gears except longlines. The boundaries of the area were later extended into the EEZs of the United Kingdom and Ireland by the European Community (see Map 2).

The ICES Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS) includes some information on this fishery. After part of the Bank was designated as international waters in 1999, the Russian Federation has been the main nation involved in the fishery. In recent years, Ireland and Scotland have also been participating in the fishery. Catch estimates of haddock on the high seas portions of the Rockall Bank for 2005 are 4 708 tonnes for the Russian Federation, 105 tonnes for Ireland and 375 tonnes for Scotland. For 2006, NEAFC reports the high seas catch of haddock by the Russian Federation was 2 154 tonnes, Norway 23 tonnes and the European Community reported a combined catch of 382 tonnes (NEAFC 2006).

Deepwater gillnet and tangle-net fishery

There have been several deep-sea gillnet fisheries in recent years that are characterized according to the target species, which in turn depends on the fishing depth and the gear

TABLE 4
Blue ling catch in ICES Areas Vb and VI, from 2004 to 2006

Year	Flag state	Catch (tonnes) by ICES Area			
		Vb1 (small part high seas)	Vb2 (EEZ)	VIa (EEZ)	VIb (EEZ and high seas)
2006	France	839	0	1 804	313
	Faroe Islands	1 230	632	13	15
	Others	38	50	513	35
	Total	2 107	682	2 330	363
2005	France	781	0	2 031	234
	Faroe Islands	1 028	609	17	1
	Others	16	20	635	98
	Total	1 825	629	2 683	333
2004	France	1 131	0	2 259	486
	Faroe Islands	751	710	10	4
	Others	33	74	532	117
	Total	1 915	784	2 801	607

Source: ICES, 2008.

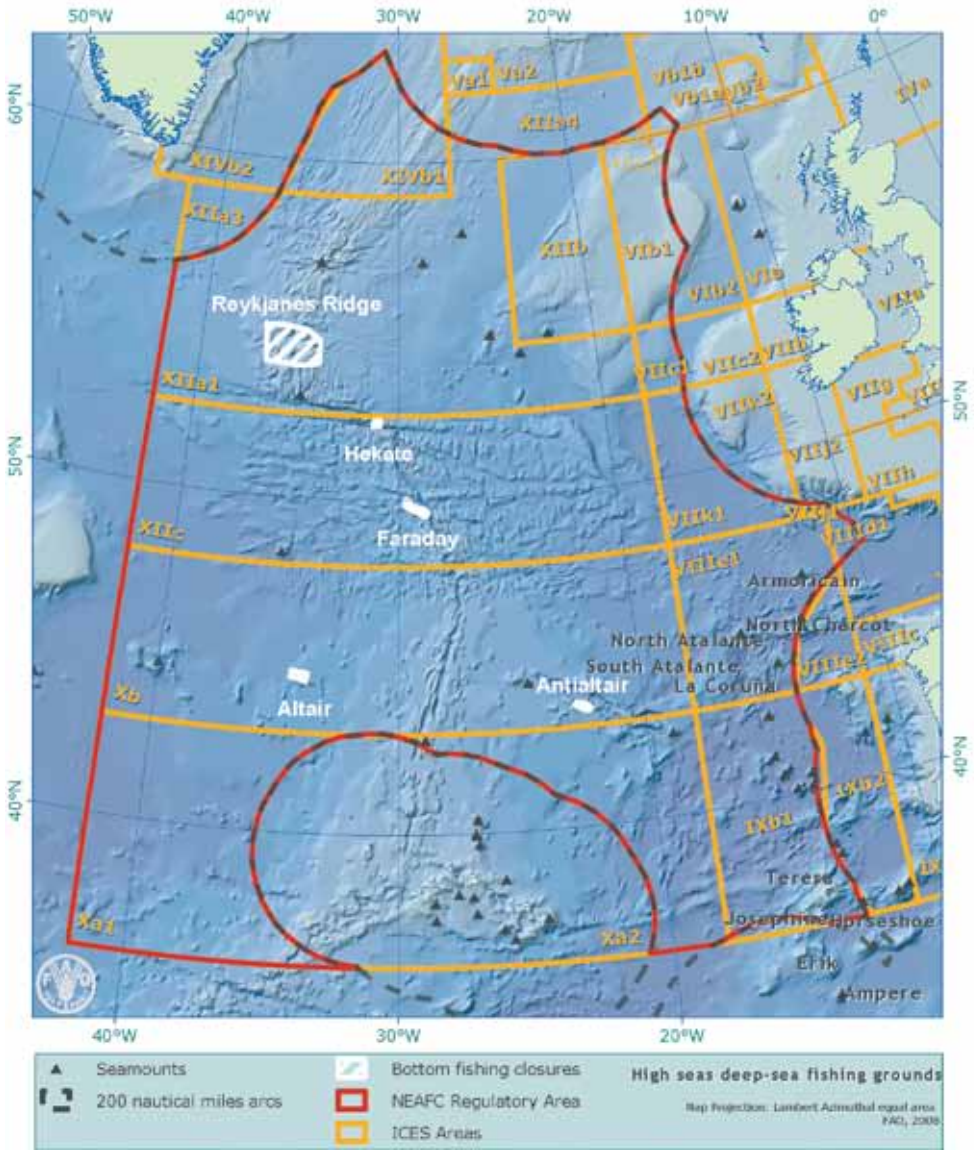
characteristics (e.g. mesh size). These are hake (*Merluccius merluccius*) (100–600 m), monkfish (100–800 m), deep-sea sharks (800–1 600 m) and deep-water red (or king) crabs (*Geryon* spp.) (600–1 200 m). These fisheries have taken place both within EEZ limits on the slopes of the European continental shelf and in the high seas on the slopes of Hatton and Rockall Banks. The main target species on the Hatton and Rockall Banks are monkfish, between 500 and 900 m, and the siki sharks deeper than 800 m. For the period 2003–2005, five to eight Spanish vessels registered in the United Kingdom were involved in bottom gillnet fishing on Hatton and Rockall Banks. In addition, a further two to three vessels were registered in Panama and Togo (Hareide *et al.*, 2005).

Since 2006, there has been a temporary ban on deep-sea gillnetting in the NEAFC Regulatory Area and in European Union waters at depths >200 m in ICES Areas VI, VIIb, VIIc, VIIj, VIIk and XII east of 27°W. This ban was amended later that year by the European Commission to allow for the hake fishery to continue at depths <600 m inside EU waters. The ban is still in force in the NEAFC Regulatory Area. In its answer to the FAO Questionnaire, the United Kingdom mentioned the activity of one gillnetter in the high seas areas of Hatton and Rockall Banks in 2006, which caught leafscale gulper shark (34 tonnes), greater forkbeard (33 tonnes), blue ling (19 tonnes), rabbit fish (13 tonnes) and other shark species (16 tonnes).

Bottom trawl fishery for blue ling

Finally, there is an important bottom trawl fishery harvesting blue ling undertaken by Faroese and French trawlers. Faroese otterboard trawlers target this species mainly during the spawning season and primarily in their EEZ, and the French trawlers catch blue ling as a bycatch of the fishery for roundnose grenadier, black scabbardfish and deep-sea sharks. The major catches of blue ling by the Faroese and French fleets take place within national jurisdictions, in ICES Areas Vb and VIa, respectively, but some fishing also occurs in international waters (ICES Areas VIb1 or Vb1a in the north of Rockall Bank on the southern slope of the Lousy Bank). Blue ling catches of these two flag states in ICES Areas V and VI are presented in Table 4. Statistics available do not differentiate high seas catch but, according to IFREMER[1] (P. Lorance, personal communication, 2007) logbook data, 1 percent of the blue ling caught by French trawlers was captured in the high seas in 2005, and 6 percent in 2006.

[1] French Research Institute for Exploitation of the Sea.



MAP 3
The Mid-Atlantic Ridge deep-sea fishing grounds (including ICES Areas)

The Mid-Atlantic Ridge

The Mid-Atlantic Ridge (see Map 3), which extends from the Icelandic EEZ to the Portuguese EEZ surrounding the Azores, is the other main high seas fishing area for deep-sea resources in the North East Atlantic. The northern portion of the MAR is called the Reykjanes Ridge. Bottom fishing grounds are essentially composed of seamounts and peaks along the ridge system.

Bottom trawlers targeting orange roughy and black scabbardfish

This fishery is conducted on the seamounts of the MAR. In recent years, the fishery has been sporadic. One Faroese bottom trawler was active in the fishery in 2004 and 2006, where the catch included roundnose grenadier and some deep-sea sharks. The fishing effort of the vessel for 2004 was 82 fishing days (ICES, 2005a). Two Irish trawlers also participated in the fishery in 2003 (65 days at sea), and one in 2004 (38 days at sea). One Irish trawler also fished in ICES Subarea X in 2004 (38 days at sea, with a total catch of 34 tonnes). For an overview of the catches, see Table 5.

TABLE 5
Irish and Faroese catches of deep-sea species on the Mid-Atlantic Ridge, from 2003 to 2006

Country	Species	Catch (tonnes)							
		2003		2004		2005		2006	
	ICES Subarea	XII	X	XII	X	XII	X	XII	X
Faroe Islands	Orange roughy	0	0	146	320	159	129	81	8
Faroe Islands	Black scabbardfish	0	0	95	112	127	56	8	11
Faroe Islands	Roundnose grenadier	0	0	8	1	5	0	1	0
Faroe Islands	Alfonsino nei	0	0	0	0	0	0	0	0
Ireland	Orange roughy	136	0	0	19	0	0	0	0
Ireland	Black scabbardfish	1	0	0	0	0	0	0	0
Ireland	Cardinal fishes nei	0	0	0	15	0	0	0	0
Ireland	Grenadiers nei	1	0	0	0	0	0	0	0
Ireland	Portuguese dogfish	5	0	0	0	0	0	0	0

Source: ICES, 2007a.

TABLE 6
Summary of the fishing effort and catch of roundnose grenadier by Russian vessels, from 2003 to 2006

Year	Number of vessels	ICES Area	Number of fishing days	Catch of roundnose grenadier (tonnes)
2006	No activity reported			
2005	1	XIIa1/XIIc	42	600
		Xb	37	799
2004	1	XIVb1	1	19
		XIIa1/XIIc	23	371
2003	2	XII	50	585

Sources: Vinnichenko *et al.*, 2005; Vinnichenko and Bokhanov, 2006; Vinnichenko, 2007.

Trawlers targeting roundnose grenadier on the Mid-Atlantic Ridge (ICES Areas XIVb1, XIIc and Xb)
The history of this fishery is briefly described in the section on the History of fisheries. Trawlers fish on the bottom during the day and off-bottom at night, following the diurnal movements of the fish. Effort in this fishery has been much lower in recent years with the activity of only one vessel reported from 2004 to 2006 by the Russian Federation to ICES WGDEEP (see Table 6). The fishing area overlaps ICES Areas XIV and XII, and continued down to ICES Area Xb in 2005. In 2004, it should be noted that the gear mentioned in the Russian report is a pelagic trawl (Vinnichenko *et al.*, 2005), but is probably operated quite close to the seafloor.

Trawl fishery targeting spawning aggregations of blue ling on the Reykjanes Ridge
One of the blue ling spawning aggregations fished in the North East Atlantic is located along the southern border of the Icelandic EEZ (ICES, 2004). In recent years, there has been sporadic activity of Spanish trawlers in this fishery, with reported catch of blue ling in ICES Area XIV. Bycatch is mainly composed of roundnose grenadier.

Mid-water trawl fishery targeting beaked redfish in the Irminger Sea
The fishing ground of the fishery for beaked redfish overlaps the south of the Icelandic EEZ, the south of the Greenland EEZ, the NEAFC Regulatory Area on the Reykjanes Ridge (ICES Areas XIVb1 and XIIa1), and Divisions 1F, 2H and 2J of the NAFO Regulatory Area (see review of the North West Atlantic). Bycatch in the fishery includes roundnose grenadier, roughhead grenadier and tusk, which indicates that, at least in some cases, the fishing gear is likely to be operating close to the bottom. The

main countries participating in the fishery are the Russian Federation, Norway (six vessels in 2006 fishing with pelagic trawl)[2], Faroe Islands, Germany, Poland, Spain (seven vessels), Portugal and Iceland. Recently, Latvia and Lithuania have also reported catches of beaked redfish in ICES Areas XIVb and XII. An unpublished report of the Spanish Department of Fisheries (De Cardenas, 2007) describes this fishery – fishing starts in the spring in ICES Areas XII and XIV and finishes in October in NAFO Divisions 1F, 2H and 2J, following the concentrations of beaked redfish.

Longline fisheries on Reykjanes and Mid-Atlantic Ridges targeting golden redfish, tusk and sharks

An experimental vertical longline fishery was undertaken by Norway in 1996 and 1997 (Hareide *et al.,* 2001). This fishery resumed in 2005–2006 with one Russian longliner. In 2005, total catch was 15 tonnes, with a fishing effort of 12 days and 47 000 hooks. In 2006, total catch was 407 tonnes, with a fishing effort of 80 days and 709 000 hooks (Vinnichenko and Bokhanov, 2006; Vinnichenko, 2007).

In 2004, a Spanish bottom longliner also conducted an exploratory fishing trip on the MAR for 54 days, with a total catch of 80 tonnes. The activity of some Norwegian longliners on the MAR is also mentioned in the 2005 WGDEEP report: two longliners in 2003 and one in 2004 (ICES, 2005a).

A few Irish longliners targeting deep-sea sharks are also mentioned in the 2005 WGDEEP report, both in ICES Subareas XII and X (one longliner, 13 days at sea in 2003).

Other deep-sea fisheries in EEZs surrounding the Mid-Atlantic Ridge or with pelagic gear

Azores deep-sea fisheries

The main deep-sea fishery in the Azores is the traditional multispecies fishery using longlines and handlines operating on seamounts. The main target species is the blackspot seabream. In 2005 and 2006 respectively, 1 451 and 957 tonnes were caught by Portugal in ICES Area X (ICES, 2007a). Other deep-sea species included in the catch are species such as alfonsino, forkbeard and black scabbardfish. While most of this fishery takes place within the EEZ surrounding the Azores islands, the fishing grounds of the largest vessels extend, to some extent, into international waters, both in the north (NEAFC Regulatory Area) and in the south (Central Eastern Atlantic).

Other seamounts in the high seas of the North East Atlantic

There are several seamounts located off the South European Atlantic Shelf (ICES Subareas VIIIe1 and IXb1). In its answer to the FAO Questionnaire, the United Kingdom mentioned the activity of one gillnetter in ICES Area VIIIe1. Fishing in this area is likely to be taking place on the seamounts present in that area (North Atalante, South Atalante, North Charcot, La Coruña and Armorican Seamounts – see Map 3) and may target species such as deep-sea sharks or deep-water red crabs.

Other seamounts are located further south in ICES Area IXb1, northeast of the Madeira EEZ, including Josephine, Horseshoe, Ampère, Erik and Teresa. No information about recent commercial fisheries in this area has been found for this review, but at least some exploratory fishing has been conducted in the past by Soviet and Portuguese vessels (Clark *et al*., 2007). This fishing ground overlaps the Eastern Central Atlantic (FAO Statistical Area 34), which is under the management of the Fishery Committee for the Eastern Central Atlantic (CECAF).

Elsewhere on both the east and west sections of the MAR, peaks are located at fishable depths, including Altair and Antialtair, which have been closed to bottom

[2] Response from Norway to FAO Questionnaire.

fisheries since 2005. Again, no information concerning fishing on these or other seamounts in recent years has been found.

The Banana Hole in the Norwegian Sea

The high seas area of the Norwegian Sea (ICES Subareas IIa1 and IIb1, known as the "Banana Hole") is not subject to bottom gear fisheries. The main pelagic species caught in this area are herring, blue whiting and mackerel. A pelagic beaked redfish fishery in the international waters of ICES Subarea IIa has developed in recent years, with catches ranging from 9 tonnes in 2002 to 27 000 tonnes in 2006 (ICES, 2007d). Canada mentioned the activity of one trawler targeting beaked redfish in 2006 (433.2 tonnes). In its response to the FAO Questionnaire, Norway reported the activity of two trawlers and one longliner in this area in 2006.

The slopes of the Vooring Plateau overlap the high seas, with depths greater than 1 300 m. It is unlikely that there is a bottom fishery in this area because of the low temperature at these depths. Maps based on NEAFC vessel monitoring system (VMS) data for the period 2003–2005 show some activity of trawlers in the area, but it can be presumed that they are pelagic trawlers.

The Loophole in the Barents Sea

A high seas area in the Barents Sea (ICES Subdivision Ia) is known as the "Loophole", a section of international waters surrounded by the Norwegian and Russian EEZs. For much of the year, the Loophole has significant quantities of ice and thus the season for possible fishing there is fairly short. Fisheries in the area are managed by a trilateral agreement between Norway, the Russian Federation and Iceland (Churchill, 1999).

Bottom trawl for Northeast Arctic cod

The main fishery in these relatively shallow waters (between 150 and 350 m in depth) is composed of bottom trawlers targeting Northeast Arctic cod. According to the Eurostat/ICES database, the main fishing nations participating in this fishery are Norway and the Russian Federation (ICES, 2007a). In its response to the FAO Questionnaire, Norway reported for 2006 the activity of two trawlers in the area, but insufficient information was available to estimate catch and effort in this specific high seas area.

In its answer to the FAO Questionnaire, the Russian Federation reported, for the 2003–2006 period, the activity of 12 to 19 trawlers and one to four longliners, depending on the year (see Table 7). These vessels fish both within the Russian EEZ and in international waters. Species such as blue ling, tusk, greater forkbeard and skate are reported as bycatch of fisheries in this region (Vinnichenko et al., 2005; Vinnichenko and Bokhanov, 2006; Vinnichenko, 2007).

TABLE 7
Russian Federation fleet fishing in the Barents Sea with bottom fishing gears

Year	Trawlers	Longliners
2006	14	3
2005	19	3
2004	12	1
2003	14	4

Catch and effort summary

Table 8 contains information on reported high seas catches of species taken in bottom fisheries in the Northeast Atlantic in 2006. The majority of the catch consists of deep-water species. NEAFC has compiled catch data for deep-sea fisheries (other than redfish and blue whiting which were included earlier statistics as well) in the Regulatory Area since 2004, the first year that high seas fisheries for most deep-sea species in the Northeast Atlantic were subject to regulation by NEAFC. The catch of all regulated deep-sea species combined was reported to be 26 503 tonnes in 2004, 73 447 tonnes in 2005 and 54 623 tonnes in 2006. Approximately 95 percent of the catch of deep-sea species in 2005 and 2006 was taken by European Community fleets. In

addition, NEAFC reports catches of 'non-regulated' (Non-RR) species on the high seas, several of which are caught using bottom gears. These consist primarily of shallower-water species such as Northeast Arctic cod (although this category does include small quantities of deeper water species such as spotted wolffish (*Anarhichas minor*). Finally, as indicated previously, the fishery for haddock in the NEAFC Regulatory Area is a bottom fishery and the catch has been included in Tables 8 and 9 even though haddock is not considered a deep-sea species. Conversely, while redfish (*Sebastes spp*) is generally considered a deep-sea species, the main fishery for redfish (beaked redfish) in the NEAFC Regulatory Area is consistently described as a pelagic mid-water fishery; thus the high seas catch figures for redfish have not been included in Tables 8 and 9.

TABLE 8
High seas bottom catch in the North East Atlantic, 2006

Species	EC	Faroe Islands	Greenland	Norway	Russian Federation	Total
Deep-sea RR (> 200 tonnes)*						
Baird's Smoothhead	299					299
Argentines	1 072			1		1 073
Blue Ling	2 109	143		376	21	2 649
Backbelly Rosefish	1 166			7		1 173
Black Scabbardfish	5 014	18				5 032
European Conger	9 461					9 461
Portuguese Dogfish	999					999
Longnose Velvet Dogfish	335					335
Greater Forkbeard	1 417			10		1 427
Greenland Halibut	6 432		1 913			8 345
Gulper Shark	238					238
Leafscalegulper Shark	1 223					1 223
Deep-Water Red Crab	461					461
Ling	9 361			271		9 632
Orange Roughy	587	89				676
Common Mora	208					208
Roundnose Grenadier	6 327					6 327
Red (Blackspot) Seabream	1 470					1 470
Silver Scabbard	516					516
Tusk	824			231	119	1 174
Wreckfish	935					935
Other Sharks**	308					308
OTHER DEEP-SEA RR (< 200 TONNES)***	584	3		67	8	662
Total Deep-Sea RR Species	**51 346**	**253**	**1 913**	**963**	**148**	**54 623**
Non-RR Species > 200 tonnes						
Atlantic Cod	1 651					1 652
Skates	1 016			13		1 029
OTHER NON-RR SPECIES (< 200 TONNES)****	89	26		1		116
Other						
Haddock	382			23	2 154	2 559
Total	54 484	279	1 913	1 000	2 302	59 978

* RR - Regulated species; non RR - Unregulated species
** Black Dogfish, Birdbeak Dogfish, Greenland Shark, Blondnose Six-Gilled Shark, Kitefin Shark, Blackmouth Dogfish, Knifetooth Dogfish
*** Alfonsinos, Rabbitfish (Rattail), Cardinal Fish, Forkbeard (Forkhead), Roughhead Grenadier, Round Skate, Small Redfish (Norw. Hadd.), Spiny (Deep-Sea) Scorpionfish
**** Wolfish, Atlantic Halibut, American Plaice, Northern Prawn
Source: NEAFC, 2006

TABLE 9
Summary of high seas bottom catch, 2004–2006

Country	2004	2005	2006
Deep Sea RR			
EC	25 157	69 883	51 346
Faroes	642	756	253
Greenland	0	0	1 913
Norway	648	620	963
Russia	56	2 188	148
Subtotal	**26 503**	**73 447**	**54 623**
Non RR			
EC		1 854	2 756
Faroes		215	26
Norway		28	14
Russian Federation		112	0
Subtotal		**2 209**	**2 796**
Haddock			
EC*	356	222	382
Faroes		3	
Norway	8	28	23
Russian Federation	5 844	4 708	2 154
Subtotal	**6 208**	**4 961**	**2 559**
Total	**32 711**	**80 617**	**59 978**

* Includes 164 tonnes caught by Poland in 2004
Sources: NEAFC 2004a; NEAFC 2005b; NEAFC 2006)

It is interesting to note that there are significant discrepancies in the reported catches in the North East Atlantic. An example is the reported catch of roundnose grenadier in recent years as shown in Table 10. This highlights the difficulty associated with data collection in high seas deep-sea fisheries.

Table 11 gives estimates of the number of vessels by fishery, based on the information presented in the previous section. These numbers should be used cautiously, since the same vessel may be involved in more than one fishery. Information on fishing time or days will be required to provide a better estimate of overall fishing effort.

Illegal, Unreported and Unregulated (IUU) fishing

Fisheries in the international waters of the North East Atlantic have been subject to IUU fishing. More than 100 000 tonnes of Northeast Arctic cod and 30 000–40 000 tonnes of haddock were estimated to be illegally fished in the Barents Sea in 2005 (Norwegian Directorate of Fisheries, 2006).

Other examples of IUU fishing include the beaked redfish fishery in the Irminger Sea. Studies carried out by the European Union Joint Research Centre in collaboration with NEAFC concluded that the fishing effort in this pelagic fishery could have been 25 percent higher during the observation days in June 2002 and 2003 than that reported to NEAFC (NEAFC, 2004b).

NEAFC now maintains a public list of vessels observed in the Regulatory Area engaging in IUU (NEAFC IUU B list). In 2007, port state control was introduced in the NEAFC Scheme of Control and Enforcement (NEAFC, 2007a). NEAFC reported (November 2007) that IUU fishing by non-contracting parties has been drastically reduced by the control of transshipment activities through the IUU A (observation) and B (confirmed IUU) lists, as well as the newly implemented port state controls (NEAFC, 2007d).

TABLE 10
Comparison of the reported catch of roundnose grenadier in the North East Atlantic

		Catch (tonnes) of roundnose grenadier: EU		
		2004	**2005**	**2006**
1	NEAFC –high seas catch only	18 038	25 024	6 327
2	ICES WGDEEP 2008 – estimated high seas catch		10 890	8 995
	High seas and some EEZ catch			
3	ICES: reported catch in Areas Vb; VIb; VIIc,j,k; VIIId,e; XIIa; IXb; X; XII; and XIVb (high seas and some EEZ combined)*	6 127	9 359	6 946
4	FAO Fishstat Area 27 – Reported catch by Estonia, France, Germany, Ireland, Lithuania, Poland, Spain (high seas and EEZ combined)**	9 058	10 230	8 741

* *Source:* ICES catch by species, area and year (1973-2007) Eurostat/ICES database on catch statistics - ICES 2007 Copenhagen. This includes all ICES Areas with a some portion in the high seas.
** Not including Denmark and Sweden – catch reported by both countries exclusively from the area (within EC waters) between the Baltic Sea and North Sea. No other EU country reported catches of roundnose grenadiers in the NE Atlantic. (FAO, 2008)

TABLE 11
Estimated number of vessels in recent years by fishery or fishing area

Fishery	Year	Estimated number of vessels
Hatton and Rockall Banks and surrounding fishing grounds		
Multispecies trawl fishery	2004–2006	45–57
Multispecies longline fishery	2004–2006	8–10
Bottom trawl fishery for haddock	/	/
Deep-sea gillnet and tangle-net fishery	2006	1 (banned since 2006)
Bottom trawl fishery for blue ling	/	/[1]
Mid-Atlantic Ridge		
Trawl fishery targeting roundnose grenadier	2004-2006	1
Trawl fishery targeting spawning aggregations of blue ling on the Reykjanes Ridge	/	1 (potential vessel)[2]
Loophole in the Barents Sea		
Bottom trawl for Northeast Arctic cod	2006	163
Bottom longline fishery	2006	3

/ = Unknown.
[1] There is no information concerning the number of Faroese vessels. French vessels involved in this fishery are probably at least some of the vessels already counted in the multispecies fishery.
[2] The Spanish trawler mentioned here is probably one of the trawlers fishing on Hatton Bank and may also be involved in the beaked redfish fishery in the NEAFC and NAFO Regulatory Areas.
[3] Two Norwegian and 14 Russian vessels.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

In the North East Atlantic, the geographic distribution of several deep-sea stocks overlaps the high seas and parts of the Icelandic, Faroese and European Union EEZs. The stocks are assessed by ICES, and the most recent fishery advice is summarized below.

In 2005, most exploited deep-sea species in the North East Atlantic were considered to be harvested unsustainably; however, it was not possible to provide advice for specific deep-sea species. Consistent with a precautionary approach, ICES recommended immediate reductions in established deep-sea fisheries unless they could be shown to be sustainable. New deep-sea fisheries or expansion of existing fisheries into new fishing areas should not be permitted unless the expansion is very cautious, and is accompanied by programmes to collect data that allow evaluation of stock status as the basis for determining sustainable exploitation (ICES, 2005b).

Stock assessments carried out in 2006 remained exploratory for most species. Advice based on the best available evidence was to reduce the 2007–2008 EU total allowable catch (TAC) compared with those in previous years or to stop fishing for most deep-sea species. In a few cases (e.g. black scabbardfish in ICES Subareas VIII and IX), the status quo was advised for stocks entirely or partly distributed in the high seas. TAC reductions were advised for roundnose grenadier (in ICES Divisions Vb, VI, VII and XIIb) and black scabbardfish (ICES Divisions V, VI, VII and XII).

Blue ling stocks in the North East Atlantic are considered to be depleted and ICES advises that catches should be reduced to the lowest possible level, primarily by stopping the directed fishery (ICES, 2006a).

Stocks of orange roughy in the North East Atlantic are considered to be small and ICES advice from 2006 states: "Orange roughy can only sustain very low rates of exploitation. Currently, it is not possible to manage a sustainable fishery for this species. Hence, ICES recommends no fishery for this species. Bycatch in mixed fisheries should be limited as far as possible" (ICES, 2006a). Limited orange roughy fisheries are currently allowed in areas other than ICES Subareas V, VI and VII but with a total catch of 150 tonnes for each contracting party and only in areas where

a "footprint" has already been established by a contracting party previous to 2005 (NEAFC, 2007c).

Deep-sea sharks, and particularly the two main commercial species in the North East Atlantic, Portuguese dogfish and leafscale gulper shark, are considered very sensitive to exploitation. The 2006 ICES advice is that no directed fisheries should be permitted unless there are reliable estimates of current exploitation rates and stock productivity. TACs should be set at zero for the entire distribution area of the stocks and additional measures taken to prevent bycatch of the Portuguese dogfish and leafscale gulper shark in fisheries targeting other species.

The status of alfonsino stocks (*Beryx* spp.) is unknown. In the high seas there are concerns about misreporting from the MAR areas (ICES, 2006b). For these species, a TAC of 316 tonnes is allowed for the whole North East Atlantic.

Finally, the status of the Rockall haddock (*Melanogrammus aeglefinus*) stock is uncertain, but stock size is considered to be low.

The lack of reporting on fishing activity increases the uncertainties in stock and exploitation status assessments, which are currently limited to the trend analysis of catch per unit effort (CPUE) and international landings declarations. The NEAFC management measures for 2007 concerning deep-sea fishing include the obligation for contracting parties to develop sampling plans for deep-sea species (including discards where necessary), and to communicate them via NEAFC to ICES, with a reviewing process. Recent estimates of the discard of juvenile roundnose grenadier are 30 percent by weight and 50 percent by number of the catch in the trawl fishery for roundnose grenadier (ICES 2008). Further uncertainty is created in the gillnet fisheries where the impact of lost and abandoned nets on species is unknown, but likely to have an impact on the status of affected stocks (Hareide *et al.*, 2006).

Status of bycatch stocks

Most deep-sea fisheries are multispecies. For example, about 70 deep-sea species have been recorded in catches of trawlers targeting roundnose grenadier. Very little is known about the status of bycatch stocks. Discard rates in these fisheries are recognized as high, but largely unreported. Many deep-sea species are considered to be vulnerable to injury, and survival rates of discards in these fisheries are very low and include a high mortality of immature fish.

In 2007, NEAFC requested ICES WGDEEP to coordinate the planning of dedicated deep-sea research surveys. The plan proposed by the Working Group (ICES, 2007b) covers an annual international survey along the European continental slope, from west of the United Kingdom to Portugal and a triennial international survey on the MAR.

Impacts on Vulnerable Marine Ecosystems (VMEs)

The ICES Working Group on Deep Water Ecology (WGDEC) provides scientific information in relation to the protection of VMEs in the North East Atlantic. Some national and international research programmes, including scientific surveys, have been conducted (Irish BIM surveys, MAR-ECO[3], HERMES[4], etc.). The ICES WGDEC has developed a database to inventory and georeference all these surveys (ICES, 2007c). Survey data and observations of commercial fishing operations are used to map the occurrence of cold-water coral reefs. These data have been used to define bottom fishing closures on Rockall and Hatton Banks (see Map 2). A set of seamounts has also been temporarily closed to bottom fishing in the international waters of the Reykjanes Ridge and on the Mid-Atlantic Ridge (see Map 3).

[3] The MAR-ECO Patterns and processes of the ecosystems of the northern mid-Atlantic project is part of the Census of Marine Life.

[4] Hotspot Ecosystem Research on the Margins of European Seas.

CONSERVATION AND MANAGEMENT MEASURES

The main measures in place for the management of deep-sea fisheries in the NEAFC Regulatory Area include the following.

- Limitations of fishing effort by fishing fleets targeting deep-sea resources have been recommended since 2004. These limitations are calculated as a percentage of the previous year's effort, and are revised each year.
- Interim area closures to bottom trawling and other static gears. Four seamounts of the Mid-Atlantic Ridge and a section of the Reykjanes Ridge are currently closed to protect vulnerable deep-sea habitats (Map 3). On Hatton and Rockall Banks, four areas were closed in 2007. For 2008, the boundaries of two of these areas were adjusted (Rockall and Hatton closures) and one additional area has been closed to bottom fishing (southwest Rockall closure) by NEAFC Recommendation IX: 2008 (Map 3).
- Prohibition of the use of gillnets, entangling nets and trammel nets at any position where the charted depth is greater than 200 m.
- Prohibition on directed orange roughy fisheries in ICES Subareas V, VI and VII.
- Prohibition of shark finning.

The NEAFC Scheme of Control and Enforcement (NEAFC, 2007a) describes all contracting parties' obligations regarding fishing vessels, catch and effort reporting, VMS, inspection at sea, port state controls, infringement procedures and measures to promote compliance by non-contracting party fishing vessels.

Contracting parties are requested to ensure that their fishing vessels communicate catch, effort and transshipment reports. Reporting is requested when entering the Regulatory Area, on a weekly basis during fishing trips inside the Regulatory Area, and when exiting the Regulatory Area. Contracting parties are also requested to report catch and effort data to ICES by semester. The European Union, a contracting party of NEAFC, has established a specific regulation (2347/2002) for deep-sea fisheries. This regulation establishes the requirement of a special fishing permit as well as reporting obligations (by semester). Deep-sea fisheries are identified by means of a list of target species. However, not all the deep-sea species listed in the NEAFC Scheme of Control and Enforcement are part of this list.

In addition, the primary management tool in the EU is a TAC. This management tool for deep-sea species was first introduced in 2003, and TACs have been revised every second year since then. Following ICES advice, TACs for 2005–2006 were set lower than for 2003–2004 and further reduced for 2007–2008. EU TACs apply to EU fleets operating in the EU and international waters and to non-EU vessels operating in EU waters.

Further management measures were discussed at an Extraordinary Meeting of the Commission of NEAFC (July 2008). The Commission adopted measures to monitor and regulate the impact of fisheries in its Regulatory Area. The new measures will require:

- all bottom fishing activity from the last 20 years to be mapped;
- fisheries to be regulated by exploratory protocols in areas where previous bottom fisheries activities did not take place;
- mapping of VMEs; and
- NEAFC contracting parties to have their vessels cease fishing when a VME is encountered in the course of fishing (NEAFC, 2008a).

NEAFC and the OSPAR Commission (for the protection of the marine environment of the North East Atlantic) have initiated the first efforts towards multisectoral management in the high seas. Joint management efforts between fisheries and conservation will be undertaken under a new memorandum of understanding which was adopted by the two organizations in 2008 (NEAFC, 2008b).

INFORMATION AND REPORTING GAPS

The low catch and effort data reporting for deep-sea fisheries in the high seas of the North East Atlantic is a major concern that has been recently outlined by the NEAFC performance review (NEAFC, 2007b).

ICES reporting areas were modified in 2005 in order to split data between the high seas and waters under national jurisdiction, and to avoid the aggregation of data related to different deep-sea fishing grounds (e.g. Hatton Bank and Reykjanes Ridge). A limited number of countries started to report to ICES WGDEEP using these new spatial reporting units in 2007. This issue is a real shortcoming in the analysis of high seas deep-sea fisheries in the region, particularly since no detailed catch and effort data are publicly available. Catch reporting by new ICES Areas might still be insufficient for the monitoring of deep-sea fisheries. For example, ICES Area VIb overlaps Hatton and Rockall Banks. Scientists have therefore recommended reporting by ICES statistical squares (1° latitude by ½° longitude).

Almost no fishing effort data are published. Measurement and reporting of fishing effort seem to be a major concern in the region. There is no requirement to record effort in EU logbooks. Although NEAFC has introduced effort reduction, every participating party measures effort in a different way. In 2007, to address this issue, NEAFC recommended that fishing effort be calculated as aggregate power, aggregate tonnage, fishing days at sea or number of participating vessels (NEAFC, 2008c).

Within the framework of the Coordinating Working Party on Fishery Statistics (CWP), under the STATLANT programme, ICES is collaborating with FAO and with RFMOs to compile annual catch statistics by flag of fishing country, species and ICES reporting area. FAO FishStat software is used for the management and dissemination of these catch statistics. The last reporting year of the current data set is 2006.

Tentative utilization of the VMS data managed by NEAFC for the spatial analysis of fishing effort and linkage to catch data has been performed by ICES Scientific Working Groups (WGDEEP in particular) in recent years. Initial results show that data quality of VMS has to be improved to be suitable for such analysis: lack of standardization in the data format, missing information (gear not always recorded) and low recording frequency (every two hours) make the separation of fishing and cruising time difficult.

SOURCES OF INFORMATION AND BIBLIOGRAPHY

In their reply to the FAO Questionnaire sent to states known as having a high seas deep-sea fishing fleet, seven countries (Canada, Estonia, Germany, France, the United Kingdom, Norway and Ukraine) officially replied with some information regarding deep-sea fishing in the high seas of the North East Atlantic. Iceland reported no activity in the high seas deep-sea fisheries in this area in recent years. The Spanish Department of Fisheries confirmed the information presented in this regional review.

The Directorate-General for Maritime Affairs and Fisheries of the European Commission (EC DG MARE) also provided some information on EU countries' deep-sea fishing fleets, but with no distinction between fishing activity in areas inside EEZ limits and on the high seas. Other sources of information have therefore also been considered: ICES Working Groups reports and working documents (e.g. Russian Federation reports to WGDEEP); the Eurostat/ICES database on catch statistics (1973–2006) (ICES, 2007a); and NEAFC public statistics (NEAFC catch statistics), which include some effort data for 2004, and catch by species and contracting party for the 2000–2006 period. Other useful information has been found in the reports of European Community working groups and projects. Some published syntheses of deep-sea fisheries in the North East Atlantic have also been considered. References to the main sources are listed at the end of this chapter.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Spain, United Kingdom (Scotland), France, Russian Federation, Norway, Faroe Islands (Denmark) and Ireland
Estimated total number of vessels	66–70
Total reported catch (tonnes)	59 978

Main fisheries			
Gear	**Target species**	**Fishing ground**	**Regional Area**
Bottom trawl	Roundnose grenadier, Baird's slickhead, black scabbardfish, leafscale gulper shark and Portugese dogfish	Slopes of the Hatton and Rockall Banks	ICES XIIb and VIb1
Longline	Deep-sea sharks, Greenland halibut, ling and tusk	Rockall Bank (200–600 m) and deeper waters	ICES XII and VI
Bottom trawl	Haddock	Rockall Bank (200–400 m)	ICES VIb1 (HS) and VIb2 (United Kingdom EEZ)
Bottom trawl	Blue ling	Rockall Bank and part of Lousy Bank	ICES VIb1 and Via (HS) ICES Vb and Via (EEZ)
Gillnet	Hake, monkfish, deep-sea sharks and deep-water red (or king) crabs	Within EEZ limits on the slopes of the European continental shelf and in the high seas on the slopes of Hatton and Rockall Banks	ICES XII and X
Bottom trawl	Orange roughy and black scabbardfish	Seamounts	ICES XII and X
Bottom trawl	Roundnose grenadier	Seamounts of the Mid-Atlantic Ridge	ICES XIVb1, XIIc and Xb
Bottom trawl	Blue ling spawning aggregations	Reykjanes Ridge	ICES XIV, etc.
Related fisheries			
Pot	Blue ling, black scabbardfish and roundnose grenadier	Inside Faroe Islands EEZ but also in international waters on the south slope of the Lousy Bank	ICES Vb
Mid-water trawl	Beaked redfish	Irminger Sea	ICES XIVb1 and XIIa1
Longline and handline	Multispecies: blackspot seabream	Seamounts	ICES X
Longline	Golden redfish, tusk and deep-sea sharks	Reykjanes Ridge and MAR	ICES XII and ICES VI

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MAP 1
High seas deep-sea fishing grounds in the North West Atlantic Ocean

North West Atlantic Ocean

FAO Statistical Area 21

GEOGRAPHIC DESCRIPTION OF THE REGION

The coastal states bordering the North West Atlantic (FAO Statistical Area 21) are Canada and the United States of America on the western side, and Greenland on the eastern side (see Map 1). South of Newfoundland, the archipelago of Saint-Pierre et Miquelon is under French jurisdiction. In the north, the area includes Baffin Bay, separated from the Arctic Ocean by the Ellesmere and Devon Islands. The southern limit between the North West Atlantic and the Western Central Atlantic (FAO Statistical Area 31) is the 35°N latitude. South of Greenland, the 42°W meridian separates the North West Atlantic from the North East Atlantic (FAO Statistical Area 27).

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

The Northwest Atlantic Fisheries Organization (NAFO) is the regional fisheries management organization (RFMO) with a management mandate in this area. It was created in 1979 to replace the International Commission for the Northwest Atlantic Fisheries (ICNAF), after the extension of coastal states' jurisdiction to 200 nautical miles. Its mandate extends to all fishery resources of the Convention Area (see Map 1), except for those managed by other RFMOs, e.g. salmon (North Atlantic Salmon Conservation Organization [NASCO]), tunas and marlins (International Commission for the Conservation of Atlantic Tunas [ICCAT]), whales (North Atlantic Marine Mammal Commission [NAMMCO] and sedentary species of the continental shelf, over which, under the 1982 UN Law of the Sea Convention, Canada has sovereign rights for the purpose of exploitation (Standing Senate Committee on Fisheries and Oceans, Canada, 2007). The NAFO Convention Area encompasses a very large portion of the North West Atlantic Ocean, including the exclusive economic zones (EEZs) of coastal states, but its management mandate applies only to the areas straddling and outside the EEZs in the NAFO Regulatory Area (NRA) (see Map 1).

The NAFO Convention states that its overall objective is to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources. In 2007, NAFO adopted a revised objective that widened its mandate to include a greater focus on managing with an ecosystem approach to fisheries. There are currently 12 members of NAFO: Canada, Cuba, Denmark (in respect of Faroe Islands and Greenland), the European Union, France (in respect of Saint-Pierre et Miquelon), Iceland, Japan, the Republic of Korea, Norway, the Russian Federation, Ukraine and the United States of America.

Management and conservation measures implemented by the Fisheries Commission of NAFO currently cover 11 species (Atlantic cod [*Gadus morhua*], Atlantic redfishes nei [*Sebastes* spp.], American plaice [*Hippoglossoides platessoides*], yellowtail flounder [*Limanda ferruginea*], witch flounder [*Glyptocephalus cynoglossus*], white hake [*Urophycis tenuis*], capelin [*Mallotus villosus*], skates [*Raja* spp.], Greenland halibut [*Reinhardtius hippoglossoides*], Northern shortfin squid [*Illex illecebrosus*] and Northern shrimp [*Pandalus borealis*]), and only apply to stocks of these species present in or straddling the NRA.

The NAFO Fisheries Commission establishes Conservation and Enforcement Measures (CEM) including management and control regulations, and a monitoring scheme, as well as inspection and surveillance measures. The NAFO Scientific Council is made up of scientists from member countries. It formulates the scientific advice based on the work performed in its four Standing Committees: STACFIS (Standing Committee on Fisheries Science), which carries out fish stock assessment; STACREC (Standing Committee on Research Coordination), which keeps track of and coordinates the various national research activities; STACPUB (Standing Committee on Publications), which is responsible for Scientific Council publications; and STACFEN (Standing Committee on Fisheries Environment), which provides information on the environment. A further standing committee conducts an annual review of compliance; the Standing Committee on International Control (STACTIC).

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Directed fisheries for deep-sea species were initiated after the Second World War, with the collapse of the traditional cod fishery and other groundfish fisheries on the shelf and continental slopes. A redfish fishery was developed by the former Union of Soviet Socialist Republics (USSR) on the southern part of the Grand Banks in the 1960s. In the late 1960s, a fishery for roundnose grenadier (*Coryphaenoides rupestris*) (most abundant between 600 and 800 metres [m]) was also developed by the former USSR. Landings rapidly peaked in 1971 at over 80 000 tonnes and then declined as quickly. Since 1980, landings have remained below 10 000 tonnes and in 1997 dropped to only a few hundred tonnes (Koslow *et al*., 2000).

A few large offshore Canadian vessels began fishing for Northern shrimp in the late 1970s to early 1980s. The greatly reduced biomass of cod, an important predator of Northern shrimp, is believed to have led to a large increase in Northern shrimp biomass in the mid-1990s and Northern shrimp catches increased substantially. The fishery for Northern shrimp on the Flemish Cap was initiated in 1993 by two Canadian vessels that were granted exploratory permits to fish the species in NAFO Division 3M. (Parsons *et al*., 1998)

A small Canadian fishery for Greenland halibut has existed at least since the 1970s. In 1991, European vessels began fishing for Greenland halibut in the NAFO Regulatory Area. These vessels had to leave the fishing grounds they were previously exploiting in the South East Atlantic because of the extension of Namibia's jurisdiction to 200 nautical miles in 1990.

Exploration of the Corner Rise Seamounts by trawlers from the former USSR began in 1976–1977. Catches in 1976 were more than 10 000 tonnes, composed of mainly splendid alfonsino (*Beryx splendens*), black scabbardfish (*Aphanopus carbo*) and wreckfish (*Polyprion americanus*). Catches declined in the following year to 800 tonnes. Commercial fishing resumed again ten years later in 1987 (one to four trawlers, 2 300 tonnes) and then ceased until the mid-1990s. Since then, fishing on these seamounts has been sporadic with limited catch. The total catch of the former USSR commercial and non-commercial fleet on the Corner Rise Seamounts between 1976 and 1996 has been estimated at 19 000 tonnes (Vinnichenko, 1997).

Current fisheries

Currently, the main deep-sea demersal fisheries take place on the continental slope of the Grand Banks in international waters – the so-called "nose" and "tail" of the Grand Banks – and on the Flemish Cap in depths ranging from 200 to 1 900 m. Some limited bottom fishing also occurs on seamount clusters in the high seas of the region.

The principal target species (see Figure 1) in the high seas bottom fisheries of the North West Atlantic are the Northern shrimp, Greenland halibut, Atlantic redfishes

nei and skates. Of these, the targeted skate fishery takes place primarily on the continental shelf on the tail of the Grand Banks, but skates have a wide depth range and often are caught as bycatch in deeper water fisheries. Atlantic cod and flat fishes such as witch flounder, American plaice, Atlantic halibut (*Hippoglossus hippoglossus*) and yellowtail flounder are bycatch species in the high seas bottom fisheries of the North West Atlantic. Yellowtail flounder is targeted by the Canadians and French (Saint-Pierre et Miquelon), but this fishery takes place in shallow waters under national jurisdictions in NAFO Divisions 3N and 3O, rarely deeper than 100 m.

Other species of commercial value taken in these deep-sea demersal fisheries include roundnose grenadier, roughhead grenadier (*Macrourus berglax*), wolffishes (*Anarhichas* spp.) and American angler (anglerfish) (*Lophius americanus*). In addition, there were sporadic targeted fisheries for splendid alfonsino on seamounts with bycatch of black cardinal fish (*Epigonus telescopus*), black scabbardfish and wreckfish, although the catch in these fisheries was small compared with the fisheries on the Grand Banks and the Flemish Cap. Northern shortfin squid (*Illex illecebrosus*) is considered to comprise a unit stock throughout its range in the North West Atlantic Ocean, from Newfoundland to Florida. It is mainly targeted inside the EEZ of the United States of America, but a small portion of the fishery takes place on the edge of the Grand Banks.

TABLE 1
Main commercial species landed by high seas deep-sea fisheries in the North West Atlantic

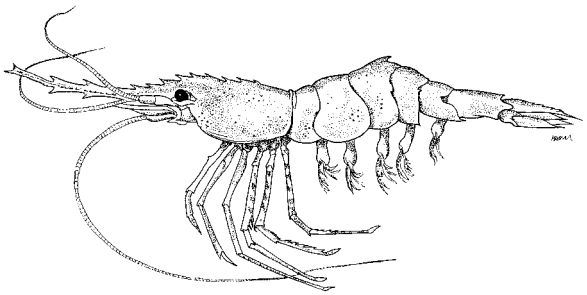
Common name	Scientific name
Main target species (Grand Banks and the Flemish Cap)	
Northern shrimp	*Pandalus borealis*
Greenland halibut	*Reinhardtius hippoglossoides*
Redfish	
Acadian redfish	*Sebastes fasciatus*
Beaked redfish (deep-sea redfish)	*Sebastes mentella*
Golden redfish	*Sebastes marinus*
Skates	*Raja* spp.
Starry ray (thorny skate)	*Raja radiata (Amblyraja radiata)*
Spinetail ray	*Bathyraja spinicauda*
Arctic skate	*Raja hyperborea*
Other species (Grand Banks and the Flemish Cap)	
Atlantic cod	*Gadus morhua*
Witch flounder	*Glyptocephalus cynoglossus*
American plaice	*Hippoglossoides platessoides*
Atlantic halibut	*Hippoglossus hippoglossus*
Yellowtail flounder	*Limanda ferruginea*
Roundnose grenadier	*Coryphaenoides rupestris*
Roughhead grenadier	*Macrourus berglax*
Wolffishes	*Anarhichas* spp.
American angler (anglerfish)	*Lophius americanus*
White hake	*Urophycis tenuis*
Northern shortfin squid	*Illex illecebrosus*
Typical seamounts species	
Splendid alfonsino	*Beryx splendens*
Wreckfish	*Polyprion americanus*
Black cardinal fish	*Epigonus telescopus*
Black scabbardfish	*Aphanopus carbo*

Table 1 lists the common and scientific names of the main species of commercial value taken in deep-sea fisheries in this region, either as targeted catch or bycatch. The table lists both true deep-sea species and those whose depth distribution extends into shallower waters. Beaked redfish (deep-sea redfish) (*Sebastes mentella*) and Acadian redfish (*Sebastes fasciatus*) have similar external characteristics, and are in general collectively reported as redfish (Ávila *et al.*, 2007). Wolffishes include Atlantic wolffish (*Anarhichas lupus*) and spotted wolffish (*Anarhichas minor*) (NAFO, 2007a). Skate species are mostly starry ray (thorny skate) (*Raja radiata*) and also to a lesser extent spinetail ray (*Bathyraja spinicauda*) and Arctic skate (*Raja hyperborea*) (González *et al.*, 2007).

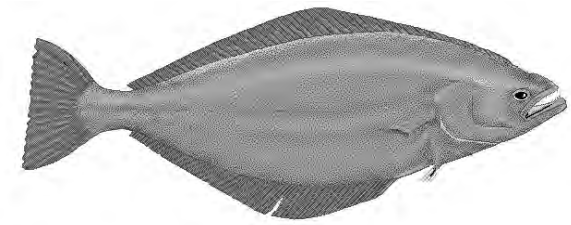
Countries known to have fleets currently participating in deep-sea fisheries in the high seas of the North West Atlantic are Canada, Estonia, Faroe Islands, Greenland,

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the North West Atlantic

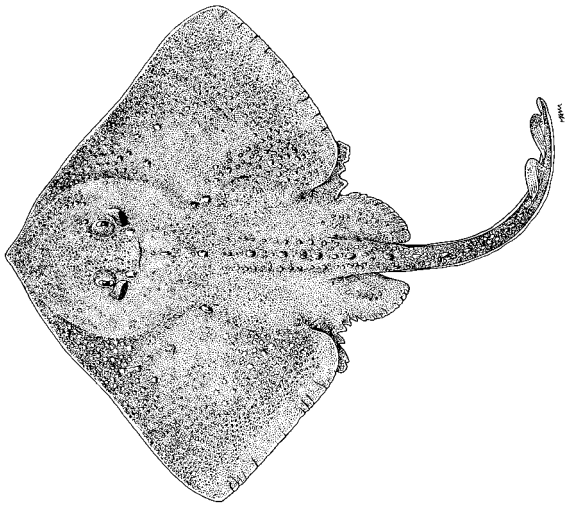
Northern shrimp (*Pandalus borealis*)



Greenland halibut (*Reinhardtius hippoglossoides*)



Starry ray (*Raja radiata*)



Source: FAO.

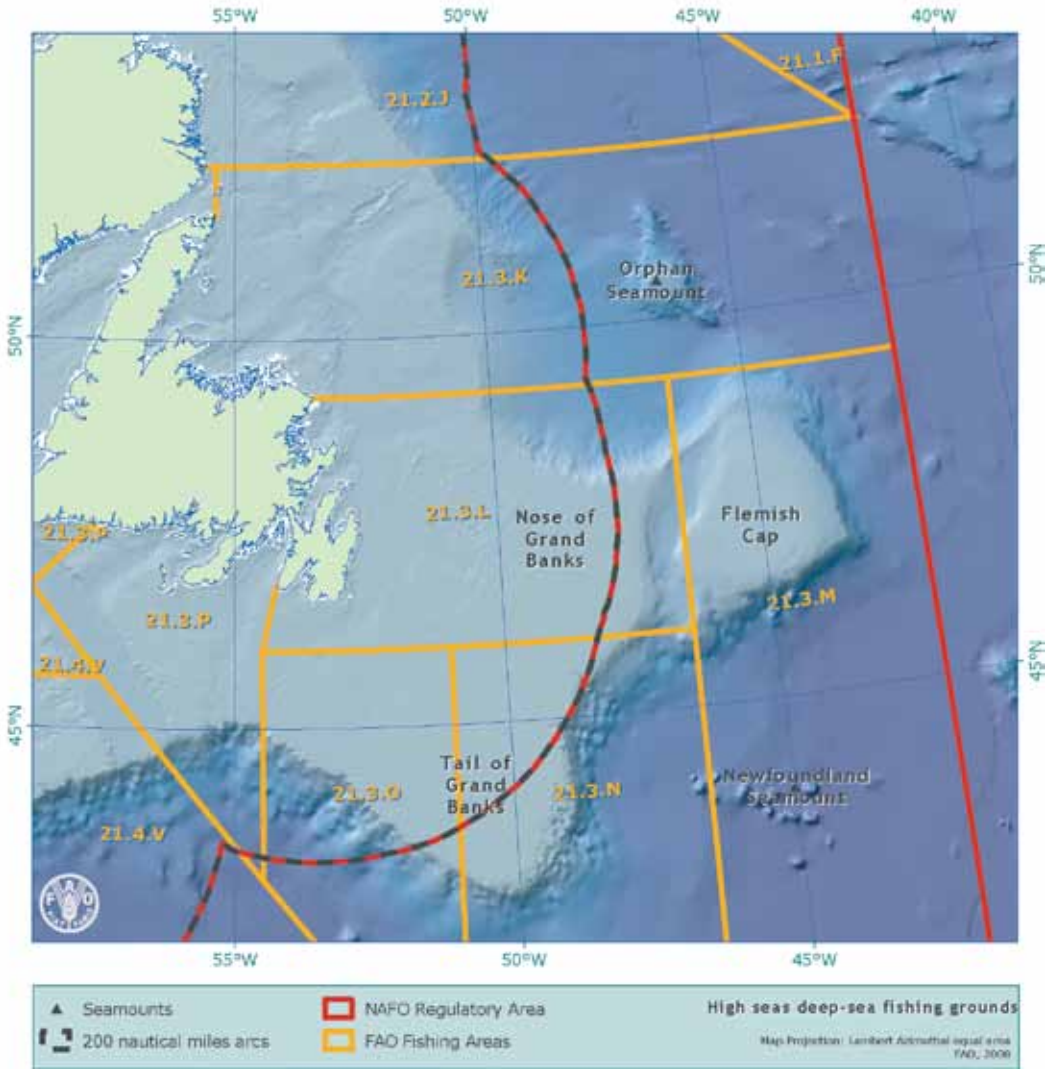
Iceland, Japan, Latvia, Lithuania, Norway, Poland, Portugal, the Russian Federation, Spain and Ukraine. The Russian Federation, Spain and Estonia take the majority of the catch. A brief description of fisheries targeting deep-sea demersal species in areas that are either straddling or lie exclusively in the high seas, is presented in the following sections by main fishing ground and NAFO subregion. Through the analysis of current management regimes, responses to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A) and consultations with NAFO, it is concluded for the purposes of this review that all non-Canadian catches after the beginning of the 1990s can be considered to have been taken exclusively in the high seas. Similarly all Canadian catches can be considered to have been taken within the Canadian EEZ, although a very small percentage may have been taken outside the Canadian EEZ.

Grand Banks of Newfoundland and the Flemish Cap

The main high seas fishing grounds for deep-sea demersal species in the North West Atlantic are on the slopes of the Grand Banks of Newfoundland in NAFO Divisions 3L, 3N and 3O and on those of the Flemish Cap in NAFO Division 3M (Map 2). Most of the Grand Banks is located inside the Canadian EEZ, but the northeastern and the southeastern parts, respectively known as the "nose" and the "tail" of the Grand Banks, are in international waters. The Flemish Cap is entirely in the high seas, about 120 nautical miles east of Canada's 200 miles limit.

Bottom trawl fishery targeting Northern shrimp (nose of the Grand Banks and the Flemish Cap; NAFO Divisions 3L and 3M)

The high seas shrimp fishing grounds are distributed around the Flemish Cap in NAFO Division 3M and on the slopes of the Grand Banks, mainly in Division 3L. The main part of the shrimp stock (between 75 and 80 percent) is exploited by Canadian vessels within the EEZ (Orr *et al.*, 2005). Fishing grounds are distributed between 150 and 600 m depth, although some fishing operations might be performed deeper down



MAP 2
Deep-sea fishing grounds of the Grand Banks and the Flemish Cap

to at least 900 millimetres (m) (Casas, 2007). Some of the larger vessels tow two trawls simultaneously (Parsons *et al*., 1998).

Bycatch consists of redfish and, to a lesser extent, species such as Greenland halibut, skates, wolffish, roundnose grenadier or hake. Gear requirements to reduce bycatch include a minimum mesh size of 40 mm and the use of sorting grids.

Since 1993, the number of vessels involved in the NRA shrimp fishery has ranged from 40 to 110, from as many as 19 nations (Skúladóttir, 2006). Both catch and effort have decreased markedly from 2004 to 2006 (see Table 2). Supplementary information from the fishery suggests that economic considerations (price of fuel and market prices for shrimp) may be affecting participation (NAFO, 2006).

Table 2 illustrates combined effort and total catch of all countries participating in the high seas fishery for Northern shrimp in both Divisions 3M and 3L. Canada's participation in the shrimp fishery is mostly inside Canada's EEZ. The data reported in Table 2 only refer to their participation on the high seas fishing ground. NAFO reported two days of fishing by two Canadian trawlers in 2006. In its answer to the FAO Questionnaire, Canada also reported the activity of one shrimp trawler in 2003 (27 fishing days, 132 tonnes). Greenland also has a sizeable Northern shrimp fishery taking place in areas under national jurisdiction. In recent years (2004–2006), Estonia has been the main flag state involved in the Northern shrimp fishery. The fisheries for Northern

TABLE 2
Reported catches of Northern shrimp in the high seas by country in NAFO Divisions 3M and 3L for the period 2004–2006

Flag state	Number of vessels[1]			Number of fishing days[1]			Total catch (tonnes)[2]					
Year	2004	2005	2006	2004	2005	2006	2004		2005		2006	
							3M	3L	3M	3L	3M	3L
Canada	0	0	1	0	0	2	0	0	0	0	10	0
Cuba	0	0	0	0	0	0	969		964	136	1 126	239
Estonia	9	7	4	1 740	1 511	638	13 444	144	12 009	281	5 651	485
Faroe Islands	6	6	4	680	535	260	4 952	1 050	2 457	1 055	1 150	1 809
France*	/	/	/	/	/	/	423	106	487	147	183	245
Greenland	1	1[3] – 2	2[3] – 4	7	24	73	0	294	10	302	793	451
Iceland	1	1	1	308	262	156	3 567	104	4 014	140	2 099	85
Latvia	4	2	1	580	320	177	3 059	143	2 112	144	1 330	244
Lithuania	3	2	1	662	384	172	4 802	144	3 652	216	1 246	486
Norway	7	2	1	999	31	34	11 738		223	74	461	245
Poland	1	1	1	75	41	36	1 158	144	458	129	224	245
Portugal	0	0	0	0	0	0	50	0	0	0	0	0
Russian Fed.	/	/	/	/	/	0	654	141	266	146	46	248
Spain	/	4	2 – 7[4]	/	450	138	1 134	140	1 384	154	877	251
Ukraine	1	0	1	49	0	90	315	145	0	0	282	121
United States of America	0	0	0	/	/	/	952	0	1 235	136	1 258	245
Total	33	26–27	19–26	5 100	3 558	1 776	47 217	2 555	29 271	3 060	16 736	5 399
							49 772		32 331		22 135	

* Saint-Pierre et Miquelon.
/ = Unknown.
Sources:
[1] Response from NAFO to FAO Questionnaire, except where otherwise noted.
[2] NAFO, 2008a.
[3] Siegstad, 2004; 2005.
[4] Casas, 2007.
Note: some countries fish under charter agreements/arrangements which explains some of the discrepancies between the lack of vessels fishing and reported catch.

shrimp in NAFO Divisions 3LNO and in Division 3M are managed separately. In 2006, the total allowable catch (TAC) was 22 000 tonnes with the Canadian 83 percent allocation to be fished within the Canadian EEZ and the remaining 17 percent of the TAC allocated to all other contracting parties to be fished in the NRA (NAFO, 2008c). In 2004, Denmark, in respect of Faroe Islands and Greenland, lodged a formal objection to the TACs for shrimp in NAFO Division 3L and set unilateral quotas of 1 344 tonnes of shrimp in NRA 3L in 2004 and 2005, and 2 274 tonnes for 2006. In NAFO Division 3M, a number of fishing days is allocated to each fishing nation. For the 2004–2006 period covered by this report, the United States of America, Cuba, the Russian Federation, France and Portugal had a quota for shrimp in the NAFO Regulatory Area. Catches have been reported by these countries, but no information concerning the number of vessels was found. Some charter arrangements might explain why these countries report catch but have no fishing vessels involved in this fishery. In the case of the United States of America, one Estonian vessel has been fishing the United States shrimp quota in recent years. According to the NAFO STATLANT 21A database[8] (hereinafter referred to as the STATLANT database), Japan reported catches in the high seas Northern shrimp fishery from 2000 to 2003 in Division 3M, but has since ceased its activities. Portugal also reported catches in this fishery in 2004 (50 tonnes). The catches of these two countries also correspond to charter arrangements.

[8] The NAFO STATLANT database contains information on annual catches by species, subareas, country and year.

TABLE 3
Number of bottom trawlers and number of fishing days in the high seas fishery by the main flag states for redfish and Greenland halibut by flag state for the period 2004–2006

Flag state	Number of vessels[1]			Number of fishing days[1]			Catch (tonnes) in 3MLNO	
							Greenland halibut (mainly 3L)	Redfish (mainly 3M and 3O)
Year	2004	2005	2006	2004	2005	2006	2006	
Russian Federation	8	5	6	951	571	476	1 531[2]	1 834[2]
Spain	32	27	23	6 196	3 832	2 842	5 859[2]	2 033[2]
Portugal	12	10	10	1 812	1 493	1 799	2 327[2]	7 802[2]
Japan	2	1	13	349	347	221	1 324[3]	419[3]
Estonia	2	2	2	462	415	328	278[3]	1 155[3]
Latvia	0	1	1	0	8	37	18[4]	250[4]
Lithuania	/	15	15	/	/	/	57[4]	397[4]
Total	56	47	44	9 770	6 666	5 703	11 394	13 890

/ = Unknown.
Sources:
[1] Response from NAFO to FAO Questionnaire, except where otherwise noted.
[2] Annual reports submitted to NAFO by respective country: Spain (González *et al.,* 2007; González *et al.,* 2006; González *et al.*, 2005); Russian Federation (Vaskov *et al.,* 2007; Vaskov *et al.*, 2006; Vaskov *et al.,* 2005); Portugal (Vargas *et al*., 2007; Vargas *et al.,* 2006; Vargas *et al.,* 2005).
[3] Returned questionnaires to FAO by respective country.
[4] NAFO, 2007b.
[5] Information provided by Lithuanian expert.

A recent assessment of fishing effort in the NRA has been performed by the NAFO Secretariat (Campanis, 2007). This study, based on the analysis of vessel monitoring systems (VMS) data, confirms that 98 percent of the time spent fishing for shrimp in the high seas was in NAFO Divisions 3M and 3L (respectively 62 and 36 percent).

Greenland halibut and redfish bottom trawl fishery (off the Grand Banks and the Flemish Cap; NAFO Divisions 3M, 3L, 3N and 3O)

This fishery targets Greenland halibut or redfish (mainly *Sebastes fasciatus*). The directed deep-sea bottom fishery for Greenland halibut commenced in 1990, whereas the bottom fishery for redfish has been a target of commercial interest for over 40 years in this region (NAFO, 2007a). Vessels engaged in this fishery switch depth and target species with the season, sometimes fishing for skate as well (see following section). The fishery for redfish is mainly conducted in Divisions 3M and 3O. Since 1998, no directed fishery for redfish has been authorized in 3L and 3N. Greenland halibut is mainly fished in Divisions 3M and 3L. The redfish fishery is conducted at shallower depths (150–800 m) than the Greenland halibut fishery (600–1 900 m), but the gear type remains roughly the same (e.g. 135-mm bottom trawls) (Power, 2005; NAFO, 2007a).

The catch composition varies with the target species, but both species are important bycatch when the other is the target (González *et al*., 2007; Vargas *et al*., 2007; Vaskov *et al.*, 2007). Roundnose and roughhead grenadier are important bycatch in the Greenland halibut fishery but are almost completely absent from fisheries for redfish in shallower depths. Other common bycatch species are American plaice, skates, witch flounder, Atlantic halibut, anglerfishes and wolffishes.

This fishery is conducted by Spain, Portugal and the Russian Federation and, to a lesser degree, Canada, Japan, Estonia, Latvia and Lithuania. Table 3 illustrates the number of vessels and effort by countries that are participating in the fishery. Spain and Portugal have, by far, submitted the most comprehensive information on fishing activity to NAFO in the form of annual reports, although the table is a compilation of information from various sources. When national reports to NAFO were used, effort was sometimes estimated because of the different reporting units used by country and/

TABLE 4
Directed skate fishery on the tail of the Grand Banks (catch and effort) for the period 2004–2006

Flag state	Number of vessels			Number of fishing days			Catch (tonnes) of skate		
	2004	2005	2006	2004	2005	2006	2004	2005	2006
Russian Federation	2[2]	2[2]	No direct fishery for skate[2]	110[2]	3[2]	0	2 835 in 3N[2] 3 415 in 3LMNO[2]	70 in 3N[2] 79 in 3LMNO[2]	0
Spain	/	/	/	247[2]	389[2]	302[2]	5 117 in 3N 6 340 in 3LMNO[2]	2 985 in 3N 3 788 in 3LMNO[2]	3 353 in 3N 3 870 in 3LMNO[2]
Portugal	/	/	/	/	/	/	967 in 3N 1 542 in 3LMNO[2]	444 in N 575 in 3LMNO[2]	535 in 3N 1 003 in 3LMNO[2]
Estonia	/	2[3, 6]	2[3, 6]	/	/	/	680[1]	424[1]	175 in 3N[3]
Lithuania	/	1[4, 6]	1[4, 6]	/	/	/	/	48 in 3LMNO[5]	135 in 3LMNO[5]
Total (3LMNO)	2	5	3	357	392	302	11 977	4 914	5 183

/ = Unknown.
Sources:
1 The STATLANT database.
2 Annual reports submitted to NAFO by respective country: Spain (González *et al.*, 2007; González *et al.*, 2006; González *et al.*, 2005); Russian Federation (Vaskov *et al.*, 2007; Vaskov *et al.*, 2006; Vaskov *et al.*, 2005); Portugal (Vargas *et al.*, 2007; Vargas *et al.*, 2006; Vargas *et al.*, 2005).
3 Returned questionnaires to FAO by respective country.
4 Information provided by Lithuanian expert.
5 NAFO, 2007b.
6 These vessels are likely to be the same vessels listed in Table 3.

or by year. For example, the data below on fishing effort for the Spanish fleet have been converted to days fished from reported hours fished based on the information provided in the annual reports to the NAFO Scientific Council. Canada is not included in Table 3 because the catch was reported from within the EEZ. For 2006, catch of both target species in 3L, 3M, 3N and 3O has been included to highlight their relative importance.

Bottom trawl fishery targeting starry ray (tail of the Grand Banks; NAFO Division 3N)
A small percentage of the total effort of the vessels involved in the redfish and Greenland halibut fishery is directed towards skates on the tail of the Grand Banks. The target species is starry ray and the most common bycatch is American plaice. The main participants in this fishery are Canada, Spain, Portugal and the Russian Federation (NAFO, 2008b). In its answer to the FAO Questionnaire, Estonia also reported some activity in the fishery. The Lithuanian bottom trawler fishing for Greenland halibut and redfish on the Grand Banks has also been involved in the fishery during the period covered by this review (48 tonnes in 2005 and 135 tonnes in 2006) (NAFO, 2007b). Mesh size of the trawls is changed from 135 to 280 mm when fishing for skates (González *et al.*, 2006; Vargas *et al.*, 2007; Vaskov *et al.*, 2006). Catch and fishing effort developed by flag states of vessels involved in the fishery during the period 2004–2006 are presented in Table 4.

Seamount areas

In addition, there are a number of seamounts in the high seas of the North West Atlantic, grouped by NAFO in four major areas or groups (Map 3): Orphan Knoll (in Division 3K), Newfoundland Seamounts (in Division 3N and 3M), New England Seamounts (in Division 6E and 6F) and the Corner Rise Seamount complex (in Divisions 6G and 6H). These are made up of a total of 43 seamount peaks, and most of the area lies in waters deeper than 1 800 m. Fishing has occurred on some of the seamounts in the Corner Rise complex and New England Seamount areas, particularly in the shallowest seamounts in the Corner Rise, but there is no evidence of demersal fishing in the other

TABLE 5
Spanish trawl experimental survey in the North West Atlantic – catch and effort, 2004

	NAFO Div. 4Vs, 4W, 4X	New England Seamounts (NAFO Div. 6E, 6F)	Corner Seamounts (NAFO Div. 6G, 6H)	South NAFO (FAO Statistical Area 31)
		Pelagic trawl		
Fishing effort (hours)	83.4 hours	115.1 hours	102 hours	48 hours
		Catch (kg)		
Splendid alfonsino	0.2 kg	2.2 kg	2 476.3 kg	2.9 kg
Lanternfishes	3.7 kg	46.1 kg	300.0 kg	118.0 kg
Deep-sea hooked squid		60.0 kg	255.0 kg	145.0 kg
Total	**3.9 kg**	**108.3 kg**	**3 031.3 kg**	**265.9 kg**
		Bottom trawl		
Fishing effort (hours)		5.25 hours	104.25 hours	
		Catch (kg)		
Splendid alfonsino			414 811 kg	
Black cardinal fish			12 338 kg	
Black scabbardfish			9 273 kg	
Total			**436 422 kg**	

Source: Durán Muñoz *et al.,* 2005.

TABLE 6
Spanish fleet fishing effort and catches in the Corner Rise complex, from 2005 to March 2007

		Year		
		2005	**2006**	**2007**
Fishing effort	Total hauls	90	22	13
	Total hours	160	43	38
Catch (kg)	Splendid alfonsino	1 125	63.7	52.1
	Wreckfish	24.7		
	Black scabbardfish	9.3	81	
	Other species	22.3	3.9	2
	Total catch	**1 181.3**	**148.6**	**54.1**

Source: González-Costas and Lorenzo, 2007.

two areas – Orphan Knoll and Newfoundland Seamounts (Kulka *et al.*, 2007). The Newfoundland seamounts have no peaks shallower than 2 500 m.

Deep-sea species fishery on seamounts

As already mentioned in the section on History of fisheries, fishing for deep-sea species on the seamounts of the NAFO Regulatory Area was initiated in the 1970s by research vessels from the former USSR. It was followed by commercial exploitation by a Russian fleet until 1996. In 2000, a United States of America research vessel made 20 trawl hauls on and over Bear Seamount, which is part of the New England Seamounts complex (in NAFO Divisions 6E and 6F) (Kulka *et al.*, 2007).

In 2004, a Spanish trawler conducted an experimental fishing survey, using pelagic and bottom trawls (Durán Muñoz *et al.*, 2005). The area of the survey included seamounts of the New England and Corner Rise regions, as well as adjacent areas in NAFO Divisions 4VWX and in the Western Central Atlantic (FAO Statistical Area 31). The catch of the main species and the effort data from this survey are summarized in Table 5. Splendid alfonsino was the main species caught by bottom trawls.

Since 2004, four Spanish vessels have been fishing with pelagic trawl gear in the Corner Rise Seamounts area. Fishing effort and catches by species have been reported to the NAFO Scientific Council by seamount (González-Costas and Lorenzo, 2007). Over the 2005–2007 period, the three main species in the landing composition were splendid alfonsino, black scabbardfish and wreckfish. A summary is presented in Table 6.

Kulka *et al.* (2007) mentioned additional fishing activity in the region by a Canadian trawler in 2005 (three fishing trips). On-board observers sighted other vessels fishing in the area, including one Russian vessel.

In its reply to the FAO Questionnaire, Estonia also reported the activity of one trawler in Division 6G in 2006 (six fishing days, for a total catch of 2.82 tonnes). The catch consisted of 1 186 kg of alfonsino, 1 162 kg of black scabbardfish, 168 kg of black cardinal fish, and 312 kg of Mediterranean slimehead.

Some of the seamounts in the Corner Rise complex are outside the NAFO Regulatory Area and instead are located within the area covered by the Western Central Atlantic Fishery Commission (WECAFC). This has been addressed at the 2007 meeting of the NAFO Scientific Council and it was agreed that efforts will be made to contact WECAFC and explore possibilities of protecting these seamounts (NAFO, 2007a). Although fished by the former USSR in the 1970s, in recent years fishing on these seamounts has been sporadic, with limited catch (Clark *et al.*, 2007).

NAFO regulations have prohibited the use of bottom gear on the four seamounts areas (Map 3) of the NRA since 1 January 2007: Orphan Knoll, and the Newfoundland, New England and Corner Rise Seamounts (see section on Conservation and management measures). The NAFO Secretariat (Thompson and Campanis, 2007) presented at the 2007 NAFO Scientific Council Meeting a study of fishing activity on and around these four seamounts areas. The results confirm that the Corner Rise Seamounts have been regularly fished in recent years, with an estimate of 20 days per year. Sporadic fishing (two to three days per year) has been observed on the New England Seamounts, few exploratory tows on the Newfoundland Seamounts, and no evidence of fishing on the Orphan Knoll.

Other related fisheries

Longline multispecies fishery (off the Grand Banks and the Flemish Cap; NAFO Divisions 3M, 3N, 3L and 3O)

In its response to the FAO Questionnaire, Canada reported a small multispecies longline fishery (one to three vessels), targeting deep-sea species such as Greenland halibut, Atlantic halibut and redfish, which operates in part on the high seas (see Table 8). This fishery is conducted over a wide bathymetric range (50–1 500 m), and also targets shallower water species such as white hake, yellowtail flounder and skates (see Table 7).

TABLE 7
Canadian longline fleet in NAFO Divisions 3N, 3L and 3O – depth range by target species

Species	Depth range (m)
Atlantic halibut	300–700
Greenland halibut	700–1 500
Redfish	300–700
White hake	50–200
Skate	50–200
Yellowtail flounder	60–100

Source: response from Canada to FAO Questionnaire.

TABLE 8
Canadian longline fleet in NAFO Divisions 3N, 3L and 3O – catch and effort data, 2004–2006

Year	Number of vessels	Number of fishing days	Total catch (tonnes)
2003	1	3	20
2004	3	34	120
2005	3	21	80
2006	0	0	0

Source: response from Canada to FAO Questionnaire.

Snow crab pot fishery

A directed fishery for queen crab (snow crab) (*Chionoecetes opilio*) is conducted by Canada in NAFO Divisions 2J, 3K, 3L, 3N and 3O, with a total catch of 49 400 tonnes reported in 2006 (Wells *et al.*, 2007). This species is considered sedentary by Canada and as such is managed solely by Canada (Fisheries Resource Conservation Council [FRCC], Canada, 2005). A portion of this fishery takes place on the high seas, but Canada has not created special reporting requirements based on catches taken either inside or outside its EEZ. Other countries have not reported catch of snow crab in recent years. One vessel fishing with crab pots on the high seas in the Corner Rise Seamounts complex has been mentioned in a document presented at the 2007 NAFO Scientific Council Meeting (Kulka *et al.*, 2007).

TABLE 9A
Number of vessels and fishing days of the main bottom fisheries in the NRA, 2004–2006 Regulatory Area

	Number of vessels			Number of fishing days		
	2004	2005	2006	2004	2005	2006
Northern shrimp (3M and 3L)	33	27	21	5 100	3 558	1 776
Redfish (3M and 3O)/Greenland halibut	56	47	44	9 770	6 666	5 703
Skates (3LNO)	2	5	3	357	392	302

Note:
– The numbers listed in this table only includes information from the main flag states in the major areas of each fishery and may include vessels that are fishing in more than one fishery.
– The numbers of vessels in each fishery do not equal the total number of vessels as shown in Table 9B because updated data broken down by country are not yet available and the information for each fishery is intended to give an overview of the involvement of each fishing nation.

TABLE 9B
Overall number of vessels and fishing days in the main fisheries in the NRA, 2004–2006

	Number of vessels			Number of fishing days		
	2004	2005	2006	2004	2005	2006
Northern shrimp	33	27	21	5 100	3 558	1 776
Groundfish	63	50	45	9 966	6 948	5 908
Pelagic Fishery						
Redfish (*Sebastes mentella*)	48	53	42	1 414	1 784	979

Source: NAFO Secretariat

TABLE 9C
Reported catch of the main deep-sea target species in the NAFO Regulatory Area

	Catch of main target species (tonnes)		
	2004	2005	2006
Northern shrimp (3M and 3L)	49 772	32 331	22 135
Redfish (3M and 3O)	6 973	12 826	13 774
Skates (3LNO)	11 476	2 853	5 255
Greenland halibut (3LMNO)	11 125	11 141	11 334
Total	**79 346**	**59 151**	**52 498**

Source: NAFO, 2008d.
Notes:
– All numbers have been taken from the above-mentioned source (except for Northern shrimp) for the sake of an appropriate time series and consistency. However, the total catch for each fishery presented in the tables of this document generally correspond to the numbers presented here.
– Minor catches are not included and therefore these numbers represent only the major part of each fishery.
– Catch by Canada is excluded from these numbers as the majority of its catch is from within its EEZ.

Trawl fishery targeting redfish (NAFO Divisions 1F and 2J)

Although this fishery is conducted with pelagic gear, the redfish species targeted (*Sebastes mentella*) is considered to be a deep-sea species. Bycatch in this fishery is minimal (Paramonov, 2007). Fishing takes place both inside and outside the EEZ of Greenland and outside the EEZ of Canada with a total catch of some 20 000 to 30 000 tonnes over the past few years. It is unknown how much of this is taken on the high seas. This species is also fished in adjacent areas in the North East Atlantic (Greenland EEZ and ICES Areas XII and XIV). Several nations are involved in this fishery, including the Russian Federation, Iceland, Lithuania, Germany, Poland, Latvia, Portugal, Faroe Islands and Spain.

Catch and effort summary

Catch and fishing effort of the four main deep-sea species targeted in the high seas of the NAFO Regulatory Area during the period 2004–2006 are presented in Tables 9A,

9B and 9C. Table 10 gives an overview of other species caught in bottom fisheries in the NAFO Regulatory Area in 2006.

Illegal, Unreported and Unregulated (IUU) fishing

NAFO maintains a list of vessels recognized as having participated in IUU fishing in the NAFO Regulatory Area. This list, available on the NAFO Web site, currently includes 19 vessels (accessed on 11 June 2008). NAFO collaborates with other RFMOs such as the North East Atlantic Fisheries Commission (NEAFC), the South East Atlantic Fisheries Organisation (SEAFO) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in order to share IUU information.

TABLE 10
Other species caught in bottom fisheries in the NAFO Regulatory Area (2006)

Species	Catch (tonnes)
Roundnose grenadier[a]	1139
American plaice[b]	882
Roughhead grenadier[a]	524
Yellowtail flounder[b]	410
Cod[b]	393
White hake[b]	251
Witch flounder[b]	158
Wolffish[a]	105
Northern shortfin squid[b]	75
Atlantic halibut[a]	53
American angler[a]	35
Total	**4 025**

Sources:
[a] FAO, 2008.
[b] NAFO, 2008d.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

In 2006, the NAFO Scientific Council adopted the Fisheries Reporting Monitoring System (FIRMS) classification to describe the status of stocks. The current classification of NAFO stocks is presented in Table 11. Target stocks of the fisheries presented in the previous section are given in bold. The status of the stock is described by letters defined below the table.

TABLE 11
Updated classification of NAFO stocks

	NAFO stock classification	
Stock	**Stock abundance status**	**Exploitation rate status**
American plaice Div. 3LNO	D	3
American plaice Div. 3M	D	1
Capelin Div. 3NO	E	0
Atlantic cod Div. 3M	D	1
Atlantic cod Div. 3NO	D	3
Thorny skate (starry ray) Div. 3LNO	**C**	**0**
Greenland halibut SA 0+1 offshore+1B-F	E	0
Greenland halibut Div. 1A inshore	E	0
Greenland halibut SA 2 + Div. 3KLMNO	**D**	**3**
Redfish Div. 3O	**E**	**0**
Redfish Div. 3LN	**B**	**1**
Redfish Div. 3M	**A**	**1**
Redfish SA1	D	0
Roughhead grenadier SA 2+3	E	0
Roundnose grenadier SA 0+1	D	0
Roundnose grenadier SA 2+3	E	0
Northern shortfin squid SA 3+4	C	1
Witch flounder Div. 2J+3KL	E	0
Witch flounder Div. 3NO	D	0
Yellowtail flounder Div. 3LNO	A	2
White hake Div. 3NO	D	0
Northern shrimp Div. 3LNO*	**A**	**1**
Northern shrimp SA 0+1*	**A**	**2**
Northern shrimp 3M*	**A**	**0**
Northern shrimp in Denmark Strait*	E	1

* Status not updated.
A = virgin or high abundance; B = intermediate abundance; C = low abundance; D = depleted; E = uncertain, not assessed.
1 = no or low fishing mortality; 2 = moderate fishing mortality; 3 = high fishing mortality; 0 = not assessed.
Source: NAFO, 2007a.

Status of target stocks

Greenland halibut stock is at a low biomass and is under a recovery plan. The latest stock assessments conclude that, despite the current management measures, the exploitable biomass estimates are declining and are at their lowest level. Catches exceed TACs and consist mainly of juvenile immature fishes. (NAFO, 2008b)

Starry ray has been under quota regulation since 2004. TACs during 2005–2007 were set to 14 500 tonnes. During that period, the average annual catch has been 5 580 tonnes. Biomass estimates have increased in recent years, but are much lower compared with the mid-1980s. The NAFO Scientific Council is recommending that TACs for 2009 and 2010 should not exceed 6 500 tonnes. (NAFO, 2008b)

Estimates of Northern shrimp stocks on the Flemish Cap and Grand Banks indicate high abundance in

recent years. The annual quota was increased between 2005 and 2006 from 13 000 to 22 000 tonnes, with 83 percent of the quota allocated to the Canadian fleet within their EEZ.

The abundance of redfish in NAFO Area 3O is considered unknown. This stock has been under TAC regulation since 2004, when an annual quota of 20 000 tonnes was adopted for the period 2005–2007. The same quota has been set for 2008 (NAFO, 2008b). In NAFO Divisions 3M and 3LN, the redfish stock abundance has been assessed as "high" and "intermediate", respectively. No directed fishery for redfish is authorized in NAFO Divisions 3NL. In Division 3M, the quota for redfish in 2006 and 2007 was 5 000 tonnes, and has been increased to 8 000 tonnes for 2008. (NAFO, 2008c)

Status of bycatch stocks

Stocks such as Atlantic cod and witch flounder in NAFO Divisions 3N and 3O (southwestern slopes of the Banks), or American plaice in 3M (Flemish Cap) are considered to be depleted, and are no longer subject to directed fishing (see section on Conservation and management measures).

Impacts on Vulnerable Marine Ecosystems (VMEs)

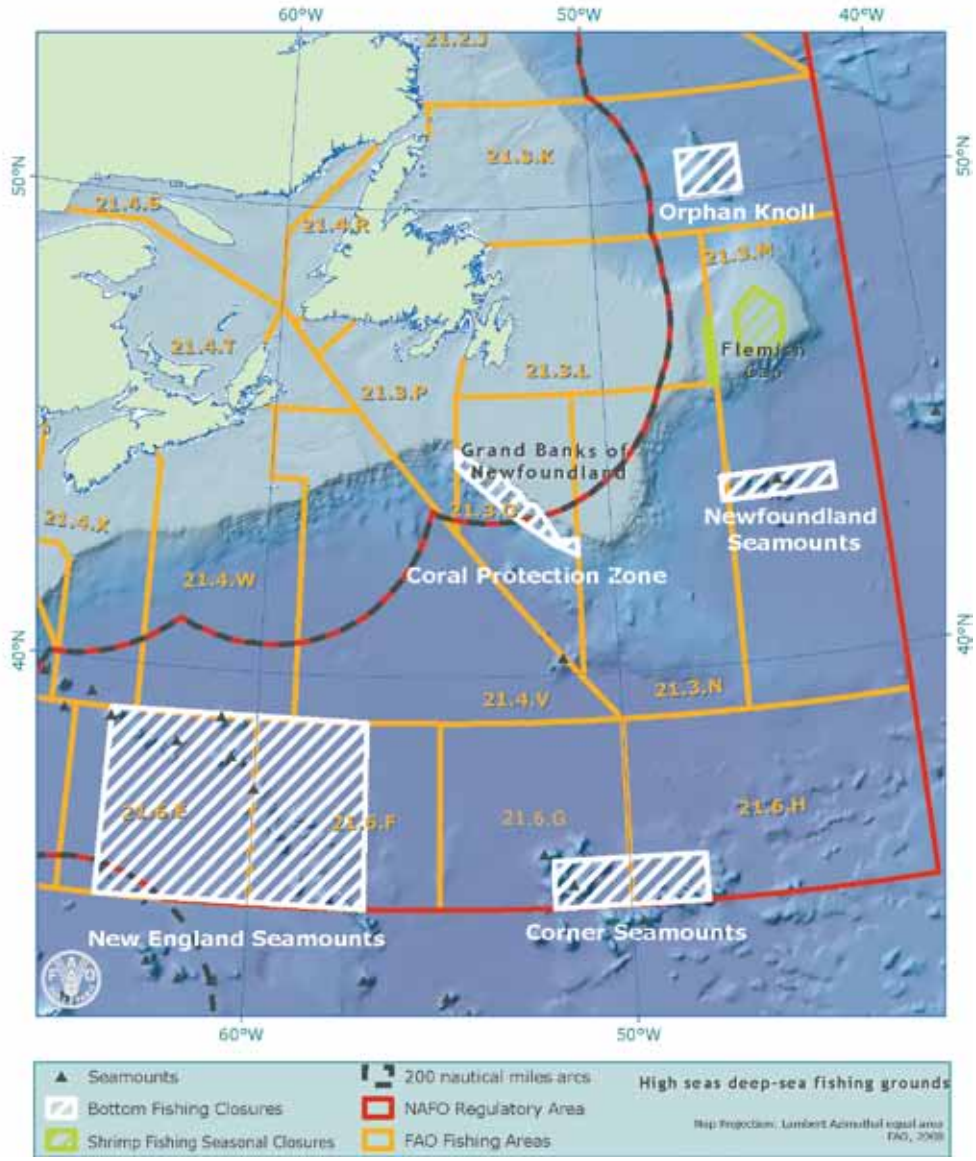
Deep-sea corals, sponges and vulnerable fish species are known to be present in the NAFO Regulatory Area. In 2005, a scientific study on deep-sea corals of the North Atlantic was conducted on two seamounts of the Corner Rise complex using a remotely operated vehicle (ROV). Evidence of impact of bottom fishing was observed, including scar marks, broken corals and crusts, displaced boulders, metallic waste or absence of sessile fauna present on other peaks in the same area (Waller *et al.*, 2007). Preliminary results of the NAFO Scientific Council and associated working groups (WGEAFM[9], WGDEC[10]) in identifying ecosystems vulnerable to deep-sea fishing are presented in the report of the June 2008 Scientific Council Meeting (NAFO, 2008b). A first list of species (including benthic taxa and fish species) sensitive and likely vulnerable to deep-sea fisheries has been established. Candidate VME sites have been identified within the NAFO Regulatory Area, including the four seamounts areas and the coral protected area for which measures have already been adopted by NAFO in 2006 and 2007 (see following section).

CONSERVATION AND MANAGEMENT MEASURES

The main management measures for deep-sea fisheries in the NAFO Regulatory Area include the following (NAFO, 2008c).

- TACs are set for all stocks under NAFO's jurisdiction and allocated to countries. These TACs are reviewed on an annual basis.
- Minimum authorized mesh sizes to be used in the NRA are as follows:
  a) 40 mm for shrimps and prawns;
  b) 60 mm for shortfin squid (*Illex*);
  c) 280 mm in the codend and 220 mm in all other parts of the trawl for skate;
  d) 130 mm for groundfish;
  e) 100 mm for pelagic *Sebastes mentella* in Subarea 2 and Divisions 1F and 3K; and
  f) 90 mm for redfish in the fishery using mid-water trawls in Division 3O.
- The shrimp fishery is managed separately in NAFO Divisions 3M and 3L. In addition to TACs, fishing effort limits are set by the contracting party in Division 3M. Time and spatial restrictions are applied in both management units. Fishing

[9] NAFO Working Group on Ecosystem Approach to Fisheries Management.
[10] ICES/NAFO Working Group on Deep-Water Ecology.



MAP 3
NAFO seamount closures, including the "Coral Protection Zone" adopted in 2007

for shrimp is prohibited from June to December in 3M and from April to June in 3L, and there are two closed areas for shrimp on the Flemish Cap (Division 3M) during certain times of the year (Map 3). In Division 3L, shrimp fishing is prohibited at depths below 200 m and limited at any one time to one vessel per flag state. Finally, the use of a sorting grid to reduce bycatch of fish is mandatory for all fleets in the 3LMNO fisheries for shrimp.

- Greenland halibut is currently under a 15-year rebuilding plan that contracting parties are obliged to uphold. The objective of this programme is to reach an exploitable biomass (age five and older) of 140 000 tonnes which should allow more stable yield over the long term. The TAC from 2008 onwards may be adjusted by Scientific Council advice, but by no more than 15 percent less or greater than the TAC of the preceding year. Within Canadian waters the

minimum fish size for Greenland halibut is 45 cm, whereas the minimum fish size in the NRA is 30 cm. In 2008, NAFO further tightened the monitoring scheme for these fisheries (NAFO, 2008c, Article 8).

Over the past three years, NAFO has started to take precautionary measures in order to protect VMEs from the adverse impact of bottom fisheries in the NRA. In 2006, NAFO members agreed to protect four seamount areas from high seas bottom trawling for a four-year period based on the ecosystem approach to fisheries (2007–2010) (see Map 3) (NAFO, 2007a), two additional seamount areas south of the Grand Banks (Fogo seamount 1 and 2) were closed in 2008 (NAFO, 2008c, Article 15). In NAFO Division 3O, a coral protection zone was established in 2007 and is closed to all fishing activity involving bottom contact gear (NAFO, 2008c). In May 2008, a special session of the NAFO Fisheries Commission adopted specific measures regarding bottom fisheries and their potential impacts on vulnerable ecosystems. In 2008, contracting parties will have to collaborate on the assessment of existing fished areas (the footprint), and from 2009, the development of bottom fisheries in new areas will have to follow a protocol, including the execution of a preliminary impact assessment. The complete set of measures is described in Chapter I bis of the 2008 NAFO *Conservation and Enforcement Measures* (NAFO, 2008c). In addition, there are specific requirements for all regulated species which can not be targeted (bycatch species) (NAFO, 2008c, Article 12).

INFORMATION AND REPORTING GAPS

Catch data publicly available are aggregated by NAFO Divisions. There is no separation of high seas and EEZ catch. This is currently a minor shortcoming because only Canada and France fish within EEZs, but this has not always been the case, and there is no guarantee that it will continue to be the case in the future.

There is some inconsistency between STATLANT data and data available from other sources, including NAFO documents. The catch estimates produced by NAFO STACFIS are often higher than the catches declared by countries in STATLANT. In addition, the data of some countries are not available and in the national reports submitted by parties to NAFO, fishing effort is reported in various units, such as fishing hours, number of fishing operations or number of fishing days. This makes it difficult to complete a comprehensive analysis.

NAFO's Secretariat has initiated some analysis of VMS data to investigate the usefulness of this type of information to assess fishing effort spatial distribution (Campanis, 2007). If the results of the study are promising, the author's conclusion was that enhancement of VMS data quality would ensure more accurate estimates. The NAFO Scientific Council recommended that positions be reported at time intervals shorter than the current two hours, and that the instantaneous speed and the course of the vessel be included in the VMS position messages transmitted (NAFO, 2008b).

SOURCES OF INFORMATION

In their reply to the FAO Questionnaire, Canada, Estonia, Germany, Japan and Ukraine included information regarding participation of some vessels in the high-seas deep-sea fisheries in the North West Atlantic. In addition, NAFO answered the FAO Questionnaire, which provided a comprehensive review of the number of vessels active and fishing effort deployed in the high seas of the NRA for the last four years. The STATLANT database contains catch data reported to NAFO up to 2005, along with research and summary documents, which are available on the NAFO Web site, and provide a valuable source of information.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Canada, Denmark (in respect of Faroe Islands and Greenland), France (Saint-Pierre et Miquelon), Germany, Iceland, Japan, Latvia, Lithuania, Norway, Poland, Portugal, Russian Federation, Spain and Ukraine
Estimated total number of vessels	67
Total reported catch of main target species (tonnes)	52 498
Total reported catch of other bottom species (tonnes)	4 025

Main fisheries				
Gear	**Main target species**	**Fishing ground**	**Regional Area**	**Remark**
Bottom trawl	Northern shrimp	Nose of the Grand Banks and the Flemish Cap	NAFO Div. 3L and 3M Div.	
Bottom trawl	Greenland halibut and redfish	Grand Banks and the Flemish Cap	NAFO Div. 3M, 3L, 3N and 3O	
Bottom trawl	Starry ray	Tail of the Grand Banks	NAFO Div. 3N	
Bottom and pelagic trawl	Splendid alfonsino, black scabbardfish, black cardinal fish and wreckfish	NAFO Seamounts zones		Closed with some provision for fishable areas
Bottom longline	Greenland halibut, Atlantic halibut and redfish	Off the Grand Banks and the Flemish Cap	NAFO Div. 3M, 3N, 3L and 3O	
Trap	Snow crab	Off the Grand Banks and the Flemish Cap	NAFO Div. 2J, 3K, 3L, 3N, 3O, 3P and 4R	

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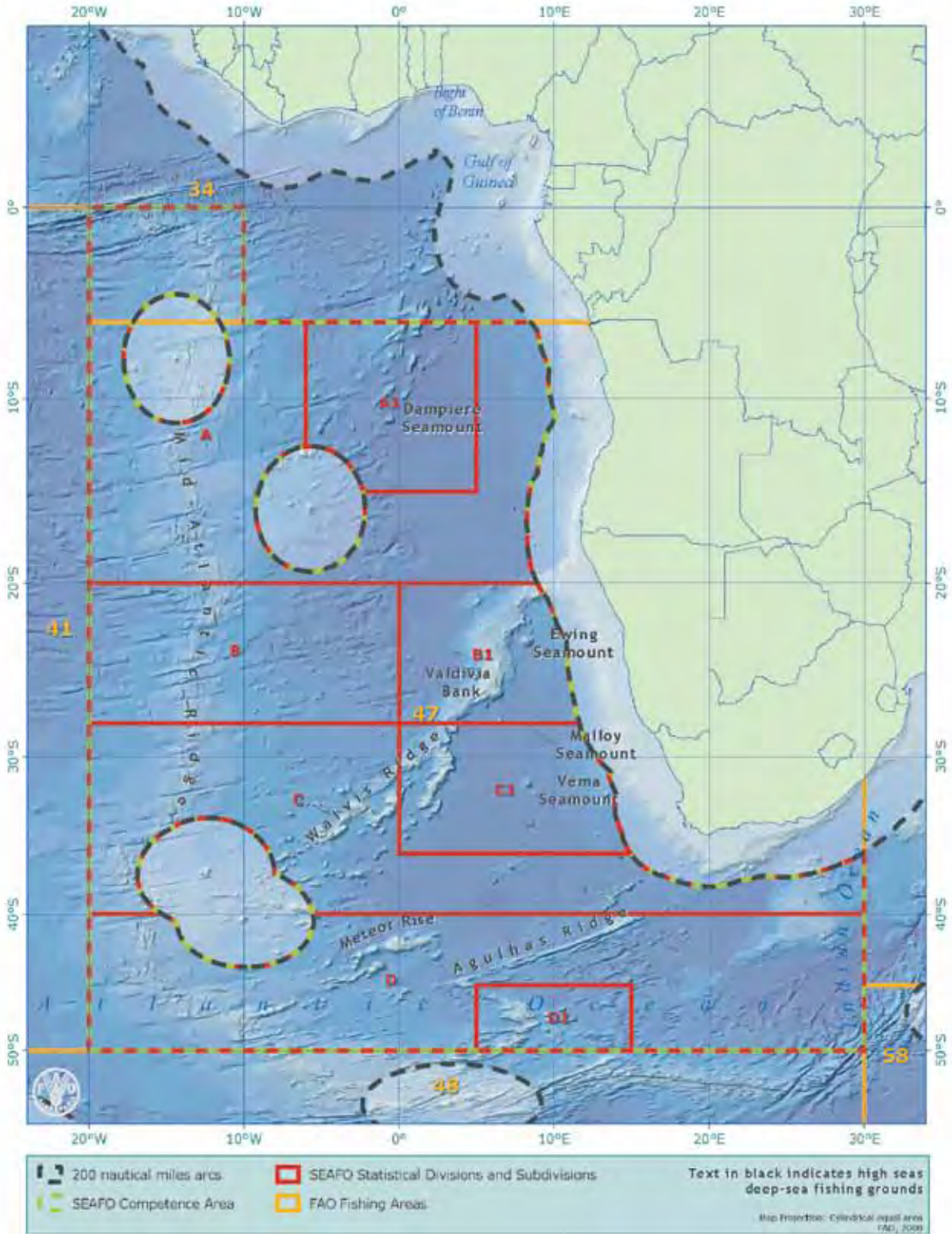


MAP 1
High seas deep-sea fishing grounds in the South East Atlantic Ocean

South East Atlantic Ocean

FAO Statistical Area 47 (and a portion of 34)

GEOGRAPHIC DESCRIPTION OF THE REGION

Angola, Namibia and South Africa are the three countries bordering the South East Atlantic Region (FAO Statistical Area 47) along the African coast. This region extends from the Central Atlantic in the north at 6°S to the Southern Ocean in the south at 50°S.

The western limit of the South East Atlantic is the 20°W meridian, which means that the southern Mid-Atlantic Ridge is within the region, at around 15°W, and extends over the entire region from north to south. Other important bottom topographic features in this region are the Walvis Ridge and the Valdivia Bank, joining the exclusive economic zone (EEZ) of Tristan da Cunha on the northern part of the Namibian continental shelf at around 18°S, and in the southern part, the Meteor Rise and the Agulhas Ridge. These are the areas largely targeted in the deep-sea bottom fisheries in the region, together with associated or isolated seamounts areas such as Ewing and Molloy Seamounts, Vema Seamount and those in SEAFO Subdivision A1 (SEAFO, 2007a). It is important to note that in the South East Atlantic, the continental shelf along the coasts does not extend beyond the EEZs of the coastal states.

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

The South East Atlantic Fisheries Organisation (SEAFO) was established in 2003 with the entry into force of the Convention on the conservation and management of fisheries resources in the South East Atlantic Ocean. The Convention applies within the Convention Area, which encompasses all areas outside the EEZs of Angola, Namibia, South Africa and United Kingdom overseas territory of Saint Helena and its dependencies in SEAFO Divisions A, C and D (see Map 1).

The SEAFO Convention Area covers about 16 million square kilometres (km^2). It is divided into four main Divisions (A–D), extending from the northern to the southern portions of the area, with each Division containing a Sub-Division (A1, B1, C1 and D1) where the majority of the bottom fishing on the high seas appears to have occurred (see Map 1). In addition to FAO Statistical Area 47, which has now been made consistent with SEAFO Sub-Divisions (Garibaldi and Hamukuaya, 2007), the SEAFO Convention Area also covers a portion of FAO Statistical Area 34 (SEAFO Sub-Division A2).

As of August 2008, contracting parties of the SEAFO Convention are: Angola, the European Union, Namibia, Norway and South Africa. The subsidiary bodies of SEAFO include the Commission, the Scientific Committee and the Compliance Committee as well as the Secretariat. The Commission has met annually since 2004 and the Scientific Committee has met annually since 2005.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

The former Union of Soviet Socialist Republics (USSR) developed a fishery for alfonsino (*Beryx* spp.) in the South East Atlantic in the late 1970s, with reported catches ranging from approximately several hundred tonnes to 2 000 tonnes per year through the mid-1980s. Iceland, Norway, Poland, the Russian Federation and Spain all reported catches of alfonsino during the mid- to late 1990s. The highest reported catch

for all distant water fleets combined only reached approximately 3 500 tonnes in 1997. Since then, the reported catch has decreased to a few hundred tonnes per year, most of which has been caught by Namibia. Ukraine, South Africa and Namibia were also fishing for pelagic armourhead (*Pseudopentaceros richardsoni*) on the high seas in the mid-1990s with catches averaging a few hundred tonnes per year. (SEAFO, 2007a)

Deep-sea trawl fisheries for orange roughy (*Hoplostethus atlanticus*) began in the mid-1990s, primarily within the Namibian EEZ, with relatively high initial catches of between 10 000 and 20 000 tonnes per year, followed by a marked decrease to approximately 1 000–2 000 tonnes per year in the period 2002–2004. Norway reported very limited fishing on orange roughy in the region in 1997, 1998 and 2000 (FAO, 2008). The activity of one Norwegian vessel is also reported by the SEAFO Scientific Committee (SEAFO, 2006a) during the same period.

Current fisheries

The main species of commercial value exploited in the SEAFO region are orange roughy, alfonsino, deep-sea red crabs (*Geryon* spp.) and Patagonian toothfish (*Dissostichus eleginoides)* (SEAFO, 2007a) (see Table 1 and Figure 1).

Bluenose warehou (blue-eye trevalla) (*Hyperoglyphe antarctica*) is known to have been landed in the port of Cape Town by both bottom trawlers and demersal longliners in recent years (Spain and Uruguay have reported minor catches to FAO in this region); these catches were made in the South Atlantic in and around the waters of Tristan da Cunha (FAO Statistical Subarea 47.4), which could represent catch taken either in the high seas or the EEZ (D. Japp, CapFish, personal communication, 2008).

Bottom and mid-water trawl fisheries for orange roughy and alfonsino

The orange roughy and alfonsino fisheries are conducted using both mid-water and bottom trawls. The main fishing areas for these species appear to be in Divisions A–C with a large portion of the catch reported from Sub-Division B1. Pelagic armourhead, oreo, cardinal fish and other deep-sea species are taken as bycatch in these fisheries.

TABLE 1
Main species targeted by deep-sea species in the high seas of the South East Atlantic

Common name	Scientific name
Main target species – trawl fisheries	
Alfonsino	*Beryx* spp.
Orange roughy	*Hoplostethus atlanticus*
Main target species – other gear types	
Deep-sea (red) crabs (*Geryon* nei)	*Geryon* spp.
Patagonian toothfish	*Dissostichus eleginoides*
Other species	
Pelagic armourhead	*Pseudopentaceros richardsoni*
Bluenose warehou (blue-eye trevalla)	*Hyperoglyphe antarctica*
Boarfishes nei	Caproidae
Cardinal fishes nei	*Epigonus* spp.
Octopus	Octopodidae
Oreo dories nei	Oreosomatidae
Squid	Loliginidae
Sharks (deep-sea) nei	Selachimorpha
Rays and skates nei	Rajidae
Wreckfish	*Polyprion americanus*

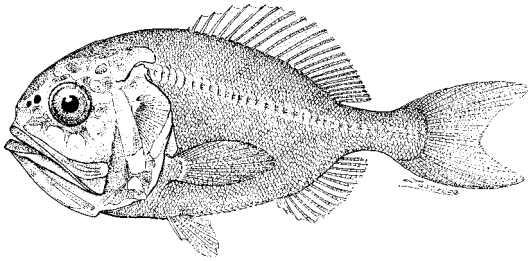
Namibia reported one vessel engaged in bottom fishing on the high seas of the South East Atlantic in 2006 with a catch of 36 tonnes, primarily orange roughy.[1] The Cook Islands reported that two high seas bottom trawl vessels operated in FAO Statistical Area 47 during the 2003–2006 period, but did not provide catch information.[2]

The Scientific Committee of SEAFO indicates that to date, only data from the Namibian orange roughy fishery provide enough information to attempt to analyse trends in stock abundance. The data available from Namibia are from 1995 to 2005 (not including 1998 when no high seas fishery occurred). During this period, seven Namibian

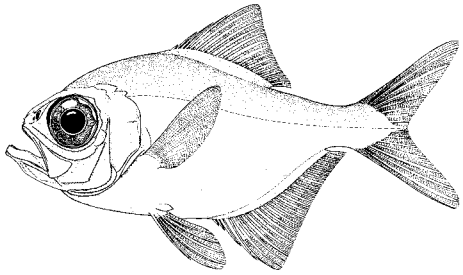
[1] Response from Namibia to 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire: see Appendix A).
[2] Response from the Cook Islands to FAO Questionnaire.

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the South East Atlantic

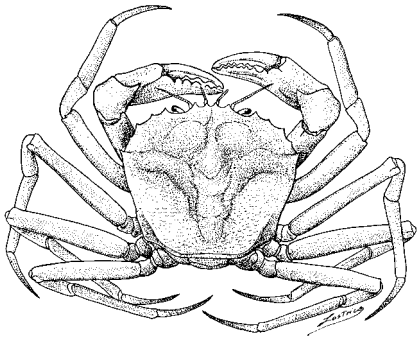
Orange roughy (*Hoplostethus atlanticus*)



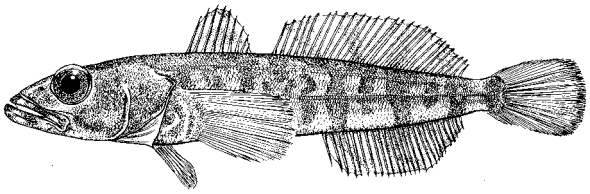
Alfonsino (*Beryx* spp.) (*Beryx decadactylus*)



Deep-sea (red) crab (*Geryon quinquedens*)



Patagonian toothfish *(Dissostichus eleginoides*)



Source: FAO.

vessels were fishing in the SEAFO Area for orange roughy and in total 1 270 trawls were made and approximately 1 000 tonnes of deep-sea species were caught. Of this amount, 290 tonnes were orange roughy and 303 tonnes were alfonsino. The Scientific Committee also reports that vessels flagged to Cyprus, Mauritius and the Russian Federation offloaded a combined total of 969 tonnes of alfonsino, 217 tonnes of squid, 46 tonnes of boarfish and 23 tonnes of pelagic armourhead in Walvis Bay, Namibia in 2004. The catch was presumed to have been taken in the SEAFO Area by vessels fishing with bottom trawl gear. (SEAFO, 2006a)

Longline fishery targeting Patagonian toothfish

The fishery for Patagonian toothfish is a bottom longline fishery largely conducted in the southern portion of the SEAFO Area, in Divisions C and D (SEAFO, 2006a). The Republic of Korea reportedly caught 243 tonnes of Patagonian toothfish in the SEAFO Area in 2003 and 10 tonnes in 2005 (SEAFO, 2007a). However, the Korean reply to the FAO Questionnaire does not mention activity in FAO Area 47 during the period 2003–2006. A Spanish vessel (or vessels) reportedly caught 101, 202 and 11 tonnes of Patagonian toothfish in the SEAFO Area in 2003, 2004 and 2006 respectively (SEAFO, 2007a). In its answer to the FAO Questionnaire, Japan reported one longliner operating in the area in 2006, targeting Patagonian toothfish (114 fishing days).[3]

[3] Response from Japan to FAO Questionnaire.

TABLE 2
Catch in tonnes by country of main species in bottom fisheries in the SEAFO Area, 2003–2006

Country	Orange roughy	Alfonsino	Pelagic armourhead/ boarfishes nei	Oreo dories	Patagonian toothfish	Red crabs	Unknown	Total (tonnes)
Cook Islands	/	/	/	/	/	/	142	142
Cyprus	/	/	22	/	/	/	437	459
Japan	/	/	/	/	230	624	/	854
Mauritius	/	/	25	/	/	/	115	140
Namibia	91*	7	4	9**	/	54	/	165
Portugal	/	5	/	/	/	/	/	5
Russian Federation	/	264	/	/	/	/	/	264
Spain	/	/	/	/	314	/	/	314
Republic of Korea	/	/	/	/	255	/	/	255
Others (combined reporting of Cyprus, Mauritius and the Russian Federation in Walvis Bay, Namibia in 2004)	/	969	46 (boarfish) / 23 (armourhead)	/	/	/	217 (squid)	1 255
Total tonnes	91	1 245	120	9	799	678	911	2 598

/ = Unknown.
* Includes catch of 31 tonnes of orange roughy in 2006; reported in the response from Namibia to the FAO Questionnaire.
** Includes catch of 4 tonnes of oreo in 2006; reported in the response from Namibia to the FAO Questionnaire.
Source: SEAFO, 2007a.

TABLE 3
Summary of available data, 2005–2006

Trawl (mid- and bottom trawl) fishery Orange roughy and alfonsino				
Country	**Year**	**Number of vessels**	**Catch[1] (tonnes)**	**Effort (number of fishing days)**
Cook Islands	2006	2[2]	/	/
Namibia	2006	1[2]	36[2]	/
Portugal	2006	/	0.3	/
Russian Federation	2005	/	54	/
Bottom longline fishery Patagonian toothfish				
Country	**Year**	**Number of vessels**	**Catch (tonnes)**	**Effort (number of fishing days)**
Japan	2006	1[2]	157	114[2]
	2005	/	73	/
Republic of Korea	2005	/	10	/
Spain	2006	1[1]	11	/
Pot fishery Deep-sea red crabs				
Country	**Year**	**Number of vessels**	**Catch (tonnes)**	**Effort (number of fishing days)**
Japan	2006	1[2]	543[2, 3]	116[2]
	2005	1[2]	234	/
Namibia	2005	1[1]	54	/

/ = Unknown.
[1] SEAFO, 2007a. All catch information comes from this source, unless noted otherwise.
[2] Returned questionnaires to FAO by respective country.
[3] There is a discrepancy between this information and that reported in SEAFO, 2007a.

Pot fishery targeting deep-sea red crab

Deep-sea red crabs are taken with pots, with a large percentage of the overall catch in the area taken in Sub-Division B1. In its answer to the FAO Questionnaire, Japan reported the activity of one trap setter in 2006, with a catch of 361 tonnes and 116 fishing days. The SEAFO Scientific Council reports the activity of one Namibian pot setter in 2005, with a total catch of 54 tonnes (SEAFO, 2006a). No information is available for other years for the 2003–2006 period.

Table 2 provides a summary of the catch by country of the main target species in 2003–2006.

Catch and effort summary

Table 3 provides a summary of the catch and effort of the above-mentioned fisheries.

Illegal, Unreported and Unregulated (IUU) fishing

Only Angola, the European Union, Namibia, Norway and South Africa are currently parties to the SEAFO Convention. Fishing for species regulated by SEAFO by vessels whose flag states are not parties to the Convention remains an issue. In this regard, the Annual Meeting of SEAFO in 2007 specifically raised concern regarding vessels from the Republic of Korea and Japan fishing in the area (SEAFO, 2007b).

A number of countries known to be fishing in the area in recent years have not fully reported catch. The report of the 2007 Meeting of the Scientific Committee of SEAFO (SEAFO, 2007a) states that vessels from Spain, Portugal, the Russian Federation, Cyprus, Mauritius, Japan, the Republic of Korea, Poland, Norway, South Africa and Namibia are known to have fished in the SEAFO Area. Most countries have provided incomplete statistics over the years and therefore an estimate of total annual catches is not possible with the data currently available. The amount of IUU fishing in the SEAFO Area is unknown (SEAFO, 2007a).

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

In 2006, the Scientific Committee of SEAFO indicated that, because of a lack of sufficient data for stock assessments, it was not possible to give specific management advice for any of the species harvested in the SEAFO Area. However, it did state that the stocks of deep-sea red crabs are not likely to be depleted.

Status of bycatch stocks

The status of bycatch species is unknown.

Impacts on Vulnerable Marine Ecosystems (VMEs)

The Census of Marine Life on Seamounts (CenSeam), a global study of seamount ecosystems, has identified the South Atlantic as a poorly known and sampled area in terms of global seamount biodiversity (SEAFO, 2007a). Impacts on VMEs are unknown but likely to have occurred as a result of bottom fisheries, in particular bottom trawling, on seamounts and ridge systems in the region (Clark *et al*., 2006).

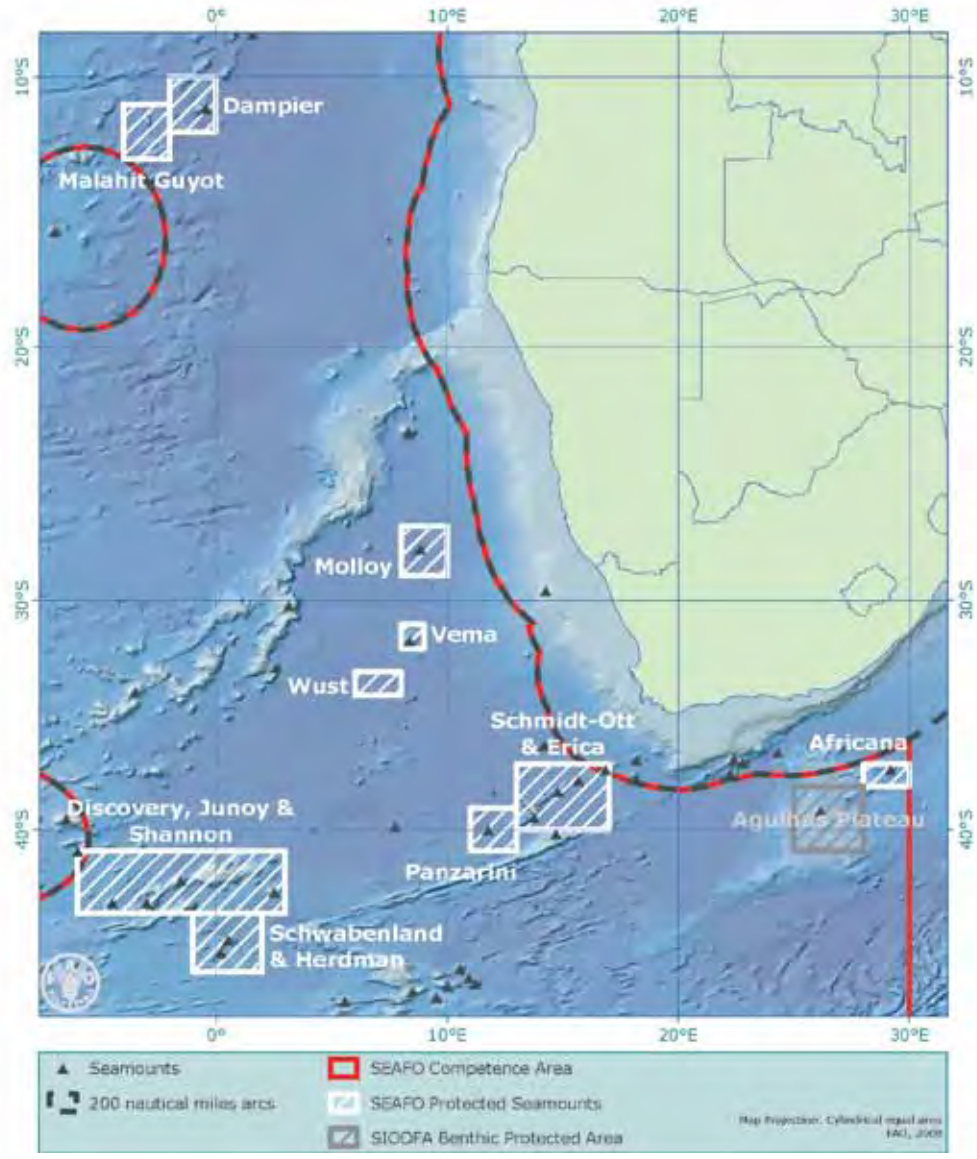
CONSERVATION AND MANAGEMENT MEASURES

Despite the lack of sufficient data for stock assessments, as mentioned above, the Scientific Committee has recommended an interim measure; for existing fisheries, fishing pressure should be reduced considerably and only be allowed to expand again very slowly if and when reliable assessments indicate that increased harvests are sustainable (SEAFO, 2006a).

In 2007, SEAFO adopted a catch limit of 200 tonnes of deep-sea red crabs in Sub-Division B1 (average of recent catch levels) and 200 tonnes in the remainder of the SEAFO Convention Area, based on a recommendation of the Scientific Committee. A quota of 260 tonnes per year of toothfish for 2008 and 2009 was also agreed. It should be noted that Patagonian toothfish is a transboundary species between the SEAFO and the CCAMLR Convention Areas and is therefore also managed by CCAMLR.[4]

To date, SEAFO has identified 13 vulnerable marine areas within the SEAFO Area. Of the 13 areas, ten are currently closed to all forms of bottom fishing (see Map 2 above): the Dampier Seamount (Area 1), the Malahit Guyot Seamount (Area 2), Molloy Seamount (Area 5), Vema Seamount (Area 6), Wust Seamount (Area 7), Africana Seamount (Area 8), Schmidt-Ott and Erica Seamounts (Area 9), Panzarini Seamount (Area 10), the Discovery, Junoy and Shannon Seamounts (Area 11), and the Schwabenland and Herdman Seamounts (Area 12). Six of these areas are considered to be unexploited while four – the Dampier, Malahit Guyot, Molloy and Vema Seamounts – have been fished to some extent in the past (SEAFO, 2006b). A further three areas – the Valdivia Bank (Area 3), Ewing Bank (Area 4) and Meter Seamounts (Area 13) – have been proposed for closure, but thus far remain open to fishing.

[4] Conservation Measure 10/07 fixing catch limits and related conditions for the Patagonian toothfish and red crab fisheries in the SEAFO Convention Area in 2008 and 2009. Adopted at the Annual Meeting of SEAFO in October 2007.



MAP 2
SEAFO Marine Protected Areas

SEAFO agreed in 2006 to close these ten areas temporarily until 2010, through the adoption of Conservation Measure 06/06 in October 2006. This measure stipulates that these areas could be reopened to exploratory fishing in 2008, based on advice from the Scientific Committee. However, in 2007, the Scientific Committee recommended maintaining the areas closed to any fishing pending an assessment of the impact of fishing and the extent to which VMEs were present in the closed areas. On the basis of the advice from the Scientific Committee, in 2007 SEAFO adopted Conservation Measure 11/07, which stipulates that the ten closed areas will only be reopened under the conditions presented in Box 1 below.

In 2007, the SEAFO Scientific Committee further recommended that the additional three areas – Areas 3, 4 and 13 – should be closed to bottom fishing and that there should be a temporary ban on all forms of trawling in the SEAFO Area, given the vulnerability to fishing of some of the species in this area, the paucity of data available for assessments, and the likely impact of trawling on vulnerable habitats on seamounts in areas that remain open to fishing in the SEAFO Area. It further recommended that for trawling to resume, vulnerable habitats (cold-water corals, sponges, etc.) should be mapped and proposals for mapping of resources, exploratory fishing and resumed

BOX 1
Extracts from Conservation Measure 11/07

"NO FISHING SHALL RESUME IN A CLOSED AREA UNTIL THE FOLLOWING PROCESSES HAVE BEEN RESPECTED;

a) Vulnerable marine ecosystems (including seamounts, hydrothermal vents and cold water corals) have been identified and mapped in the area and an assessment has been made on the impact of any resumption of fishing on such vulnerable marine ecosystems. This information shall be submitted to the Scientific Committee for its evaluation and recommendation to the Commission.

b) Subject to the decision of the Commission, Contracting Parties may submit Research Fishing Plans for evaluation by the Scientific Committee on its impact both on the sustainability of the fisheries resources and on their possible impact on vulnerable marine habitats. The Scientific Committee shall submit its recommendation to the Commission for decision on any re-opening of the area to fishing."

commercial fishing should be submitted to the SEAFO Scientific Committee for consideration before any activity takes place. Any resumption of trawling should be at a low level until it can be demonstrated that higher levels of fishing are sustainable. The Scientific Committee also recommended that all forms of gillnet fishing be banned until management measures relating to the total length of the nets and soak times can be introduced and enforced. The Scientific Sub Committee further recommended that exploratory fishing surveys in unexplored areas should not be permitted since they may cause irreversible damage to the seamounts (SEAFO, 2007a). However, at its Annual Meeting in 2007, SEAFO did not act on the broader recommendations of the Scientific Committee regarding trawling and bottom gillnet fishing in the Convention Area (SEAFO, 2007b).

INFORMATION AND REPORTING GAPS

In 2006, the Scientific Committee of SEAFO recognized a number of gaps in relation to information and reporting. For example, and as mentioned in earlier sections, there is a problem with incomplete submission of fishery data, such as catch and effort data, by countries. Thus, the Scientific Committee recommended steps to address these issues, including a need for regular reporting of accurate catch information; updating and improvement of historical data time series; the need to develop a robust scheme of collecting information appropriate for ecosystem management of fisheries; better enforcement of mandatory observer deployment for biological data collection; and improved understanding of seamount ecology and threats.

As indicated earlier, in addition to the above, the SEAFO Scientific Committee has recognized the need to map areas where vulnerable habitats occur, as well as the need for more accurate information on catch and bycatch.

Furthermore, assessments are needed on the impacts of bottom fisheries on non-target, associated and dependent species, and vulnerable benthic ecosystems.

SOURCES OF INFORMATION

In their reply to the FAO Questionnaire sent to states known as having a high seas deep-sea fishing fleet, the Cook Islands, Japan and Namibia officially responded with some information regarding deep-sea fishing in the high seas of the South

East Atlantic. Other sources used were SEAFO reports and the United Nations Environment Programme/Census of Marine Life reports, as well as others listed in the bibliography.

SUMMARY TABLE FOR 2006*

Main flag states involved in fisheries*	Cook Islands, Japan, Namibia and Spain
Estimated total number of vessels	6
Total reported catch (tonnes)	747.3

Main fisheries			
Gear	**Target species**	**Fishing grounds**	**Regional Area (FAO Area 47 and a small portion of 34)**
Mid-water trawl/bottom trawl	Orange roughy Alfonsino	Walvis Ridge (incl. Valdivia Bank, Ewing and Molloy Seamounts), Agulhas Ridge, Mid-Atlantic Ridge, Meteor Rise, Mt Vema Seamount	Throughout SEAFO Area
Pot	Deep-sea red crabs	SEAFO B1, D1	SEAFO Areas B1, D1
Longline	Patagonian toothfish	SEAFO C, D	SEAFO Areas C, D

* According to country responses to the FAO Questionnaire and SEAFO reports.
Note: poor reporting is a significant problem in relation to the management of the fisheries in this region.

ACKNOWLEDGEMENTS

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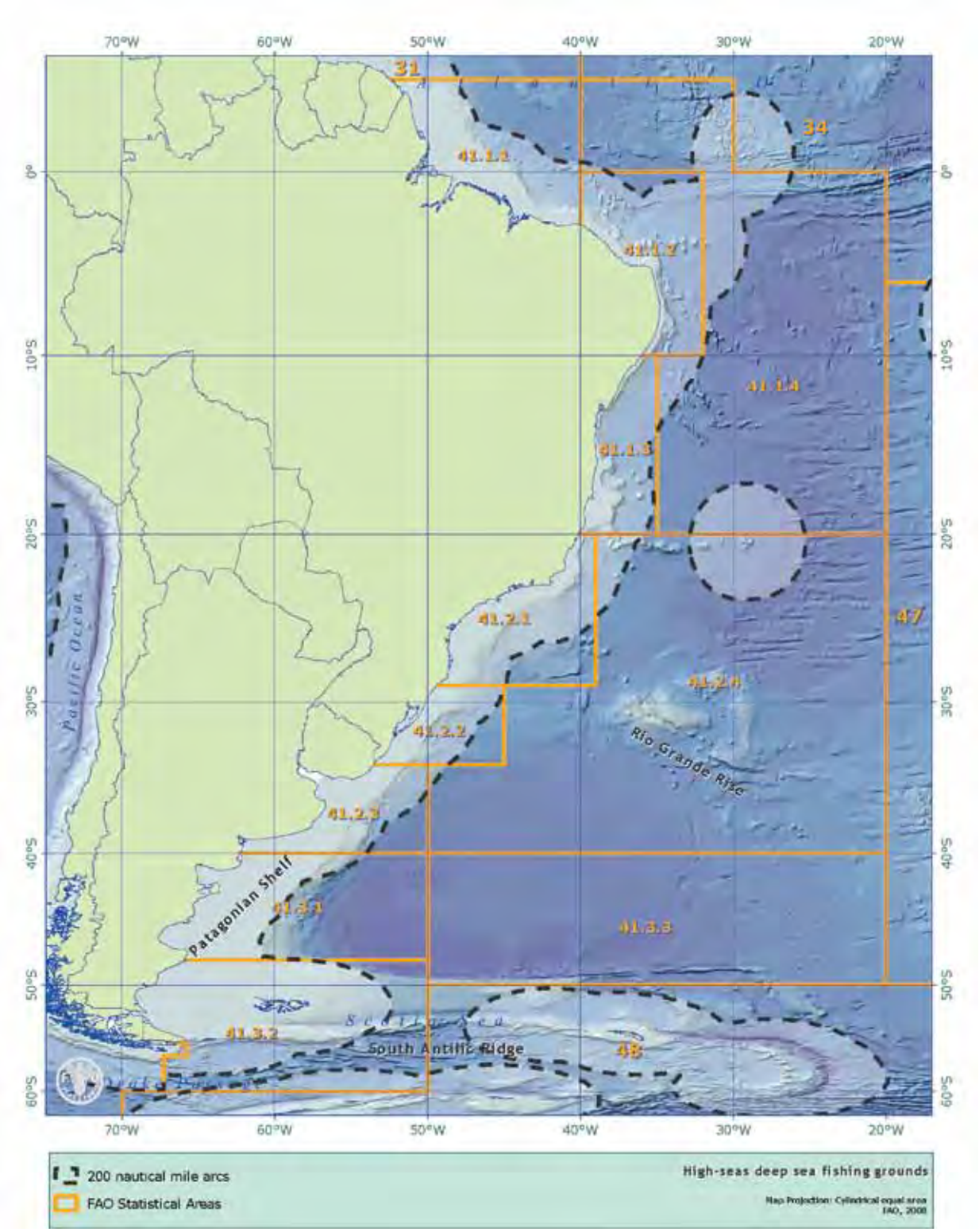


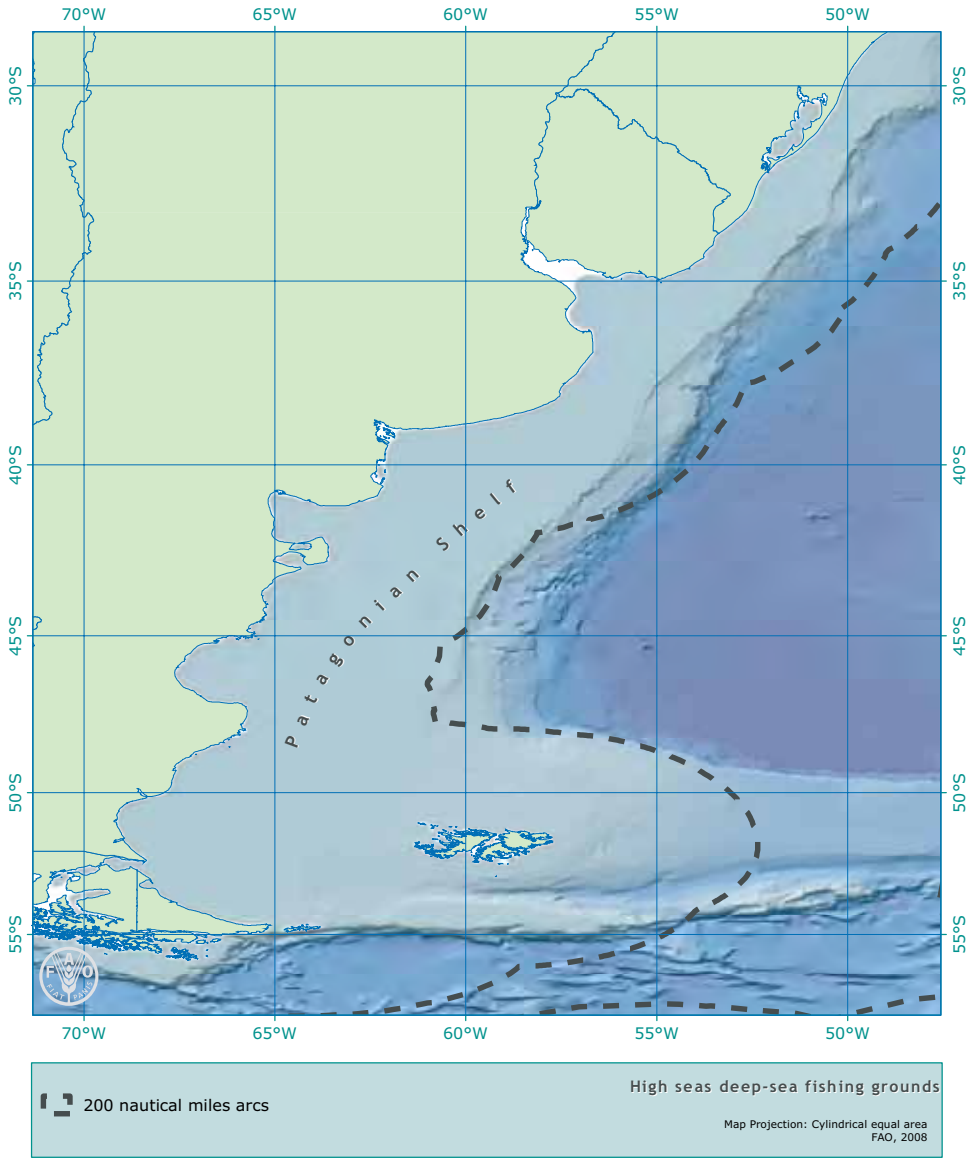
MAP 1
High seas deep-sea fishing grounds in the South West Atlantic Ocean

South West Atlantic Ocean

FAO Statistical Area 41

GEOGRAPHIC DESCRIPTION OF THE REGION

The South West Atlantic, corresponding to FAO Statistical Area 41, covers a total surface of 17.65 million square kilometres (km²) between 5°N latitude off the coast of Brazil south to 60°S latitude off the coast of Argentina (Map 1). The area includes a total continental shelf area of approximately 1.96 million km² of which a large portion off the coast of Argentina – the Patagonian Shelf – extends beyond 200 nautical miles from the baseline from which the breath of the territorial sea is measured (Map 2) (FAO, 2005). Individual seamounts and ridge systems are also present in the area and include the Rio-Grande Rise area.



MAP 2
High seas deep-sea fishing grounds off the Patagonian Shelf

The main geographic features that are high seas fishing grounds are: the Patagonian Shelf, the Rio-Grande Rise and other seamounts.

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

There is no multilateral regime currently in place for the high seas bottom fisheries in the South West Atlantic region. However, as states respond to calls for improved management and conservation, initiatives to create new RFMOs in unregulated high seas areas may emerge. The European Union (EU) has recently issued a communication stating that it intends to support and advance the creation of an RFMO and interim measures in the region (EC, 2007c). However, Argentina considers that conditions are not yet met for the creation of such an organization or the adoption of such measures. Most of the demersal stocks fished on the high seas are straddling stocks, including species that do not have typical deep-sea species characteristics such as Argentine hake (*Merluccius hubbsi*), Argentine short-fin squid (*Illex argentinus*) and southern blue whiting (*Micromesistius australis*) (Maguire *et al.*, 2006).

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Fisheries for Argentine hake and Argentine shortfin squid, the principal target species in the current high seas bottom fisheries in the region, developed in the 1960s and 1970s by Argentine and distant water fleets, primarily from the former Union of Soviet Socialist Republics (USSR), Poland and Japan. In the 1980s, fleets from other distant water nations such as the Republic of Korea, Spain, Taiwan Province of China, Cuba and Germany, began targeting these species in the South West Atlantic. Throughout the 1990s, the Republic of Korea and Taiwan Province of China reported catches of shortfin squid of approximately 100 000–200 000 tonnes per year, with Japan reporting a catch of some 100 000 tonnes per year during the same period. The Argentine catch of shortfin squid fluctuated between 200 000 and 400 000 tonnes per year during the 1990s.

A fishery also took place on the Rio-Grande Rise area seamounts in the 1980s, targeting mainly alfonsino (*Beryx* spp.). This fishery, undertaken by the former USSR, was resumed in 2000 when a new seamount in the area was discovered, but no data are available on the catch. Other fisheries are reported to have taken place on individual seamounts in the area. (Clark *et al.*, 2007)

Spain and Japan and, to a lesser extent, Poland, Portugal and the Russian Federation report substantial fisheries for Argentine hake between the mid-1980s and the early 1990s, with only Spain continuing to report significant catches since the mid-1990s (between 15 000 and 27 000 tonnes per year from 1996 to 2001). The Argentine fishery for Argentine hake extends as far back as the 1950s with reported catches in the period 1977–2005 ranging between 250 000 and 600 000 tonnes per year. Unfortunately, it is not possible to determine from the available data the extent to which the catch of Argentine hake, Argentine short-fin squid or other species caught by distant water fleets reporting catches in the region has been taken on the high seas (or within national jurisdiction) (FAO, 2008).

Current fisheries

Table 1 and Figure 1 provide an overview of the main target species.

Bottom trawl fisheries for Argentine hake and Argentine shortfin squid

The main high seas bottom fisheries in the South West Atlantic region currently occur on the Patagonian Shelf and upper slope areas beyond 200 nautical miles from

the baseline from which the breath of the territorial sea is measured south of 40°S latitude and north of the Falkland Islands (Malvinas) (FAO Statistical Area 41.3).[1] Most of the fishing appears to be done by bottom trawling with the principal target species being Argentine shortfin squid and Argentine hake. However, a number of distant water fishing nations report substantial catches of other species in recent years, such as southern blue whiting, Patagonian grenadier (*Macruronus magellanicus*) and elasmobranches including rays, stingrays and mantas nei (FAO, 2008).

Spain reported that over the period 2003–2006, between 22 and 27 bottom trawl vessels operated in the South West Atlantic (Table 2). In 2006, 27 trawlers fished in the region with a high seas catch of 44 967 tonnes. Over 80 percent of the catch consisted of Argentine hake and Argentine shortfin squid. Other species reported retained in the catch were southern blue whiting, Patagonian grenadier, Longtail southern cod (*Patagonotothen ramsayi*), forkbeard (*Phycis phycis*), Patagonian squid (common squid) (*Loligo gahi*) and pink cusk eel (*Genypterus blacodes*).[2]

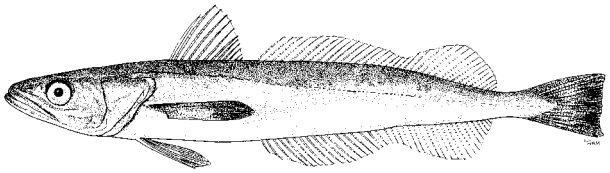
Estonia reported that a single vessel operated in the South West Atlantic in both 2005 and 2006 (Table 3). Fishing effort was reported as 81 days in 2005

TABLE 1
Main target species in the South West Atlantic

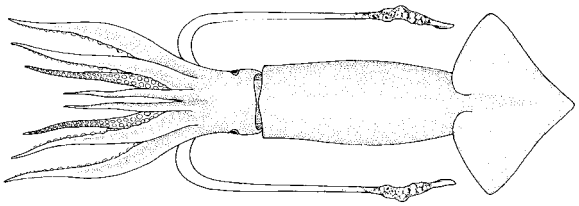
Common name	Scientific name	Spanish name
Main target species – trawl fisheries		
Argentine hake	*Merluccius hubbsi*	Merluza argentina
Argentine shortfin squid	*Illex argentinus*	Pota argentina
Main target species – bottom longline fishery		
Patagonian toothfish	*Dissostichus eleginoides*	Austromerluza negra
Other species		
Patagonian squid (common squid)	*Loligo gahi*	Calamar patagónico
Forkbeard	*Phycis phycis*	Brótola de roca
Patagonian grenadier	*Macruronus magellanicus*	Merluza de cola
Pink cusk eel	*Genypterus blacodes*	Congribadejo rosado
Longtail Southern cod	*Patagonotothen ramsayi*	Nototenia coluda
Antarctic rockcods noties nei	*Nototheniidae*	Tramas, doradillos nep
Southern blue whiting	*Micromesistius australis*	Polaca austral
Southern hake	*Merluccius australis* (*Merluccius polylepis*)	Merluza austral

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the South West Atlantic

Argentine hake (*Merluccius hubbsi*)



Argentine short-fin squid (*Illex argentinus*)



Source: FAO.

TABLE 2
Spanish high seas bottom catch in the South West Atlantic, 2003–2006

Year	Argentine hake	Argentine shortfin squid	Rockcod	Patagonian grenadier	Pink cusk eel	Other	Total catch (tonnes)	Number of vessels (trawlers)
2006	22 283	14 481	2 865	1 858	1 049	2 431	44 967	27
2005	21 403	11 111	1 275	2 709	1 193	4 880	42 571	24
2004	17 255	2 788	317	526	566	1 462	22 914	23
2003	7 136	9 266	36	1 550	818	3 567	22 373	22

Source: response from Spain to FAO Questionnaire.

[1] Reference made to the Falkland Islands (Malvinas) is geographic in nature and does not prejudge the questions related to the territorial status of these islands.

[2] Response from Spain to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire: see Appendix A).

TABLE 3
Catch of the Estonian high seas bottom trawl vessel, 2006

Argentine hake	Argentine shortfin squid	Rockcod	Patagonian grenadier	Pink cusk eel	Other	Total catch (tonnes)	Number of vessels (trawlers)
700	499	127	73	22	48	1 469	1

Source: response from Estonia to FAO Questionnaire.

TABLE 4
Uruguayan high seas bottom catch in the South West Atlantic (2004–2006)

Year	Argentine hake	Argentine short-fin squid	Patagonian Toothfish	Total catch (tonnes)
2006	28 029.3	4 989.2	130.3	33 148.8
2005	41 180.8	4 894.2	669.4	46 744.4
2004	39 613.4	3 702.3	52.7	43 368.4

and 59 days in 2006. The high seas catch amounted to 878 tonnes in 2006. Over 95 percent of the catch consisted of Argentine hake and Argentine shortfin squid. The remainder of the retained catch consisted of Antarctic rockcods, pink cusk eel, sharks, and elasmobranches including rays, and skates nei.[3]

Uruguay reported catches of Argentine hake, Patagonian toothfish and Argentine short-fin squid (Table 4). The number of vessels involved and the fishing effort is unknown.[4]

The Republic of Korea reported that from 2003 through 2006, between 11 and 19 trawlers operated in the South West Atlantic each year. In 2006, 16 trawlers were fishing on the high seas in the region. In 2006, the total catch of the fleet of the Republic of Korea (including trawlers, longliners and trap setters) was 64 762 tonnes of fish and squid. The fishing effort of the trawl fleet is not known. The majority of the catch appears to consist of squid with Patagonian grenadier, hakes, rays and skates also taken in the fisheries.[5] Information on the catch and species composition per gear type was not made available.

Bottom longline fishery for Patagonian toothfish

The Republic of Korea reported that from 2003 through 2006, between five and nine longliners operated in the South West Atlantic per year. In 2006, seven longliners from the Republic of Korea were fishing for a total of 250 days on the high seas in the region.[6] Ukraine reported that two longliners in 2006, and one longliner in 2005, operated in the South West Atlantic targeting Patagonian toothfish (*Dissostichus eleginoides*); however, details on catch or effort were not reported.[7] FAO reports that 376 tonnes of Patagonian toothfish were reported by Ukraine in 2006 in the South West Atlantic (FAO, 2008).

Other bottom fisheries

A Working Document from the European Commission (EC) indicated that, in addition to the Spanish, Estonian and Korean fleets mentioned above, some 50 or more vessels registered in the Falkland Islands (Malvinas)[8], or flagged to China and Taiwan Province of China also participate in the bottom fisheries on the high seas of the South West

[3] Response from Estonia to FAO Questionnaire.
[4] Response from Uruguay.
[5] Response from the Republic of Korea to FAO Questionnaire.
[6] Response from the Republic of Korea to FAO Questionnaire.
[7] Response from Ukraine to FAO Questionnaire.
[8] See footnote 1.

Atlantic (EC, 2007a).In its response to the FAO Questionnaire, China reported no high seas bottom fishing in the region.[9]

The data available from the FAO FISHSTAT database (FAO, 2008) include reports of substantial catches of Argentine short-fin squid as well as Patagonian grenadier and several other groundfish species over the past several years by Japan, China, Taiwan Province of China, Portugal, the Russian Federation, Belize, Panama, the Falkland Islands (Malvinas)[10], Namibia and the United Kingdom among others (in addition to Spain, the Republic of Korea and Estonia). For example, the catch of Argentine short-fin squid by China is listed as 140 000 tonnes between the years 2003–2005; for Japan the catch is approximately 43 000 tonnes and the catch by Taiwan Province of China is listed at some 210 000 tonnes for the same period. However, the statistics in FAO (2008) do not differentiate between catches on the high seas and catches within EEZs, nor by gear type; thus it is impossible to determine how much, if any, of the catch by these countries is taken on the high seas and/or in bottom fisheries in the region (FAO, 2008).

TABLE 4
Summary of available catch and effort data for 2006

Country	No. of vessels	Catch (tonnes)	Effort (days per year)
Trawl (mid- and bottom trawl) fishery			
Estonia	1	878	59
Republic of Korea	16	64 762*	–
Spain	27	44 967	–
Bottom longline fishery			
Republic of Korea	7	–	250
Ukraine	2	376**	–
Trap fishery			
Republic of Korea	2	–	270

* This figure is the reported catch combined for all Republic of Korea vessels engaged in bottom fisheries on the high seas of the South Pacific, including those employing trawl, longline and other gears.
** Information derived from FAO FishStat (FAO, 2008).
Sources: responses by countries to FAO Questionnaire; FAO, 2008.

Other current bottom fisheries in the region include fisheries on individual seamounts, such as on the Rio-Grande Rise; however, no data are available on these fisheries (Clark *et al.*, 2007).

In addition, two trap setters from the Republic of Korea were fishing for a total of 270 days on the high seas in the region in 2006.[11]

Catch and effort summary

Table 4 provides a summary of catch and effort by gear type and country in 2006.

Illegal, Unreported and Unregulated (IUU) fishing

Little information is available on IUU bottom fishing activities in this area. These fisheries are currently unregulated by a multi-lateral mechanism.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

According to an FAO review of straddling and highly migratory stocks worldwide in 2006 (Maguire *et al.*, 2006), Argentine short-fin squid was considered fully exploited; Argentine hake was considered overexploited or depleted, with signs of recovery in recent years; southern blue whiting was considered fully to overexploited; and the pink cusk eel and Patagonian grenadier were considered moderately exploited. The status of rockcods, sharks and rays is unknown.

Status of bycatch stocks

The bycatch of non-commercial species is largely unknown.

[9] Response from China to FAO Questionnaire.
[10] See footnote 1.
[11] Response from the Republic of Korea to FAO Questionnaire.

Impacts on Vulnerable Marine Ecosystems (VMEs)

A recent assessment of the likely distribution of stony or hard cold-water corals in relation to seamounts worldwide concluded that they are likely to be found in association with seamounts at fishable depths throughout the South Atlantic Ocean between 20° and 60°S latitude (Clark *et al.*, 2006). Biogeographic assessments of the likely distribution of other species potentially vulnerable to deep-sea bottom fisheries have yet to be conducted with respect to seamounts, other underwater features and the continental slope areas of the Patagonian Shelf.

A study conducted for the EC reports three main harvesting areas for EC vessels bottom fishing in the South West Atlantic, two of which are located in international waters bordering the Argentine EEZ. According to the EC, in these two areas, the sea bed falls rather abruptly from 200 to 1 000 m corresponding to locations where deep-water corals and sponges are likely to occur on the steep continental slope. Although hakes and squid are harvested mainly on sandy bottoms on the shelf flats, trawls extending beyond the shelf break may be deployed deep and thus threaten to damage any coral reefs they encounter (EC, 2007a).

CONSERVATION AND MANAGEMENT MEASURES

At least some of the vessels operating in the region are subject to reporting requirements and other measures by the flag states concerned. The EC reports that vessels flagged to EU countries are subject to monitoring, including some level of onboard observer coverage, and licensing arrangements. Argentina reports that use of vessel monitoring systems (VMS) is required for the commercial Argentinean fleet operating in the area.

Recently, Spain announced that it will conduct a research survey specifically aimed at the identification of VMEs in the region. The EC meanwhile has issued draft regulations for the management of the high seas bottom fisheries conducted in the region by vessels flying the flag of EU member states. These regulations are designed to implement the UN General Assembly Resolution 61/105 and would essentially require flag states of the EU to regulate fishing activities in a manner consistent with the UN Resolution (EC, 2007b). Argentina reported on the adoption of conservation and management regulations in relation to the sedentary species of the Argentinean shelf, including the establishment of management areas beyond 200 miles from the baseline. This would imply that the EC draft regulations would not apply to these species in this area.

INFORMATION AND REPORTING GAPS

There is a need for more accurate information on catch, bycatch and the locations of areas fished in relation to potential impacts on VMEs, particularly along the slope areas of the Patagonian Shelf. Assessments of the known or likely distribution of VMEs in the region are needed. In addition, stock assessments of the bottom fisheries on the high seas need to be conducted, insofar as these are not covered by, or incorporated into, assessments by coastal states of the straddling fish stocks in the region. Furthermore, there have been no systematic assessments of the impact of the fishery on non-target, associated and dependent demersal species or vulnerable benthic ecosystems.

SOURCES OF INFORMATION

In their responses to the FAO Questionnaire sent to states known as having a high seas deep-sea fishing fleet, four countries (Estonia, the Republic of Korea, Spain and Ukraine) officially replied with some information regarding deep-sea fishing in the high seas of the South West Atlantic Ocean. China also responded but did not report fisheries in this area. In addition, FAO reports, communications from the European Commission, the Census of Marine Life and other sources as footnoted were used.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Spain, Estonia, the Republic of Korea and Ukraine
Estimated total number of vessels	55
Total reported catch (tonnes)	110 983

Main fisheries			
Gear	**Target species**	**Fishing grounds**	**FAO Statistical Area**
Bottom trawl fisheries	Argentine hake and Argentine shortfin squid	Patagonian Shelf and upper slope areas	FAO Statistical Area 41.3
Bottom longline fishery	Patagonian toothfish	Unknown	FAO Statistical Area 41
Trap	Unknown	Unknown	FAO Statistical Area 41
Bottom gear	Unknown	Seamounts, e.g. on the Rio-Grande Rise	FAO Statistical Area 41

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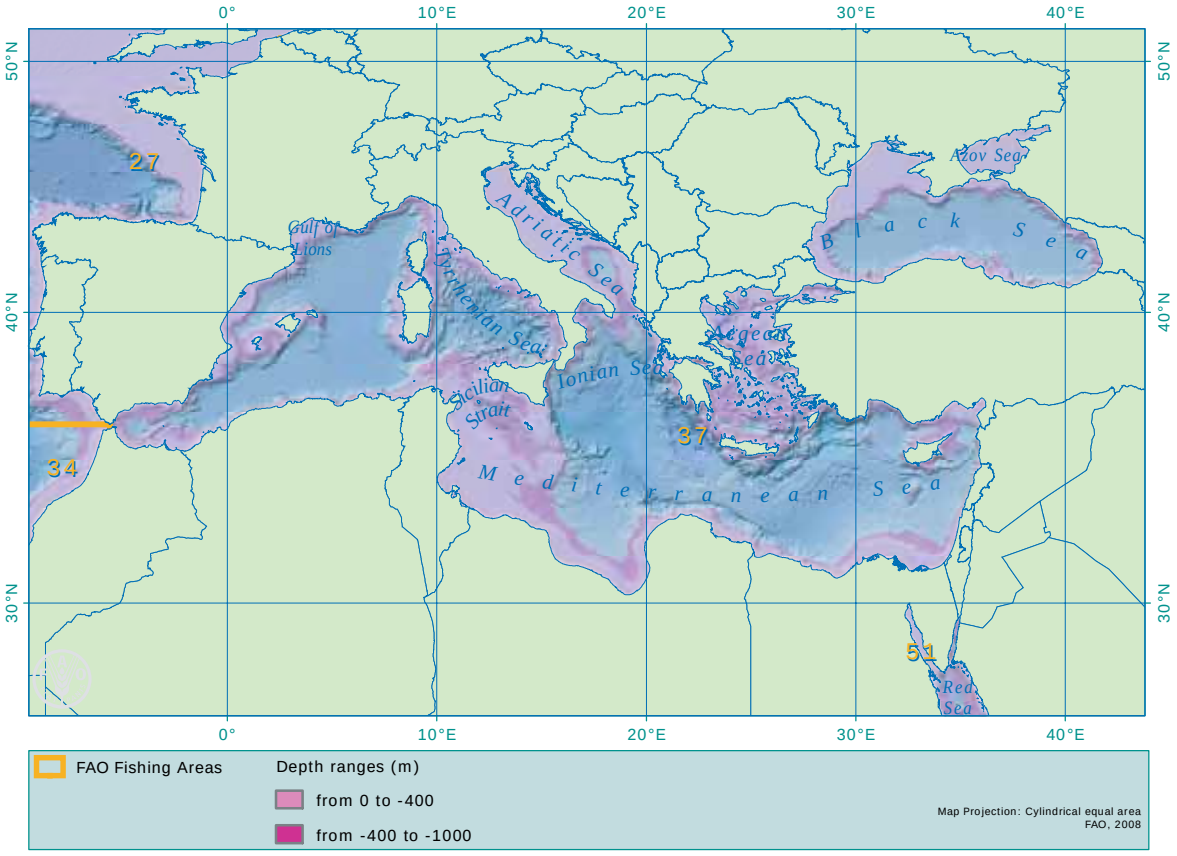


MAP 1
The Mediterranean Sea

The Mediterranean Sea

FAO Statistical Area 37

GEOGRAPHIC DESCRIPTION OF THE REGION

The Mediterranean Sea is almost entirely landlocked between continents and is a deep sea with some areas of sea floor that reach depths of around 5 000 metres (m). The maximum depth is 5 121 m in the Matapan-Vavilov Deep, off the southern coast of Greece (Cartes *et al.*, 2004). The Strait of Gibraltar, in the western end of the Mediterranean, constitutes the only natural connection with the Atlantic Ocean. The strait is a shallow and narrow channel (320 m deep and 14 kilometres [km] wide). The Mediterranean is connected to the Black Sea through an even shallower channel of 70 m in its northeastern corner. Furthermore, it has been connected with the Red Sea since 1869, through the Suez Canal. A series of transverse ridges, with a north-south trend, subdivide the Mediterranean Basin morphologically and sections of these emerge above sea level (Sverdrup *et al.*, 1942, in Sardà *et al.*, 2004). One of these, between the island of Sicily and the African coast (sill depth of about 400 m) divides the basin into its western and eastern depressions. Representing less than 25 percent of the total basin area (Got *et al.*, 1942, 1985, in Sardà *et al.*, 2004), the continental shelves are considered narrow (Sardà *et al.*, 2004). However, the continental shelf is more expansive directly off the coasts of Tunisia, the Libyan Arab Jamahiriya and the southern Italian island of Sicily, as well as in the Adriatic (see Map 1).

JURISDICTIONS IN THE REGION[1]

Although there is no legal obstacle to doing so, most of the Mediterranean states have not, to date, exercised their right to establish, implement or give effect to the claims on exclusive economic zones (EEZs). Some have, however, claimed EEZs (Papanicolopulu, 2007). All states have jurisdiction over territorial waters extending from a range of 3 to 12 nautical miles (nm), depending on the state concerned. As the majority of the states in the region have ratified the United Nations Convention on the Law of the Sea (UNCLOS), the jurisdictions mostly extend out to 12 nm zones from the baseline. As a consequence, apart from the 12 nm territorial seas of each state and the proclaimed protected fishing/ecological zones, a major part of the Mediterranean is high seas, enjoying the restricted freedoms as set out in UNCLOS (Tudela *et al.*, 2004). Importantly, these high seas lie within close distances to the coasts, rendering their access easy and essentially open (Cacaud, 2005).

A variety of zones both in accordance with UNCLOS and *sui generis* zones have been declared, such as 12-nm continguous zones adjacent to territorial seas, archaeological contiguous zones and *sui generis* zones including fisheries zones or fisheries protected zones and ecological protection zones (Papanicolopulu, 2007).

The Black Sea also has complicated jurisdictional issues with some states currently claiming the establishment of EEZs and trying to define the limits of their maritime jurisdictions.

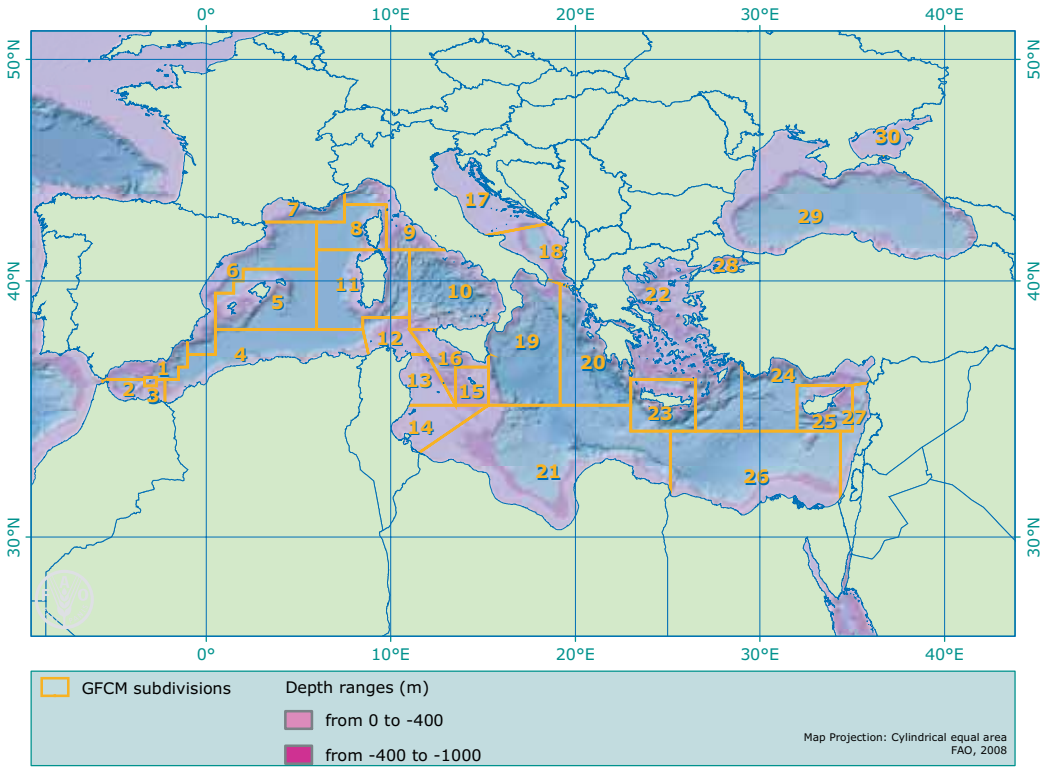
[1] This section is an informative and neutral summary on the regime pertaining to the exercise of jurisdiction by the coastal states concerned. It should not be interpreted as having legal relevance and/or implications of any kind.

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

The Agreement for the establishment of the General Fisheries Commission for the Mediterranean (GFCM), under the provisions of Article XIV of the FAO Constitution, was approved by the FAO Conference in 1949 and entered into force in 1952[2] (see Map 2 for the Convention Area). The objectives of GFCM are to promote the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture in the Mediterranean, Black Sea and connecting waters (FAO Statistical Area 37).[3] GFCM has the authority to adopt binding recommendations for fisheries conservation and management in its Convention Area. Membership is open to both Mediterranean coastal states and regional economic organizations as well as to United Nations member states whose vessels engage in fishing in Mediterranean waters. Currently, there are 23 member countries, together with the European Community.[4] GFCM studies and responds to matters pertaining to deep-sea fisheries through Subcommittees and Working Groups. Those relevant to this review include Working Groups on Demersal Species, Stock Assessment Methodologies and on Bycatch and Incidental Catch.

Table 1 provides an overview of the various Geographical Sub-Areas (GSAs) of the Mediterranean discussed in this review, as well as their depth range and likely jurisdiction (concluded through Geographic Information System [GIS] analysis).



MAP 2
The GFCM Convention Area (the Mediterranean, Black Sea and connecting waters) and Geographical Sub-Areas (GSAs)

[2] Amendments to the Agreement were approved in 1963, 1976 and 1997.

[3] This review, however, mainly focuses on the Mediterranean Sea.

[4] Members of GFCM include: Albania, Algeria, Bulgaria, Croatia, Cyprus, European Community, Egypt, France, Greece, Israel, Italy, Japan, Lebanon, the Libyan Arab Jamahiriya, Malta, Monaco, Montenegro, Morocco, Romania, Slovenia, Spain, the Syrian Arab Republic, Tunisia and Turkey. http://www.gfcm.org/gfcm/about/5 (Accessed 5 August, 2008).

TABLE 1
Geographical Sub-Areas (GSAs) of the Mediterranean discussed in this review

Number	Name	Estimated depth range (and jurisdiction)
1	Northern Alboran Sea	Some areas between 400 and 1 000 m, minor areas of 0–400, the rest below 1 000 m; likely to be national waters
5	Balearic Islands	Area largely deeper than 1 000 m, with smaller areas of between 400 and 1 000 m; likely to be national waters
6	Northern Spain	Largely below 1 000 m, minor areas between 400 and 1 000 m; likely to be national waters
7	Gulf of Lions	Only a small portion between 400 and 1 000 m and the rest 0–400 m or below 1 000 m; likely to be national waters
9	Ligurian and Northern Tyrrhenian Sea	Portions below 1 000 m, minor areas between 400 and 1 000 m and portions above 400 m; likely to be national waters
11	Sardinia	Only minor areas of between 400 and 1 000 m; likely to be national waters
16	South/Strait of Sicily	On continental shelf; minor areas of below 1 000 m, some areas of 400–1 000 m
17	Northern Adriatic Sea	Only 0–400 m depth range; likely to be national waters
18	Southern Adriatic Sea	Portion of areas between 400 and 1 000 m, as well as below 1 000 m; likely to be national waters
19	Western Ionian Sea	Primarily below 1 000 m with small areas from 400 to 1 000 m
20	Eastern Ionian Sea	Primarily below 1 000 m
21	Southern Ionian Sea	Larger areas between 400 and 1 000 m; likely to be national waters
22	Aegean Sea	Portion of below 1 000 m as well as portions of between 400 and 1 000 m; likely to be national waters
24	North Levant	Largely below 1 000 m
25	Cyprus	A significant portion of between 400 and 1 000 m; likely to be national waters
26	South Levant	Largely below 1 000 m, portions of 0–400 m and small areas of between 400 and 1 000 m
27	Levant	Possibly territorial waters of neighbouring countries, mainly below 1 000 m; likely to be national waters

Note: this table was prepared based on the information in the review. Its purpose is solely to identify deep-sea areas by GSA. It is not aimed at addressing jurisdictional matters.
Source: FAO maps.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

The Mediterranean has been addressed in a different manner from the other regions presented in this review because of the particular issue of identification of the high seas in the region. The 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire: see Appendix A) was therefore not sent to countries with a bottom fishing fleet exclusively fishing in the Mediterranean. This regional review was carried out through a desktop study and focuses on the Mediterranean Sea and it does not include deep-sea fisheries in the Black Sea.

Through consultations with experts on deep-sea fisheries in the Mediterranean, a working definition for the purpose of this review was developed: those fisheries on the slope of the continental shelf and on the sea bed, between 400 and 1 000 m in depth, continental shelf excluded. In addition, it was decided to focus on two primary fisheries, as described below, in the deep seas, and not necessarily in the high seas because of the difficulty in defining high seas in the region, which have been the area of primary interest.

The two commercially important deep-sea bottom fisheries described in this review are the multispecies fishery for European hake (*Merluccius merluccius*)[5] and the

[5] In fact, the European hake has two subspecies – one in the Atlantic and one in the Mediterranean. In this review, the focus is on the Mediterranean subspecies; *Merluccius merluccius smiridus*. However, for simplicity it is referred to as European hake (*Merluccius merluccius*).

directed fisheries for red shrimps (*Aristaeomorpha foliacea* and, in particular, *Aristeus antennatus*).

History of fisheries

Although the Mediterranean coastal states have a long history of fishing, deep-sea fishing only began in the first decades of the last century, as a result of the development of new technology that made fisheries in deeper waters possible. For example, red shrimps became the target of deep-water bottom trawl fishing in the Ligurian Sea in the 1930s (Sardà *et al.*, 2004).

In the central Mediterranean, preceding the collapse of the *A. foliacea* and *A. antennatus* stocks in the late 1970s, exploitation of these species had progressively been decreasing. Fishing of *A. antennatus* resumed following signs of stock recovery in 1985 (Orsi Relini and Relini, 1988, in Sardà *et al.*, 2004); however, *A. foliacea* was still extremely scarce and commercially insignificant in the late 1990s (Fiorentino *et al.*, 1998, in Sardà *et al.*, 2004). Suggested causes of the collapse included overfishing together with environmental decay, hydrology, failure of recruitment and parasitic attack on already stressed stocks (Orsi Relini and Relini, 1985; Relini and Orsi Relini, 1987, both in Sardà *et al.*, 2004).

Current fisheries

Fisheries down to a depth of 700 m have been common since the middle of the last century, and bottom trawl fisheries currently extend to almost 1 000 m, but grounds below this depth are considered beyond the reach of fishing boats (Sardà *et al.*, 2004). In addition, as will be explained in the section on Conservation and management measures, there is a GFCM ban in place on fishing with towed dredges and trawlnets below 1 000 m.

Two of the deep-sea demersal target species of greatest commercial value are European hake and blue and red shrimp (*Aristeus antennatus*) (see Table 2 and Figure 1). Other deep-water shrimp species, such as the giant red shrimp (*Aristaeomorpha foliacea*), are also a target species but are often grouped together in catch reports. For example, catch reported to FAO as "blue and red shrimp" may also include giant red shrimp. Therefore, although the discussion in this review will largely focus on *Aristeus antennatus*, it is possible that this also includes *Aristaeomorpha foliacea*, even when not referred to specifically. Furthermore, sometimes both of these species are reported together as Aristeid shrimps nei.

In Mediterranean terms, the species described here can be called deep-sea species, although they might not occur in waters as deep as in other deep-sea high seas fisheries around the world. Orsi Relini *et al.* (2002) suggest that the hake distribution in the Mediterranean Sea has a wide range – from 25 to 1 000 m. However, hake is mainly abundant at depths ranging from 100 to 400 m. The blue and red shrimp prefer a depth range of 501 to 800 m, but can

TABLE 2
Some of the main species targeted by deep-sea fisheries in the Mediterranean

Common name	Scientific name
Main target species – trawl fisheries	
European hake	*Merluccius merluccius*
Blue and red shrimp	*Aristeus antennatus*
Giant red shrimp	*Aristaeomorpha foliacea*
Main target species – gillnet and longline fisheries	
European hake	*Merluccius merluccius*
Associated species	
Norway lobster	*Nephrops norvegicus*
Deep-water rose shrimp	*Parapenaeus longirostris*
Blackbelly rosefish (blue-mouth redfish)	*Helicolenus dactylopterus*
Others species (mainly discarded)	
Greater forkbeard	*Phycis blennoides*
Four-spot megrim	*Lepidorhombus boscii*
Golden shrimp	*Plesionika martia*
Horned octopus (curled octopus)	*Eledone cirrosa*
European conger	*Conger conger*
Blue whiting	*Micromesistius poutassou*

Sources: GFCM SCSA, 2003; D'Onghia *et al.*, 2003; Sardà *et al.*, 2004; EC, 2002.

be found at both shallower and deeper depths (Cau *et al.*, 2002).

Trawl fisheries for red shrimps

The trawl fisheries for red shrimps take place on sandy, muddy bottoms and Cau *et al.* (2002) suggest that the blue and red shrimp is more abundant in the west and the giant red shrimp in the east.

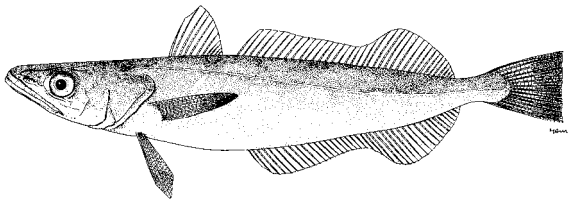
In the central Mediterranean, the main fisheries targeting red shrimps are located along the Italian Ionian Sea (GSA 19, see Map 2). Fishing takes place from coastal waters to depths of 700 to 750 m (Sardà *et al.*, 2004) and is potentially largely located in the deep seas.[6] The Strait of Sicily and southern Sardinia (GSAs 16 and 11) constitute the location for the main *A. foliacea* fisheries. *A. antennatus* is mostly caught in the western Mediterranean and in the Ionian Sea (GSAs 19, 20 & 21) Although the red shrimp fisheries are often distinct, there is some degree of overlapping. (Bianchini and Ragonese, 1994; Sardà *et al.*, 2001, both in Sardà *et al.*, 2004). In the Greek Ionian Sea (GSA 20), because of the steep bottoms and narrow continental shelf, fishing is mainly carried out only down to a depth of 400 m (Stergiou *et al.*, 1997, in Politou *et al.*, 2003); however, Politou *et al.* (2003) note that there is potential for expansion of, for example, red shrimp trawling into deeper waters and some occasional exploitation has begun.

In terms of catch volume in the different GSAs, around 300 tonnes of red and blue shrimp per year were landed from the Northern Alboran Sea (GSA 1) during the period 1976–2001. The last three years of that period indicated a decrease in catch. In the area of the Balearic Islands (GSA 5), landings averaged 170 tonnes between 2000 and 2003. Lastly, in the northern Spain area (GSA 6), the average annual landing around the year 2000 was 114 tonnes. (GFCM SCSA, 2003)

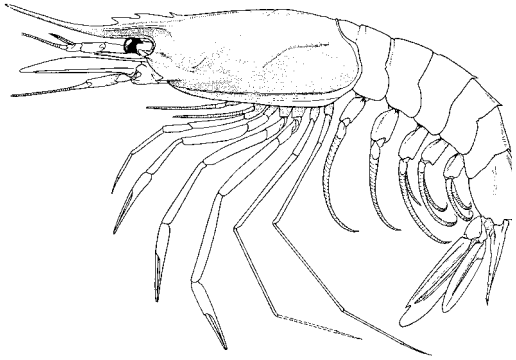
In Table 3, an attempt has been made to review catch reported by countries

FIGURE 1
Examples of species targeted by deep-sea fisheries in the Mediterranean

European hake (*Merluccius merluccius*)



Blue and red shrimp (*Aristeus antennatus*)



Source: FAO

TABLE 3
Catch (tonnes) of blue and red shrimp by country and GSA

Country	2002	2003	2004	2005
Adriatic (GSA 17[c] & 18[a])				
Italy[d]	114	130	134	119
Balearic Islands (GSA 5[a])				
Algeria	893	1 027	1 310	1 542
Spain	922	909	951	658
Ionian Sea (GSAs 19[b], 20[c] & 21[a])				
Albania	34	22	15	12
Italy[d]	1 081	1 542	698	1 732
Tunisia	20	–	6	149
Gulf of Lions (GSA 7[c])				
Spain	111	81	74	–
Sardinia (GSA 11[b])				
Italy[d]	573	737	714	1 323
Tunisia	31	24	37	14

Source: FAO, 2008.
[a] Likely to include deep-sea areas.
[b] Possibly includes deep-sea areas.
[c] Unlikely to include deep-sea areas.
[d] The Italian catch was reported as "Aristeid shrimps nei" by Italy but can be assumed to consist of *A. foliacea* and *A. antennatus*.
Note: this table is based on the most specific catch data that could be found. However, some of the catch of the above-mentioned species may not be included because of different, and less specific, ways of reporting catch, such as reporting as "crustaceans", or "shrimp/prawns".

[6] See Table 1 for a summarized analysis of each GSA mentioned.

from 2002 to 2005, in areas where trawling for blue and red shrimp is likely to take place below 400 m and off the continental shelf (assumptions made through GIS analysis). In this period, the largest amounts of catch were taken by Italy in the Ionian Sea and off Sardinia, and by Algeria and Spain off the Balearic Islands.

Hake fisheries

In the Mediterranean, European hake is caught in multispecies fisheries by bottom trawlers that operate over the continental shelf and slope (Goñi *et al.*, 2004), but also by gillnetters and set bottom longliners. Gillnetters and longliners are assumed to be operating in the deep sea (i.e. off the shelf and below 400 m). Similarly, bottom trawlers may also fish on the slope below 400 m and therefore in the deep seas.

In 2001, hake was exploited in the Gulf of Lions (GSA 7; only a small portion of which is potentially deep seas), by 113 French trawlers, 95 French gillnetters, 26 Spanish trawlers and 20 Spanish longliners. While the catch of the trawlers mainly included juveniles living on the continental shelf which are not considered to be in the deep seas, the gillnetters and longliners mainly exploited the adult part of the stock (spawners) living on the slope and in non-trawlable areas. During the period 1988–2001, 80 percent of the landings were done by trawlers. While the total number of trawlers decreased during this period (from 196 to 139), the number of gillnetters and longliners increased (from 20 to 95, and from 13 to 20 boats respectively). Total landings in 1988 were estimated at 2 941 tonnes compared with a similar 2 693 tonnes in 2001. It was also noted that discards periodically represented a significant part of the total hake catch, both in weight and in number. (GFCM SCSA, 2003)

In the Ligurian and North Tyrrhenian Sea (GSA 9), a hake fishery operated in 2001 to 2002, involving about 150 trawlers as well as a more limited number of vessels belonging to the artisanal fleet. In this area, annual landings are around 500 tonnes. Discards of undersized individuals can be considered important, although a reduction in discards and landings of undersized individuals did take place through enforcement of management measures. (GFCM SCSA, 2003)

In Table 4, an attempt has been made to review catch reported by countries from 2002 to 2005, in areas where fishing for European hake is likely to take place below 400 m and off the continental shelf (assumptions made through GIS analysis). In this period, the largest amounts of catch were taken by Italy (GSA 17, 18, 19, 20, 21 and 11), Greece (GSA 22), Spain (GSA 5) and France (GSA 7).

TABLE 4
Catch (tonnes) of European hake by country and GSA

Country	2002	2003	2004	2005
Adriatic (GSAs 17[c] & 18[a])				
Croatia	624	460	678	870
Italy	2 260	2 998	2 834	3 753
Serbia and Montenegro	18	18	19	19
Slovenia	2	5	1	3
Aegean (GSA 22[a])				
Greece	2 339	2 565	3 065	3 073
Balearic Islands (GSA 5[a])				
Algeria	209	31	22	12
Morocco	197	187	203	156
Spain	4 005	3 895	3 829	3 935
Gulf of Lions (GSA 7[c])				
France	2 663	2 452	1 291	1 019
Spain	701	–	334	428
Ionian Sea (GSAs 19[b], 20[c] & 21[a])				
Albania	200	384	473	267
Greece	591	604	683	798
Italy	4 251	4 297	4 680	7 121
Malta	–	–	–	–
Tunisia	638	242	740	520
Levant (GSAs 24[b], 26[a], 27[c] and possibly including 25[a] [Cyprus])				
Cyprus	3	11	10	28
Israel	68	60	39	36
Syrian Arab Republic	63	70	86	110
Sardinia (GSA 11[b])				
France	–	–	1	1
Italy	1 948	2 066	2 072	4 506
Tunisia	900	960	812	775

Source: FAO, 2008.
[a] Likely to include deep-sea areas.
[b] Possibly includes deep-sea areas.
[c] Unlikely to include deep-sea areas.

TABLE 5
Total catch (tonnes) by country and fishery for all GSA areas, 2002–2006

GFCM member country	Catch 2002 (tonnes)		Catch 2003 (tonnes)		Catch 2004 (tonnes)		Catch 2005 (tonnes)		Catch 2006 (tonnes)	
	Hake	Shrimp	Hake	Shrimp	Hake	Shrimp	Hake	Shrimp	Hake	Shrimp
Albania	200	34	384	22	473	15	267	12	280	18
Algeria	209	893	31	1 027	22	1 310	12	1 542	44	1 423
Croatia	624	–	460	–	678	–	870	–	920	–
Cyprus	3	–	11	–	10	–	28	–	23	–
France	2 663	–	2 452	–	1 292	–	1 020	–	1 031	–
Greece	2 930	–	3 169	–	3 748	–	3 871	–	4 794	–
Israel	68	–	60	–	39	–	36	–	18	–
Italy	8 459	1 768[a]	9 361	2 409[a]	9 586	1 546[a]	15 379	3 174[a]	18 570	3 623[a]
Malta	–	–	–	–	–	–	7	–	5	–
Montenegro[b]	18	–	18	–	19	–	19	–	19c	–
Morocco	197	–	187	–	203	–	156	–	958	–
Slovenia	2	–	5	–	1	–	3	–	3	–
Spain	4 706	1 033	3 895	990	4 163	1 025	4 363	696	4 766	1 004
Syrian Arab Republic	63	–	70	–	86	–	110	–	62	–
Tunisia	1 538	51	1 202	24	1 552	43	1 295	163	1 336	9
Total	21 680	3 779	21 140	4 472	21 872	3 939	27 436	5 587	32 829	6 077

[a] The Italian catch was reported as "Aristeid shrimp nei" by Italy but can be assumed to consist of *A. foliacea* and *A. antennatus*.
[b] The country has only been fishing/reporting capture this year, or this and last year. Before 2006, catch by Montenegro was reported as catch by the State Union of Serbia and Montenegro. From 2007, Montenegro alone is a GFCM member.
[c] FAO estimate.
Sources: FAO Fisheries and Aquaculture Information and Statistics Service – Global Capture Production 1950-2006; FAO, 2008.
Note: this table is based on the most specific catch data that could be found. However, some of the catch of the above-mentioned species may not be included because of different, and less specific, ways of reporting catch, such as reporting as "crustaceans", or "shrimp/prawns".

Catch and capacity summary

Table 5 provides an overview of the total catch of European hake and blue and red shrimp per country from 2002 to 2006 in the Mediterranean. However, there is no information available on whether this catch was caught in international waters or in waters under national jurisdiction. Overall, the main fishing states in terms of the blue and red shrimp appear to be Italy (with an average of 2 504 tonnes caught per year over this period), Algeria (average of 1 239 tonnes per year) and Spain (average of 949.6 tonnes per year). In the European hake case, the main fishing states appear to be Italy (average of 12 271 tonnes per year), Spain (average of 4 378.6 tonnes per year), Greece (average of 3 702.4 tonnes per year), France (average of 1 691.6 tonnes per year) and Tunisia (average of 1 384.6 tonnes per year).

Table 6 provides an overview of the different types and numbers of vessels (>15 m) that could possibly

TABLE 6
GFCM Authorised Vessels List (vessels of >15 m)

Country	Vessel type				Total
	Bottom trawlers[a]	Other trawlers[b]	Longliners (set longlines)	Gillnetters (set gillnets)	
Albania	117	6	–	possibly 1	123/124
Algeria	Vessel types not specified but a total of 543 (>15 m) vessels registered				543[c]
Croatia	–	151	–	–	151
Cyprus	15	–	–	–	15
France	28	89	–	5	122
Greece	323	–	45	19	387
Israel	No information				–
Italy	1 745	3	90	8	1 846
Malta	14	1	15	–	30
Montenegro	No information				–
Morocco	Vessel types not specified but a total of 577 (>15 m) vessels registered				577[c]
Slovenia	4	2	–	1	7
Spain	802	–	3	19	824
Syrian Arab Republic	No information				–
Tunisia	Vessel types not specified but a total of 760 (>15 m) vessels registered				760[c]

[a] Mostly bottom otter trawlers but also bottom beam trawlers, bottom pair trawlers and non-specified bottom trawlers.
[b] Including mid-water otter trawlers, mid-water pair trawlers and non-specified trawlers.
[c] Only a total number of vessels reported, without indication of type.
Source: GFCM Authorised Vessels List. http://www.gfcm.org/gfcm/topic/16163
Note: according to FAO Species Fact Sheets, these are the vessel types most likely to be catching European hake and blue and red shrimp.

be fishing for European hake and blue and red shrimp. It should be noted that this vessel information is based on general information in the GFCM Authorised Vessels List and thus it does not necessarily correspond to the number of vessels actually fishing for these species. Furthermore, this information only exists for 2008, as this was the year the list was made operational. Overall, it shows that Italy, Spain and Greece have the largest number of vessels, with fleets largely consisting of bottom trawlers.

Illegal, Unreported and Unregulated (IUU) fishing

IUU fishing in the Mediterranean is technically all fishing taking place by vessels that are not on the Authorised Vessels List. Pursuant to Recommendation GFCM/2005/2, GFCM established a Web-based Authorised Vessels List, for which Members provide information and updates. This "white list" complements a "black list" of vessels presumed to have carried out IUU fishing activities in the GFCM area, although the latter is still not in place.

In combating IUU fishing, the GFCM Members have adopted several measures including, for example, General Guidelines for a GFCM Control and Enforcement Scheme. In 2008, a binding Recommendation on a Regional Scheme on Port States Measures to Combat Illegal, Unreported and Unregulated (IUU) Fishing (Recommendation GFCM/2008/1) was adopted. This recommendation includes calls on contracting parties to:

- designate and publicize national ports to which foreign vessels may be permitted access and, to the greatest extent possible, ensure that every port designated and publicized has sufficient capacity to conduct inspections and take other port state measures in accordance with the Recommendation;
- before granting access to their designated ports, require the masters of vessels to notify the competent authorities of the port they wish to use at least 72 hours before the estimated time of arrival;
- not allow a vessel to use its ports for landing, transshipping or processing of fish if the vessel:
  (a) at the relevant time was engaged in fishing in the GFCM Area and was not flying the flag of a contracting party; or
  (b) has been sighted as being engaged in, or supporting, IUU fishing in the GFCM Area, unless the vessel can establish that the catch was taken in a manner consistent with relevant GFCM conservation and management measures;
- ensure that any vessel or vessel engaged in fishing related activities that enters into its port without prior authorization shall be automatically subject to inspection.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

For European hake, the following assessments have been made in relation to the status of stocks. In 2002/3, stock assessments in the Gulf of Lions (GSA 7) and the Ligurian and Northern Tyrrhenian Sea (GSA 9) pointed at growth overexploitation, with a risk of recruitment overexploitation (GFCM SCSA, 2003). In 2005/6, growth overexploitation was reported for the Balearic Islands, northern Spain and the Gulf of Lions (GSA 5, 6 and 7), with a risk of recruitment overexploitation in the latter fishing area (GFCM SAC, 2006). In 2006/7, slight growth overexploitation was reported for the Balearic Islands, and the stock in Northern Spain was deemed to be overexploited (GFCM, 2008).

Corresponding management advice given by the Scientific Advisory Committee (SAC) has generally been related to reducing effort and improving trawl selectivity. However, as noted in SAC, it is necessary to have a clear idea of the overall effort level before reducing fishing effort. In addition, the programme of work set out for the Sub-

Committee on Stock Assessment (SCSA) for 2008 includes carrying out joint stock assessments of hake (*Merluccius merluccius*) and associated species in each GSA or a group of GSAs. (GFCM SAC, 2008).

For blue and red shrimp, the following assessments have been made on the status of stocks. In 2002/3, stock assessments in the Northern Alboran Sea (GSA 1), Balearic Islands (GSA 5) and northern Spain (GSA 6) pointed at stocks being fully exploited (GFCM SCSA, 2003). In 2005/6, stocks in the Balearic Islands and northern Spain were still deemed to be fully exploited (GFCM SAC, 2006) and, in 2006/7, stocks in northern Spain were overexploited according to the stock assessment (GFCM SAC, 2008).

Management advice given by SAC in relation to the blue and red shrimp has included the recommendation to reduce fishing effort by 10 percent (8 942 fishing days for a fleet of 130 vessels). In 2007, the implementation of 40 millimetre (mm) square mesh was recommended. (GFCM SAC, 2008)

Relevant conservation and management measures will be discussed in a later section.

Status of bycatch stocks

Little is known about the impact of fishing on benthic communities, non-target species and biodiversity in the region, as studies of the effects of fishing on deep-sea ecosystems have mostly focused on population structure and dynamics of target species.

Studies on discarding during deep-water trawling targeting red shrimps in the Ionian Sea showed that discarded catch represented a large fraction of the total catch (20–50 percent). It is suggested that this is almost exclusively a result of unwanted fish species and that discard rates seem to increase with the total catch and depth. In this fishery, discards of target species and other commercial species such as European hake, Norway lobster (*Nephrops norvegicus*), deep-water rose shrimp (*Parapenaeus longirostris*) and blackbelly rosefish (blue-mouth redfish) (*Helicolenus dactylopterus*) are negligible. However, species of low commercial value, such as greater forkbeard (*Phycis blennoides*), blue whiting (*Micromesistius poutassou*), four-spot megrim (*Lepidorhombus boscii*), golden shrimp (*Plesionika martia*), horned octopus (curled octopus) (*Eledone cirrosa*) or European conger (*Conger conger*), are discarded. (D'Onghia *et al.*, 2003; Sardà *et al.*, 2004)

Because of the multispecies nature of the demersal fishery targeting European hake and other species, there are a large number of associated species involved – for example, most of those mentioned in relation to the red shrimp fisheries (EC, 2002). Presumably, as in the red shrimp fisheries, the associated species of commercial value are likely to be retained, whereas those of low commercial value are possibly discarded to a larger extent. As mentioned above, stock assessments of European hake and associated species will be carried out during 2008.

Impacts on Vulnerable Marine Ecosystems (VMEs)

Unique and potentially vulnerable habitats of the Mediterranean include cold seeps, which are well represented along the Mediterranean Ridge, as well as deep-sea coral mounds and seamounts (Cartes *et al.*, 2004).

Although trawling, especially for red shrimp, generally takes place on muddy bottoms, fishing grounds of deep-water shrimp are also located around the perimeter of white-coral habitats, as well as on the margin of submarine canyons in the western Mediterranean (Sardà *et al.*, 2004). In addition to the possible direct effect of trawling on these VMEs, another problem related to trawling is the effects of sediment resuspension and related increased sedimentation, even at depths well beyond the ones trawled. It is suggested that although direct trawling (or other fishing methods) on coral reefs is the main obvious threat to the remaining Mediterranean deep-water coral reefs, trawling in the neighbouring bathyal mud bottoms could be equally deleterious

on these suspension feeders. Through a recent study, it was shown that sediment resuspension from trawlers working at 600–800 m depth reached a depth of 1 200 m. (Palanques *et al.,* 2004, in Cartes *et al.*, 2004)

It is suggested that most cold-water coral reefs in the Mediterranean are subfossil and date back to the last glacial age, a time of cooler seawater and better food availability. However, it is also noted that an indirect human impact has contributed to their decline – progressive human-induced forest destruction has led to the covering of white-coral mounds with a fine layer of sediment. One healthy and well developed deep-sea coral mound (consisting primarily of *Lophelia pertusa* and *Madrepora oculata*) is known to exist in the Ionian Sea and is now under protection, as mentioned in the section on Conservation and management measures. Such coral reefs, being natural deterrents to trawling, are believed to produce a positive spillover effect on the deep-water demersal resources fished on adjacent muddy bottoms. (Cartes *et al.*, 2004) Furthermore, in 2003, Maltese scientists discovered a second living and healthy deep-water coral bank, also consisting of *Lophelia* and *Madrepora*, at a depth of 390–617 m, some 20–40 km off the southern coast of Malta. This may also be a large reef and it is currently being investigated (Schembri *et al.*, 2007; GFCM SAC, 2007).

In terms of seamounts, although not comparable in numbers to certain Atlantic and Pacific areas, there are some seamounts located in the Gulf of Lions, the Alboran Sea, the eastern Tyrrhenian basin (to the south of the abyssal plain), and in the Levantine Sea (Cartes *et al.*, 2004). A total of 59 potential large seamounts has been identified for the Mediterranean (Kitchingman *et al.*, 2007). The biodiversity of this region is still poorly studied and largely unknown. One large seamount is the Eratosthenes Seamount, located off the south coast of Cyprus and west of Israel – 120 km in diameter and extending from the seafloor to within 800 m of the sea surface. (Cartes *et al.*, 2004) It is home to both *Aristaeomorpha foliacea* and *Aristeus antennatus*, as well as other species of commercial interest (Galil and Zibrowius, 1998, in Cartes *et al.*, 2004). However, overall there seem to be little fishing on seamounts in this region.

Finally, it should be noted that in the Mediterranean, anthropogenic threats to VMEs are not limited to fishing – other major threats include waste disposal (solid trash and other toxic compounds), pollution (Haedrich, 1996, in Cartes *et al.*, 2004), oil exploration/pipelines or, more indirectly, climate change (Danovaro *et al.,* 2001, in Cartes *et al.*, 2004).

CONSERVATION AND MANAGEMENT MEASURES

Target stocks

Various recommendations that are relevant to the target stocks of deep-sea high seas fisheries have been adopted by GFCM Members, in addition to the IUU measures. These include:

- REC-GFCM/29/2005/1 on the management of certain fisheries exploiting demersal and deep-water pelagic species – this recommendation calls on the Members to prohibit the use of towed dredges and trawlnet fisheries at depths beyond 1 000 m, as well as to adopt measures aimed at increasing the selectivity of demersal trawlnets, notably by immediate implementation of at least a 40 mm mesh size opening for the whole demersal trawl codend. Exploration and implementation of additional measures in order to improve the selectivity further are encouraged.
- Resolution GFCM/31/2007/3 – through this resolution GFCM Members agreed on voluntary implementation of at least the 40 mm square mesh codend in bottom trawling.
- REC-GFCM/31/2007/1 on the mesh size of trawlnets exploiting demersal resources – Members may continue authorizing, until 31 May 2010 only, the use of codend mesh size smaller than 40 mm to operate in certain local and seasonal

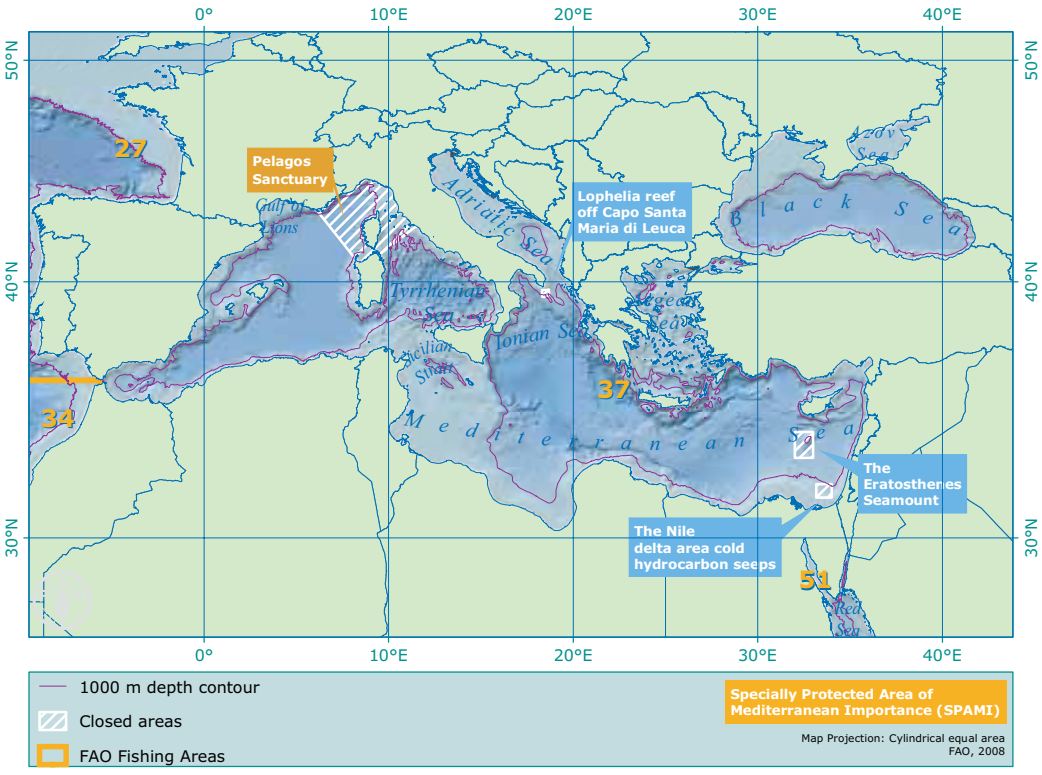
demersal trawl fisheries exploiting not-shared demersal stocks. However, this derogation applies only to fishing activities already formally authorized by the GFCM Members and shall not involve any future increase in fishing effort provided.

In addition, a recommendation on the management of fishing effort on demersal species (GFCM/2006/1) has been adopted, requiring GFCM to develop a management programme of the fishing effort concerning, in particular, demersal trawl fisheries exploiting, among others, European hake, blue and red shrimp and red shrimp, in the following GSAs: Northern and Southern Alboran Sea (GSAs 1 and 3), northern Spain (GSA 6), Balearic Islands (GSA 5), Gulf of Lions (GSA 7), Corsica (GSA 8), Ligurian and North Tyrrhenian Sea (GSA 9), South and Central Tyrrhenian Sea (GSA 10), Sardinia (GSA 11), south of Sicily (GSA 16), Northern Adriatic Sea (GSA 17), Southern Adriatic Sea (GSA 18), Western Ionian Sea (GSA 19), Eastern Ionian Sea (GSA 20) and the Aegean Sea (GSA 22) (as well as in the adjacent Sub-Areas, if relevant).

A Compliance Committee, with reviewing compliance and implementation of conservation and management measures as one of its core functions, has been established (through Recommendation GFCM 2006/6). In terms of implementation of such management measures, it was resolved in a 2008 GFCM resolution (GFCM/2008/1) that Members should report annually to the Secretariat on the implementation of GFCM measures, in a standard format agreed upon in the resolution.

Vulnerable Marine Ecosystems

In protecting VMEs, REC-GFCM/30/2006/3 established three fisheries restricted areas in order to protect the deep-sea sensitive habitats. This recommendation sets out that fishing with towed dredges and bottom trawlnets shall be prohibited in the following areas: Lophelia reef off Capo Santa Maria di Leuca (to protect the deep-water coral reefs located in international waters), the Nile delta area cold hydrocarbon seeps and the Eratosthenes Seamount (see Map 3).



MAP 3
Restricted areas in the Mediterranean Sea

INFORMATION AND REPORTING GAPS

In terms of catch reporting, it has been noted that countries report their catch but no distinction is made between that taken in waters under national jurisdiction and that taken in international waters. Countries are likely to have information on where the catch was caught, but this is not necessarily included in the reporting to GFCM. Misreporting is feared to be common. Another challenge is the varying types of logbooks being used throughout the GFCM Area; this is currently being addressed through work towards establishing a standardized GFCM logbook (GFCM, 2008).

In terms of implementation of conservation measures, the Compliance Committee noted in the report of the Second Session of the Compliance Committee (Appendix I of GFCM, 2008), that a limited number of Members fulfilled the requirement to report on the status of implementation of GFCM Recommendations and Resolutions and that the lack of information undermines efforts to assess the effectiveness of GFCM measures. In the report of the Thirty-second Session of GFCM (GFCM, 2008), the lack of necessary information, particularly on fishing mortality and current fishing effort (fleet capacity, operational units), was noted. However, some rectification of this is expected to come through the adoption of the GFCM Task 1 Statistical Matrix (Resolution GFCM/2007/1), which provides a standard format for data reporting.

SOURCES OF INFORMATION

Information was gathered from various types of GFCM reports, the GFCM Authorised Vessels List, communication with GFCM staff, FAO statistical databases and scientific journals.

SUMMARY TABLE

	European hake	Blue and red shrimp[a]
Main flag states involved in fisheries in 2006	Italy, Greece, Spain, Tunisia, France and Croatia	Italy, Algeria and Spain
Estimated number of vessels of main flag states[b]	Trawlers[c]: Italy (1 748), Greece (323), Spain (802), France (117) and Croatia (151) Gillnets: Italy (8), Greece (19), Spain (19) and France (5) Set bottom longlines: Italy (90), Greece (45) and Spain (3) Not specified: Algeria (543) and Tunisia (760)	
Total reported catch by all flag states (tonnes) in 2006	32 829	6 077
Gear	Trawlers[c], gillnets and set bottom longlines	Trawlers[c]
Main fishing areas (GSAs) in 2002–2005	Italy (GSAs 17, 18, 19, 20, 21; 11), Greece (GSA 22), Spain (GSA 5) and France (GSA 7)	Italy (GSAs 19, 20, 21, 11), Algeria and Spain (GSA 5)
Status of stocks	From slight growth overexploitation to overexploited stocks	From fully exploited stocks to overexploitation
Status of bycatch species	Multispecies hake fishery – status of associated species is largely unknown	Status of discarded and associated species is unknown

[a] Could possibly include catch of giant red shrimp. Catch reported as "Aristeid shrimp nei" by Italy.
[b] As noted in the Catch and capacity summary, this does not necessarily correspond to the number of vessels actually fishing for these species.
[c] Including bottom otter trawlers, bottom beam trawlers, bottom pair trawlers, mid-water otter trawlers, mid-water pair trawlers and non-specified bottom trawlers.

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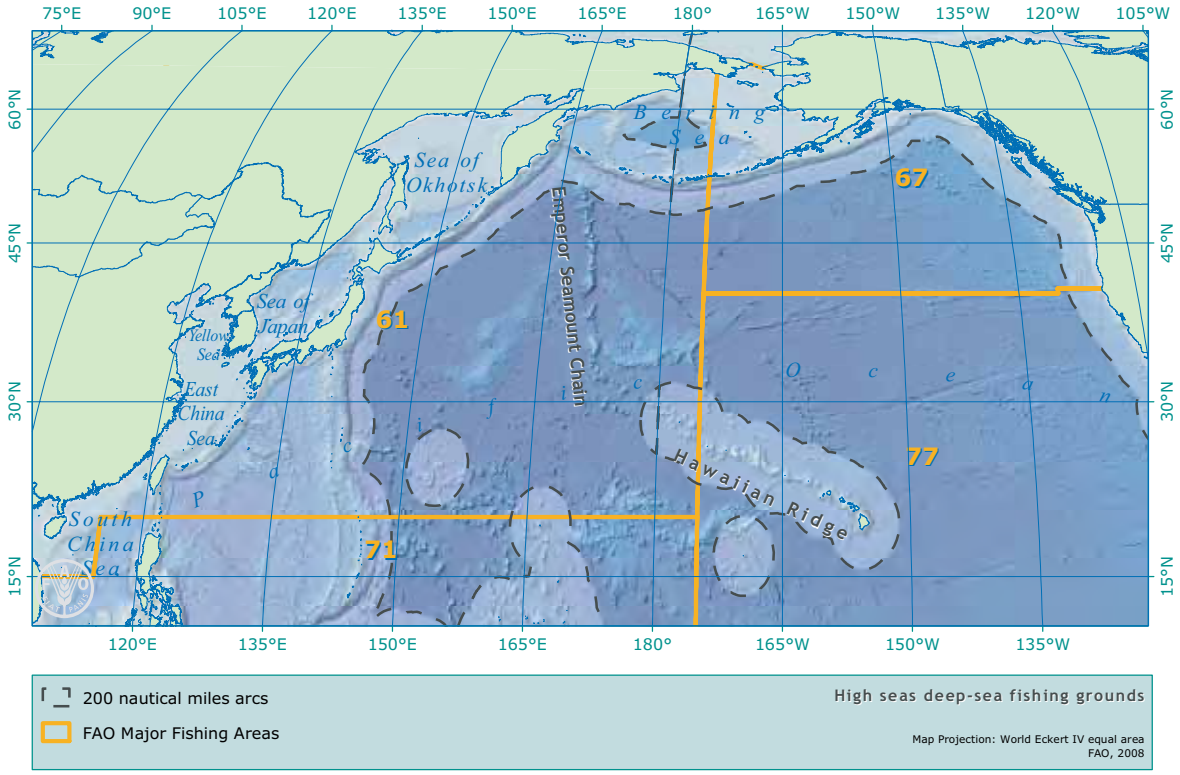
THE PACIFIC OCEAN



MAP 1
High seas deep-sea fishing grounds in the North Pacific Ocean

North Pacific Ocean

FAO Statistical Areas 61 and 67 (and portions of Areas 71 and 77 south of the equator)

GEOGRAPHIC DESCRIPTION OF THE REGION

The Pacific Ocean is the oldest of the world's ocean basins with a total area of 155.6 million square kilometres (km^2) – an area larger than the entire land surface of the Earth. The North Pacific Ocean is bounded by Asia to the west, North America to the east and the Aleutian Island chain and Bering Sea to the north (Map 1). The ocean bottom is dominated by a series of fracture zones running roughly east to west in the eastern North Pacific and a series of ridge systems and deep-ocean trenches in the north, central and western portions of the North Pacific.

On the high seas, a prominent submarine ridge, the Emperor Seamount chain, extends over 2 000 kilometres (km) from the Aleutian Island chain south to the Hawaiian Ridge in the Central Pacific (see Map 2). Some of the seamounts, particularly those south of Ojin, are known as areas of aggregation for slender armourhead (pelagic armourhead) (*Pseudopentaceros wheeleri*), alfonsino (*Beryx* spp.) and other species of commercial value. These seamounts have supported trawl, gillnet, longline and pot fisheries.

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

No regional fisheries management organization (RFMO) currently exists to regulate bottom fisheries in the high seas of the North Pacific. However, since August 2006, a multilateral process has been under way to negotiate an agreement for the regulation of high seas bottom fisheries in the North Western Pacific. The area to be covered under the agreement initially corresponded to FAO Statistical Area 61, although more recently there has been a tentative agreement amongst the countries involved to consider extending the area of coverage to the remainder of the North Pacific Ocean, as well as extending the target species to include pelagic species not covered by existing treaties.

Four countries to date have been involved in the negotiations – Japan, the Russian Federation, the Republic of Korea and the United States of America. As part of the negotiating process, the four parties have established a Scientific Working Group and an interim secretariat hosted by the Government of Japan, and have also adopted interim measures for the management of high seas bottom fisheries.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Deep-sea fisheries in the high seas in the North West Pacific began in the 1960s. Most of the deep-sea fishing in the high seas targeted seamount peaks along the Emperor and Hawaiian Seamount chains, with the latter feature having been mostly incorporated into the United States of America's exclusive economic zone (EEZ) in 1977. The trawl fisheries over the Emperor Seamount were initiated by vessels from the former Union of Soviet Socialist Republics (USSR) in 1967. In 1969, Japanese trawlers began exploratory fishing operations near the Milwaukee Seamounts (Yuryaku and Kammu). The main target species were slender armourhead and alfonsino. Japanese research vessels conducted extensive surveys in 1972 on the distribution and biology of slender armourhead and alfonsino, which contributed to the development of the trawl fishery on several seamounts, including the Kimmei, Milwaukee, Colahan and Hancock

Seamounts and other seamount groups in the Emperor chain. Other seamounts in the region that are considered too steep to trawl were exploited by bottom gillnet fisheries (Uchida and Tagami, 1984; Yanagimoto and Nishimura, 2007a).

Based on information reported to FAO (FAO, 2008), the total annual landings were, with some exceptions, relatively large during the initial years of the fishery, ranging between some 10 000 to 18 000 tonnes of slender armourhead per year. By the mid-1970s, catches fell dramatically; in the late 1970s, the catch amounted to around 1 000 tonnes per year and, by the mid-1980s, the reported catch was negligible.

However, according to information provided at the second round of negotiations for a North Western Pacific RFMO in January 2007, three to 13 Japanese bottom trawlers have operated in the area over the past 20 years. With the decline of slender armourhead came an increase in catches of alfonsino, with total landings reaching 13 000 tonnes in 1980. From the mid-1980s, the catch in the deep-sea fisheries was primarily composed of alfonsino and oreo, with a few exceptions. However, catches of slender armourhead increased abruptly around 1992 and in 2004. The seamount trawl fishery has been characterized by pulse recruitments of armourhead with a periodic shift in the catch from slender armourhead to alfonsino and vice versa (Yanagimoto and Nishimura, 2007a, 2007b, 2007c).

In assessing the potential impact of fisheries on the seamounts of the North Pacific it is also important to note that a fishery for precious corals nei (red coral) (*Corallium* spp.) existed in the 1960s–1980s on the Emperor Seamount chain using mainly tangle-net dredges (Grigg, 1993; Clark *et al.*, 2007).

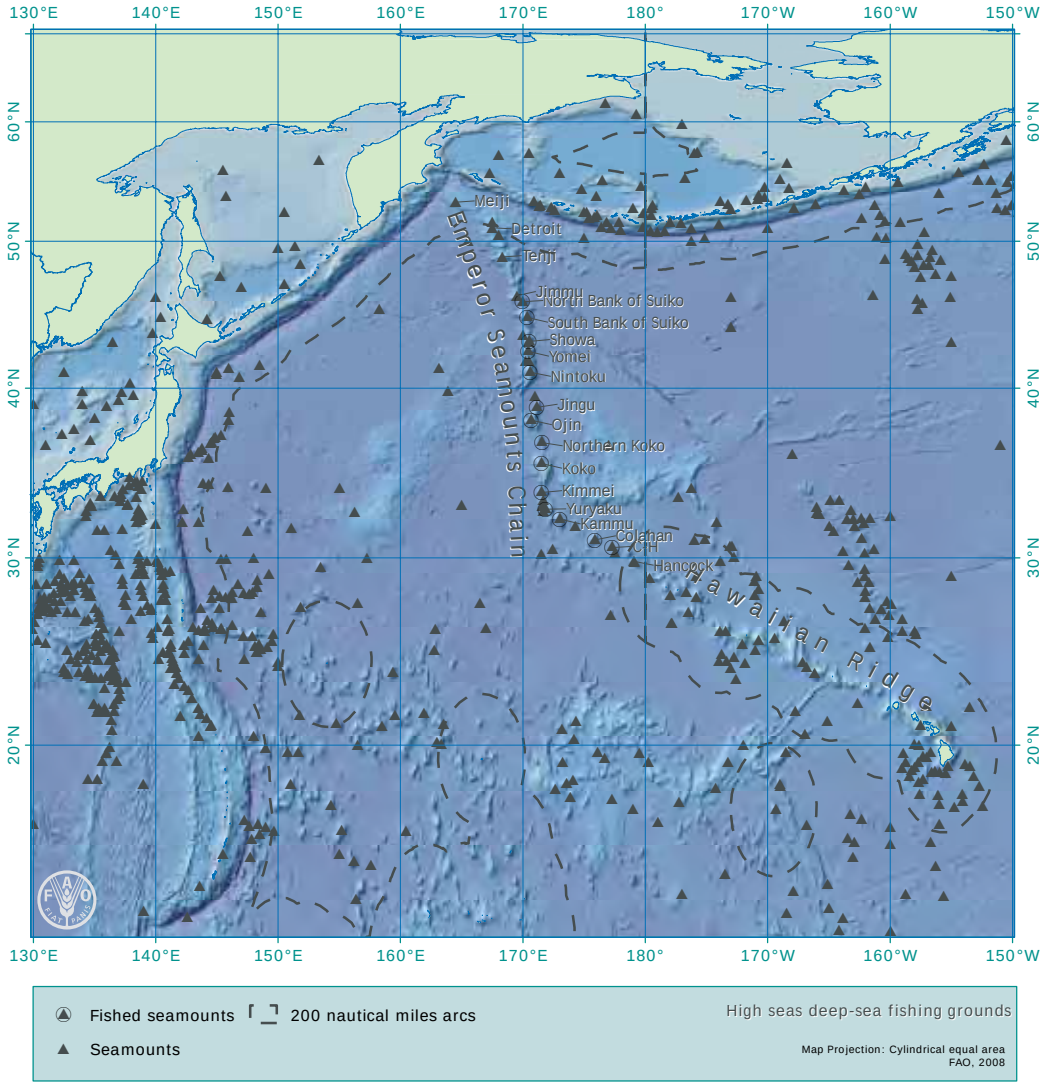
TABLE 1
Main targeted species in the North Pacific

Common name	Scientific name
Main target species – trawl fishery	
Alfonsino	*Beryx* spp.
Slender armourhead (pelagic armourhead)	*Pseudopentaceros wheeleri*
Main target species – gillnet fisheries	
Warty oreo	*Allocyttus verrucosus*
Alfonsino	*Beryx* spp.
Slender armourhead (pelagic armourhead)	*Pseudopentaceros wheeleri*
Main target species – trap/pot fisheries	
Deep-sea (red) crabs (*Geryon* nei)	*Geryon* spp.
Deep-sea crabs	*Paralomis* spp.
	Chionoecetes tanneri
Main target species – longline fisheries	
Deep-sea sharks	
Channeled rockfish (scorpionfish)	*Setarches guentheri*
Rockfishes nei	*Helicolenus avius*
	Hozukius guyotensis
Skilfish	*Erilepis zonifer*
Other species	
Pacific barrelfish (butterfish/ medusafish)	*Hyperoglyphe japonica*
Pencil cardinal (cardinal fish)	*Epigonus denticulatus*
Slender frostfish (cutlassfish)	*Benthodesmus tenuis*
Mirror dory (mirror perch)	*Zenopsis nebulosus*
Goosefish	*Lophiodes miacanthus*
Morid cods	*Physiculus* spp.
Pacific grenadier	*Coryphaenoides acrolepis*
Sablefish	*Anoplopoma fimbria*
Shortspine spurdog	*Squalus mitsukurii*

Current fisheries

High seas bottom fishing has occurred in the North West Pacific over the past few years, primarily on seamounts and guyots in the Emperor Seamount chain, including the Nintoku, Jingu, Ojin, Koko, Kimmei, Yuryaku, Kammu, Colahan and C-H Seamounts (see Map 2). The main species targeted in the high seas deep-sea trawl fishery in the North West Pacific are slender armourhead and alfonsino. The gillnet fishery targets slender armourhead, alfonsino and oreo. A trap fishery for deep-sea crabs took place in 2006, a limited longline fishery has targeted deep-sea sharks and rockfishes (Jo *et al.*, 2007) and a current longline fishery targets skilfish (*Erilepis zonifer)* (A. Baitalyuk, personal communication, 2008). Table 1 and Figure 1 show the main species targeted in the different fisheries.

There are no confirmed reports of high seas bottom fisheries in the North East Pacific, nor in the Central North Pacific. Anecdotal information indicates that a deep-sea longline fishery for morwongs (*Nemadactylus* spp.) has developed on seamounts within the



MAP 2
The Emperor Seamount chain and Hawaiian Ridge

EEZs of one or more Pacific Islands in the Southern North Pacific, suggesting that there may be similar deep-sea longline fisheries in the high seas.

Bottom trawl fishery targeting alfonsino and armourhead[1]

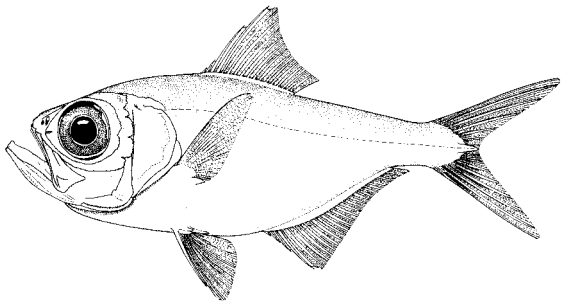
Japan reports in its response to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A) that seven vessels were engaged in high seas bottom trawl fishing in the North West Pacific (FAO Statistical Area 61) in 2006.[2] The *Report of the Second Meeting of the Scientific Working Group* (NWPBT/03/Inf4, 2007) indicates that the catch by the Japanese high seas trawl fleet in the North West Pacific in 2006 consisted of 1 488 tonnes of slender armourhead and 3 656 tonnes of alfonsino. There were 973 fishing days in total. Trawling takes place between 250 and 1 200 m depth on various seamounts in the Emperor chain (K. Miyauchi, Fisheries Agency of Japan, personal communication, 2008).

[1] Information in this section, unless otherwise noted, has been provided by the Interim Secretariat, 5th Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean, personal communication, 2008.

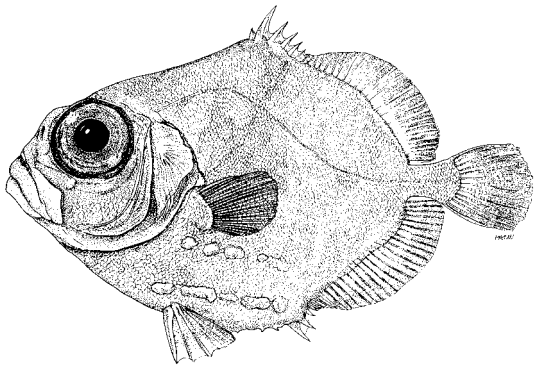
[2] Response from Japan to FAO Questionnaire.

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the North Pacific

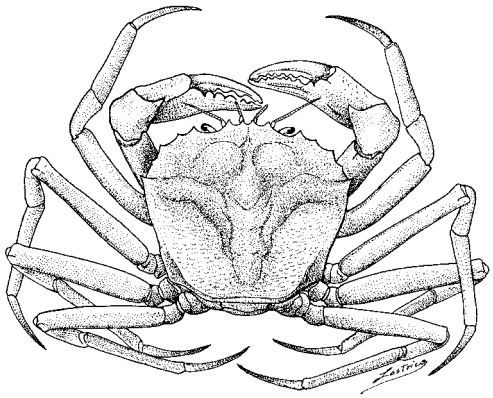
Alfonsino (*Beryx* spp.) (*Beryx splendens*)



Warty oreo (*Allocyttus verrucosus*)



Deep-sea (red) crab (*Geryon quinquedens*)



Source: FAO.

Two Korean vessels fished in 2004, with a total catch of 214 tonnes for 90 fishing days. One Korean trawl vessel fished in 2005 and two fished in 2006. In 2005, a commercial trawl vessel caught 750 tonnes for 146 days of fishing (see Table 2). The total catch in 2006 was 460 tonnes for 109 fishing days.

Russian vessels have engaged in high seas bottom trawl fisheries over the past several years. In both 2002 and 2003, one vessel was active and, in 2005, six vessels engaged in trawling in the area with a reported catch of 297 tonnes of alfonsino and 232 tonnes of armourhead.[3] No fishing by Russian vessels took place in 2006.

A summary of available data on bottom trawl fisheries is provided in Table 2.

Bottom gillnet fishery targeting alfonsino and oreo

Between one and four Japanese bottom gillnet vessels have operated in the high seas of the North West Pacific since 2000 (Yanagimoto and Nishimura, 2007a). The gillnet fishery takes place primarily between 350 and 1 200 m depth (K. Miyauchi, Fisheries Agency of Japan, personal communication, 2008). The target species are slender armourhead, alfonsino and oreo (Yanagimoto and Nishimura, 2007a). Japan reports that one vessel operated in 2006 for 221 days, with catches of 375 tonnes of alfonsino, 124 tonnes of slender armourhead and 324 tonnes of other species (Interim Secretariat, 5th Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean, personal communication, 2008).

Bottom longline fishery

One Korean longline vessel operated for 56 days in 2004. The total catch was 21 tonnes of which approximately 14 tonnes were deep-sea sharks and 2 tonnes were rockfish (SWG3/WP5/K, 2008).

New Zealand reported that one longliner operated in FAO Statistical Area 61 in 2006 for one day, catching 1.8 tonnes.[4]

[3] Response from the Russian Federation to FAO Questionnaire.
[4] Response from New Zealand to FAO Questionnaire.

TABLE 2
Summary of available data on bottom trawl fisheries in the high seas of the North West Pacific Ocean, 2003–2006

Country	Year	No. of vessels	Catch (tonnes)				Fishing effort (days per year)
			Slender armourhead	Alfonsino	Other*	Total catch	
Republic of Korea	2004	2	185	16	13	214	90
	2005	1	141	513	96	750	146
	2006	2	139	289	32	460	109
Japan	2003	3	449	2 005	3 494	5 948	680
	2004	7	9 965	1 357	2 629	13 681	939
	2005	8	5 638	3 877	2 020	11 534	/
	2006	7	1 488	3 656	3 101	8 245	973
Russian Federation	2003	1	/	/	28	28	/
	2005	6	232	297	242	771	/

/ = Unknown.
Source: Information provided by the Interim Secretariat, 5th Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean, personal communication, 2008.
* Other species include mirror dory, Pacific barrelfish and rockfishes nei.

TABLE 3
Summary of available data, 2006

Country	No. of fishing vessels and fishing effort (days)				Catch (tonnes)			
	Trawlers	Longliners	Gillnetters	Other	Armourhead	Alfonsino	Other	Total
Japan	7 (993)	0	1 (221)	0	1 612	4 031	3 425	9 068
Republic of Korea	1 (99)	0	0	0	139	289	32	460
Belize	0	0	0	5[a]	0	0	801[b]	801
New Zealand	0	1 (1)	0	0	0	0	1.8	1.8
Russian Federation	0	0	0	0	0	0	0	0

[a] Listed as "crabs" in the response from Belize to FAO Questionnaire.
[b] Listed as "other types of multipurpose vessels – shrimp/crab pots" in the response from Belize to FAO Questionnaire.

The Russian Federation also reported one longline vessel that operated in 2003 and one vessel that operated in 2004, with catches of 5 and 20 tonnes of rockfish, respectively.[5] The present target species for the Russian longliners in this fishery is skilfish with notable bycatch of Pacific grenadier (A. Baitalyuk, personal communication, 2008).

Pot fishery for deep-sea crabs

Belize reported five vessels fishing with traps for deep-sea crabs in the high seas of the North West Pacific in 2006, with a total catch of 801 tonnes.[6]

The Russian Federation reported two vessels operating in this fishery in 2002 with a total catch of 47 tonnes (43 tonnes of crab and 4 tonnes of other species) and one in 2003 with a catch of 8 tonnes of crab (Interim Secretariat, 5th Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean, personal communication, 2008).

Catch and effort summary

Table 3 provides a summary of the catch and effort of the high seas fisheries described.

Illegal, Unreported and Unregulated (IUU) fishing

Fisheries in the northwest Pacific were unregulated by a multilateral mechanism before February 2007. In February 2007, however, vessels flying the flag of

[5] Response from the Russian Federation to FAO Questionnaire.
[6] Response from Belize to FAO Questionnaire.

parties to the Second Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean (described in the section on Conservation and Management Measures) became subject to an interim measures agreement.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

The status of fish stocks is not fully known, but it would appear from a major decline in catch per unit effort (CPUE) data that slender armourhead and alfonsino stocks are overexploited or depleted (Yanagimoto and Nishimura, 2007b; 2007c).

Status of bycatch stocks

No estimate of current bycatch of non-commercial species is available, nor is the status of bycatch species known.

Impacts on Vulnerable Marine Ecosystems (VMEs)

Impacts on VMEs are unknown but likely to occur, including on cold-water corals and other sessile species associated with seamounts and ridge systems in the region. Periodic sampling of the fauna of the seamounts in the Emperor chain has taken place in past decades and evidence of coral, sponges and other benthic habitat forming species has been found. For example, the Aries VII expedition to the Milwaukee Seamount Group sampled a number of unidentified species of coral and sponges (Porifera, Gorgonocephalidae, Isididae and Antipatharia) (Stocks, 2005).

CONSERVATION AND MANAGEMENT MEASURES

As mentioned previously, interim measures for the regulation of the high seas bottom fisheries have been adopted (see Box 1). These measures apply to fisheries conducted in FAO Statistical Area 61 and commit parties (see section on Management regime) to take the following actions as specified in paragraphs 4 and 5 of the agreement.

The measures specified came into effect with the adoption of the agreement in February 2007. The remaining provisions of the interim measures agreement became applicable and operational as of 31 December 2007. The agreement contains additional provisions related to the provision and sharing of scientific information, and the monitoring and control of high seas bottom fishing vessels.

At the Fourth Inter-governmental Meeting on Establishment of a New Mechanism for Management of High Seas Bottom Fisheries in the North Western Pacific Ocean in Vladivostok in May 2008, the parties to the negotiations agreed to define the existing trawl footprint as limited to the summits of the following seamounts in the Emperor chain: Suiko, Youmei, Nintoku, Jingu, Ojin, Koko, Kimmei, Yuryaku, Kammu, Colahan and C-H, and the bottom gillnet footprint to the summits and slopes of the same seamounts (NWPBT/04, 2008).

INFORMATION AND REPORTING GAPS

A number of scientific research surveys and exploratory fishing surveys have been conducted by the Russian Federation, the Republic of Korea, the United States of America and Japan in previous decades. The main objectives of the surveys were to study the spatial distribution of commercially important species, estimate their biomass, collect biological information, study oceanographic conditions, identify changes of species composition, and study bottom topography and the structure of benthic communities (T. Yanagimoto, Hokkaido National Fisheries Research Institute, Fisheries Research Agency [FRA], Japan, and A. Orlov, Russian Research Institute of Fisheries and Oceanography [VNIRO], personal communication, 2007). However,

BOX 1

Establishment of new mechanisms for protection of vulnerable marine ecosystems and sustainable management of high seas bottom fisheries in the North Western Pacific Ocean[1]

4. Interim measures

Each country will take the following interim measures in accordance with its national laws and regulations in order to achieve sustainable management of fish stocks and protection of vulnerable marine ecosystems in the high seas areas of the North Western Pacific Ocean:

A. Limit fishing effort in bottom fisheries on the high seas of the North Western Pacific Ocean to the existing level in terms of the number of fishing vessels and other parameters which reflect the level of fishing effort, fishing capacity or potential impacts on marine ecosystems.

B. Not allow bottom fisheries to expand into areas of the North Western Pacific Ocean where no such fishing is currently occurring, in particular, by limiting such bottom fisheries to seamounts located south of 45 degrees North Latitude and to provisionally prohibit bottom fisheries in other areas of the North Western Pacific Ocean covered by these measures.

C. Notwithstanding subparagraphs A and B above, exceptions to these restrictions may be provided in cases where it can be shown that any fishing activity beyond such limits or in any new areas would not have a significant adverse impact on marine species or any vulnerable marine ecosystem.

D. The participants will work to establish science-based standards and criteria for any determinations pursuant to subparagraph C that any proposed fishing activity will not have a significant adverse impact on marine species or any vulnerable marine ecosystems. It is important that any such criteria be objective, transparent and based on the best available scientific information.

E. Pending the development of such criteria for assessing the impacts of fishing activity on marine species and vulnerable marine ecosystems, no exceptions (as provided in subparagraph C) to the provisions of subparagraphs A and B will be authorized.

F. Upon adoption of such criteria, any determinations, by any flag state or pursuant to any subsequent arrangement for the management of the bottom fisheries in the areas covered by these interim measures, that fishing activity would not have a significant adverse impact on marine species or any vulnerable marine ecosystems, will be made publicly available through agreed means.

G. Further, in areas where, in the course of fishing operations, evidence of vulnerable marine ecosystems, such as coldwater corals or other associated species, is encountered, participants will require vessels flying their flag to cease bottom fishing activities. All such encounters, including the location and the species in question, will be reported to the interim secretariat, who will notify the other parties so that appropriate measures can be adopted in respect of the relevant site.

5. Contingent action

In addition to the interim measures contained in paragraph 4 above, bottom fisheries in the areas where vulnerable marine ecosystems are known to occur or are likely to occur, based on the best available scientific information, shall cease by 31 December 2008, unless conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems, consistent with the relevant provisions of the 2006 United Nations General Assembly Resolution on Sustainable Fisheries (A/61/L.38) and such international standards as may be developed pursuant thereto.

[1] http://www.fpir.noaa.gov/Library/IFD/NWPBT_InterimMeasure-1-1.pdf

more complete information on the status of target fish stocks and bycatch species is necessary. Comprehensive assessments of the known or likely distribution of VMEs and the potential impacts of high seas bottom fisheries are now under way.

SOURCES OF INFORMATION

In their reply to the FAO Questionnaire sent to states known as having a high seas deep-sea fishing fleet, Belize, Japan, New Zealand, the Republic of Korea and the Russian Federation officially replied with some information regarding deep-sea fishing in the high seas of the North Pacific. Russian and Japanese experts who attended an FAO workshop provided substantial information and comments. Additional information was drawn from the papers submitted to the First and Second Meetings of the Scientific Working Group and the Second Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean, and other sources as footnoted.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Japan, Republic of Korea, Belize, New Zealand, Russian Federation
Estimated total number of vessels	16
Total reported catch (tonnes)	10 331

Main fisheries			
Gear	**Target species**	**Fishing grounds**	**Regional Area**
Bottom trawl	Slender armourhead, alfonsino, oreo	Emperor Seamounts (including Nintoku, Jingu, Ojin, Koko, Kimmei, Yuryaku, Kammu, Colahan and C-H)	FAO Area 61
Pot	Deep-sea red crabs	Emperor Seamount	FAO Area 61
Bottom gillnet	Slender armourhead, alfonsino, oreo	Emperor Seamount	FAO Area 61
Longline	Shark, scorpionfish, slender armourhead, alfonsino, oreo, skilfish	Emperor Seamount	FAO Area 61

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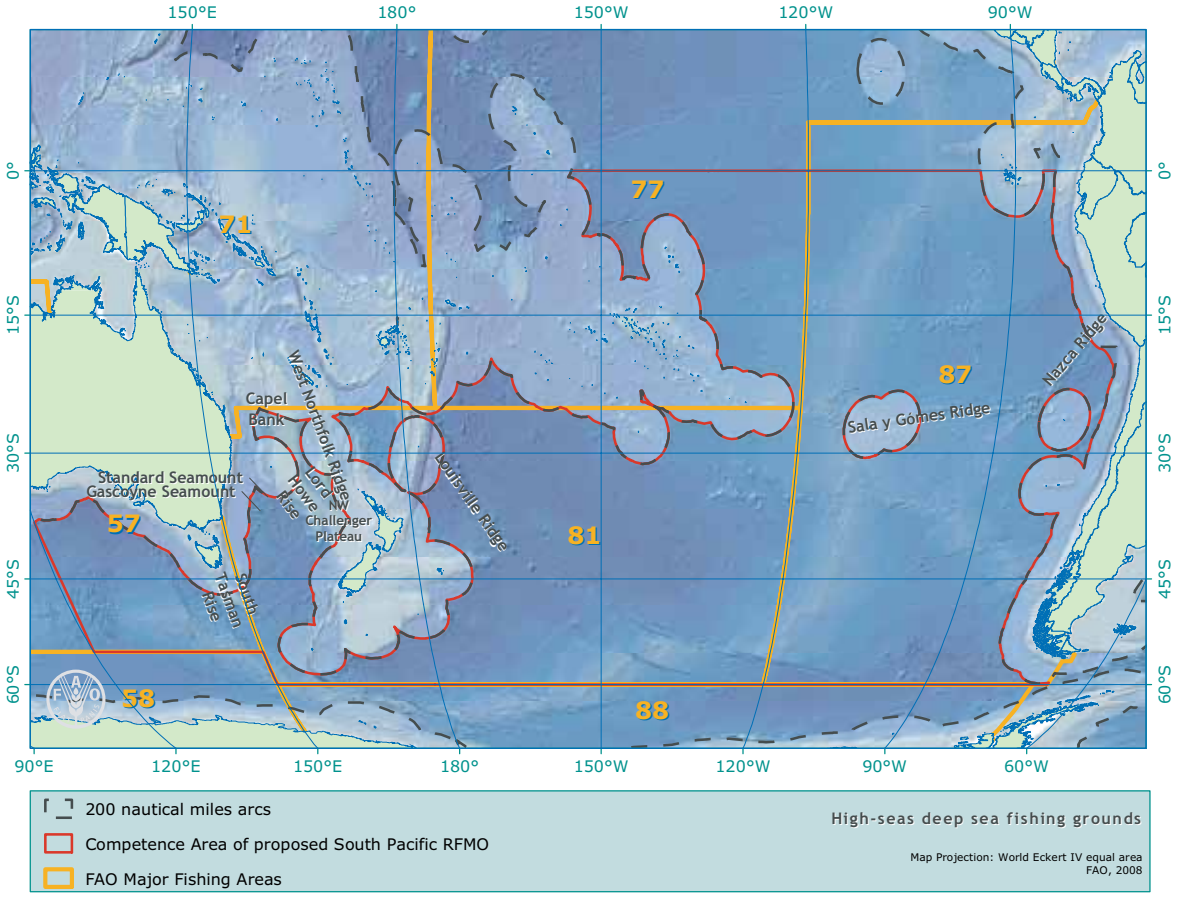


MAP 1
High seas deep-sea fishing grounds in the South Pacific Ocean

South Pacific Ocean

FAO Statistical Areas 57 (eastern part), 81, 71 and 77 south of the equator, and a large portion of 87

GEOGRAPHIC DESCRIPTION OF THE REGION

The South Pacific Ocean extends from the equator to the Southern Ocean, and from the Malay Archipelago and Australian continent in the west to the South American continent in the east (Map 1). The Pacific Ocean is the largest, oldest and deepest of the world's oceans. It contains over 30 000 islands; the oceanic islands are the tops of mountains rising from the ocean basin. The high seas areas of the South Pacific extend from the western boundaries of the exclusive economic zones (EEZs) of Pacific Island nations in the Central Western Pacific, and from the western and southern boundaries of the Australian EEZ across to the EEZ boundaries of Chile, Peru and Ecuador in South America. There are many submerged mountains or seamounts, as well as major ridge systems in the South Pacific.

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

The high seas bottom fisheries of the South Pacific have to date been unregulated, with the exception of the fishery on the South Tasman Rise. In this area, catches by Australian and New Zealand vessels have at times been restricted by a total allowable catch (TAC) imposed under a Memorandum of Understanding between the two countries.

An agreement to establish a regional fisheries management organization (RFMO) for the management of fisheries for non-highly migratory species on the high seas of the South Pacific is currently under negotiation. The area to be covered by the South Pacific Regional Fisheries Management Organisation (SPRFMO) has been established, except for the northern boundary. However, for the purposes of the interim measures (see Box 1) agreed at the Third International Meeting on the Establishment of a South Pacific Regional Fisheries Management Organisation, the northern boundary is the equator.

Negotiations were initiated in 2006 and, although no RFMO yet exists, the participants in the negotiations to establish SPRFMO adopted a set of interim conservation and management measures for bottom fisheries in 2007 (described in the section on Conservation and management measures). In support of these measures, an interim secretariat has been established, together with a Science Working Group (SWG), to coordinate the compilation of scientific information to support the establishment of SPRFMO. Two subgroups have been formed to support the SWG; the Jack Mackerel Subgroup and the Deep-water Subgroup, which has still not been convened. A Data and Information Working Group was also formed to support the development of the organization. The tasks of this latter group include identification of the types of data to be collected; development of standards for the collection, verification exchange and reporting of data; and development of standards for data security, as well as terms and conditions for making data available.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Trawl fleets from the former Union of Soviet Socialist Republics (USSR) began fishing for deep-sea species in the high seas in the South Pacific in the early 1970s. During this

period, former USSR vessels fished on the Geracyl Ridge, southeast of the Louisville Ridge, with catches of pencil cardinal (bigeye cardinal fish) (reportedly *Epigonus denticulatus*) totalling about 15 000 tonnes (Clark *et al*., 2007). They also targeted orange roughy (*Hoplostethus atlanticus*), blue grenadier (*Macruronus novaezelandiae*), oreo dories nei and other deep-sea species throughout the 1970s and early to mid-1980s. At the same time, New Zealand first developed deep-sea trawl fisheries for orange roughy inside its EEZ in the late 1970s while, in Australian waters, deep-sea fishing for orange roughy began in the latter half of the 1980s (FAO, 2008).

Expansion of New Zealand and Australian deep-sea fisheries into international waters was followed by the establishment of a fishery on the Louisville Ridge, some 600 kilometres (km) east of the New Zealand EEZ. This began in 1993 and another fishery, on the South Tasman Rise, adjacent to the southern portion of Australia's EEZ (south of Tasmania), was developed in 1997. Vessels of New Zealand and Australia dominated these high seas fisheries, although vessels from other nations such as Norway, Japan, the Republic of Korea, Belize, Ukraine and Panama participated at various points over the years (Gianni, 2004).

In addition, exploratory fisheries in the southeastern Pacific were undertaken by Chile in the early 1990s on the Nazca Ridge for Chilean jagged lobster (*Projasus bahamondei*). Three vessels were involved in these fisheries with a total of 267 tows in depths ranging from 260 to 405 m (Arana, 1994).

High seas catches of orange roughy, the principal target species in these high seas bottom trawl fisheries, peaked in the 1994–1995 fishing year at approximately 15 000 tonnes. Over the past several years, however, the catch of orange roughy has fallen to about 2 000–3 000 tonnes per year (Clark, 2008).

TABLE 1
Main target species of bottom fisheries in the high seas of the South Pacific

Common name	Scientific name
Main target species – trawl fishery	
Orange roughy	*Hoplostethus atlanticus*
Other species – trawl fisheries	
Alfonsino	*Beryx* spp. (primarily *Beryx splendens*)
Black oreo	*Allocyttus niger*
Black cardinal fish	*Epigonus telescopus*
Grenadiers, rattails nei	Macrouridae
Common mora (ribaldo)	*Mora moro*
Kitefin shark (seal sharks)	*Dalatias licha*
Smooth oreo dory	*Pseudocyttus maculatus*
Giant boarfish (sowfish)	*Paristiopterus labiosus*
Spiky oreo	*Neocyttus rhomboidalis*
Main target species – non-trawl fisheries	
Bluenose warehou (blue-eye trevalla)	*Hyperoglyphe antarctica*
Morwongs (king tarakihi)	*Nemadactylus* spp.
Yellowtail amberjack (yellowtail kingfish)	*Seriola lalandi*
Violet warehou (ocean blue-eye trevalla)	*Schedophilus velaini* (*Schedophilus labyrinthica*)
Other species – non-trawl fisheries	
Rubyfish	*Plagiogeneion rubiginosum*
Hapuka (wreckfish)	*Polyprion* spp.

Current fisheries

The high seas bottom fisheries in the South Pacific have been concentrated in the southwest Pacific Ocean (FAO Statistical Area 81) over the past decade, with the majority of the fishing conducted by vessels flagged to New Zealand and Australia (Gianni, 2004). Elsewhere in the South Pacific, there appears to be little deep-sea fishing on the high seas. However, there is a seamount fishery for orange roughy inside the Chilean EEZ on the Chilean Rise. In addition, deep-sea fisheries in the 1970s and 1980s were conducted on the Nazca and Sala y Gómez Ridge systems by former USSR fleets in the international waters of the southeast Pacific (Clark et al., 2007). Only Belize and Chile have reported any bottom fishing on the high seas of the southeast Pacific in recent years (see section on Other bottom fisheries).[1] Table 1 and Figure 1 present an overview of the main species targeted in the high seas of the South Pacific.

[1] Responses to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A).

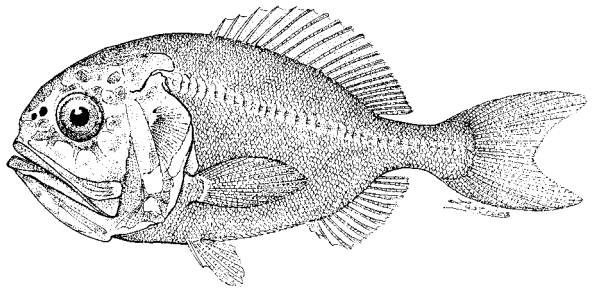
Bottom and mid-water trawl fishery for orange roughy and alfonsino

Over the past few years, the primary areas of international waters where deep-sea bottom trawl fisheries take place are the Northwest Challenger Plateau and the Lord Howe Rise in the Tasman Sea. More recently, a fishery for orange roughy has developed on the West Norfolk Ridge, in the northern Tasman Sea. Deep-sea trawling also takes place on the Louisville Ridge, east of the New Zealand EEZ. The South Tasman Rise, south of the Australian EEZ, was heavily fished over the past decade (Gianni, 2004). In the past few years the orange roughy fishery in this area has declined to very low levels and the fishery in the high seas area was recently (in 2007) closed by the Governments of New Zealand and Australia to their vessels (Clark *et al.*, 2007; New Zealand Ministry of Fisheries, 2007). These areas are all located in the southern portion of the South West Pacific Ocean. Most of the reported catch in recent years has been taken by New Zealand and Australian vessels (Gianni, 2004; Clark, 2008).

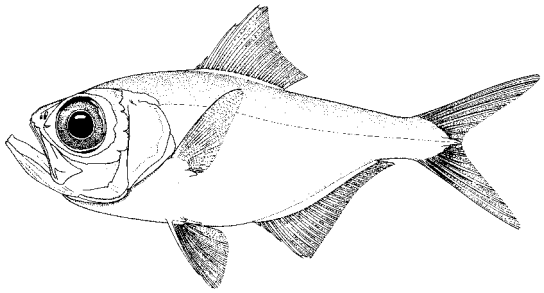
New Zealand reported that in the period 2002–2006, between 15 and 28 vessels per year were engaged in bottom fishing on the high seas of the South Pacific. In 2006, there were 15 New Zealand bottom and mid-water trawl vessels. The total catch in 2006 was 1 930[2] tonnes, consisting of 1 415 tonnes of orange roughy and 28 tonnes of alfonsino. (Penney *et al.*, 2007; SPRFMO Secretariat, personal communication, 2008)

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the South Pacific

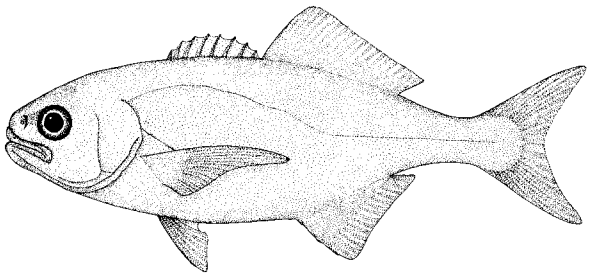
Orange roughy (*Hoplostethus atlanticus*)



Splendid alfonsino (*Beryx splendens*)



Bluenose warehou (*Hyperoglyphe antarctica*)



Source: FAO.

The Australian high seas bottom trawl fishing fleet in 2006 consisted of four trawl vessels.[3] The trawl fleet caught 452 tonnes of fish, of which 209 tonnes were alfonsino (*Beryx* spp.) and 166 tonnes were orange roughy. Australia reported the fishing effort for this fleet as 121 hours combined in 2006 (Sampaklis *et al.*, 2007).

The Cook Islands reported that five deep-sea trawlers, ranging in length from 40 to 90 metres (m), have been fishing on the high seas of the South West Pacific (FAO Statistical Area 81) over the past few years. However, only two were in operation under the Cook Islands flag in the South West Pacific in 2006. No information was provided on the catch of this fleet. Given the size of most of the vessels involved, the catch could

[2] This number may change as the SPRFMO Secretariat receives updated information.
[3] Response from Australia to FAO Questionnaire.

TABLE 2
Catch of major species in South West Pacific high seas trawl fisheries, 2002–2006

Flag	Tows	Catch (tonnes) by species										
		ORH	SSO	BOE	SOR	BYX	EPT	RIB	BSH	BOA	RAT	Total
New Zealand[a]	11 145	9 259	248	598	78	250	638	276	120	85	274	11 827
Australia[b]	/	1 263	97	/	77	296	0	/	/	/	/	1 733
Other[a]	2 568	2 767	58	298	2	181	46	15	0	0	1	3 368
Total												**16 928**

ORH–Orange roughy; SSO–Smooth oreo; BOE–Black oreo; SOR–Spiky oreo; BYX–Beryx spp.; EPT-Cardinal fish; RIB-Ribaldo; BSH-Seal shark; BOA-Sowfish; RAT-Rattails.
/ = Unknown.
Sources:
[a] SPRFMO Secretariat, personal communication, 2008. This does not include information separately reported to FAO (FAO, 2008 or FAO Questionnaire).
[b] Sampaklis *et al.*, 2007. The total includes 106 tonnes of other species.

be substantial as compared with the catch of other nations' vessels operating in the region.[4]

Belize reported two trawl vessels operating on the high seas of the South Pacific in 2006, with a total catch of 344 tonnes. This catch consisted of 200 tonnes of orange roughy and 101 tonnes of alfonsino, as well as another 43 additional tonnes of unspecified catch.[5]

Ukraine reported that one bottom trawl vessel has occasionally been fishing for orange roughy along the Louisville Ridge over the past few years but did not provide information on the catch.[6]

The Republic of Korea reported a catch of alfonsino in 2005 of 194 tonnes and 464 tonnes respectively in the South West and Western Central Pacific (FAO, 2008). In its answer to the FAO Questionnaire, the Republic of Korea mentioned the activity of two trawlers in the South East Pacific (FAO Area 87) for the same year (2005), and three in 2006.

China also reported catch of orange roughy to the SPRFMO Secretariat, ranging from 500 to 700 tonnes per year, between 2001 and 2006 (570 tonnes in 2006) (SPRFMO, 2008).

Trawl catches by all fleets combined consist primarily of orange roughy, with bycatch species of commercial value including alfonsino, oreo, black cardinal fish (*Epigonus telescopus*), bluenose warehou (blue-eye trevalla) (*Hyperoglyphe antarctica*), common mora (ribaldo) (*Mora moro*), kitefin sharks (seal sharks) (*Dalatias licha*), and grenadiers, rattails nei.

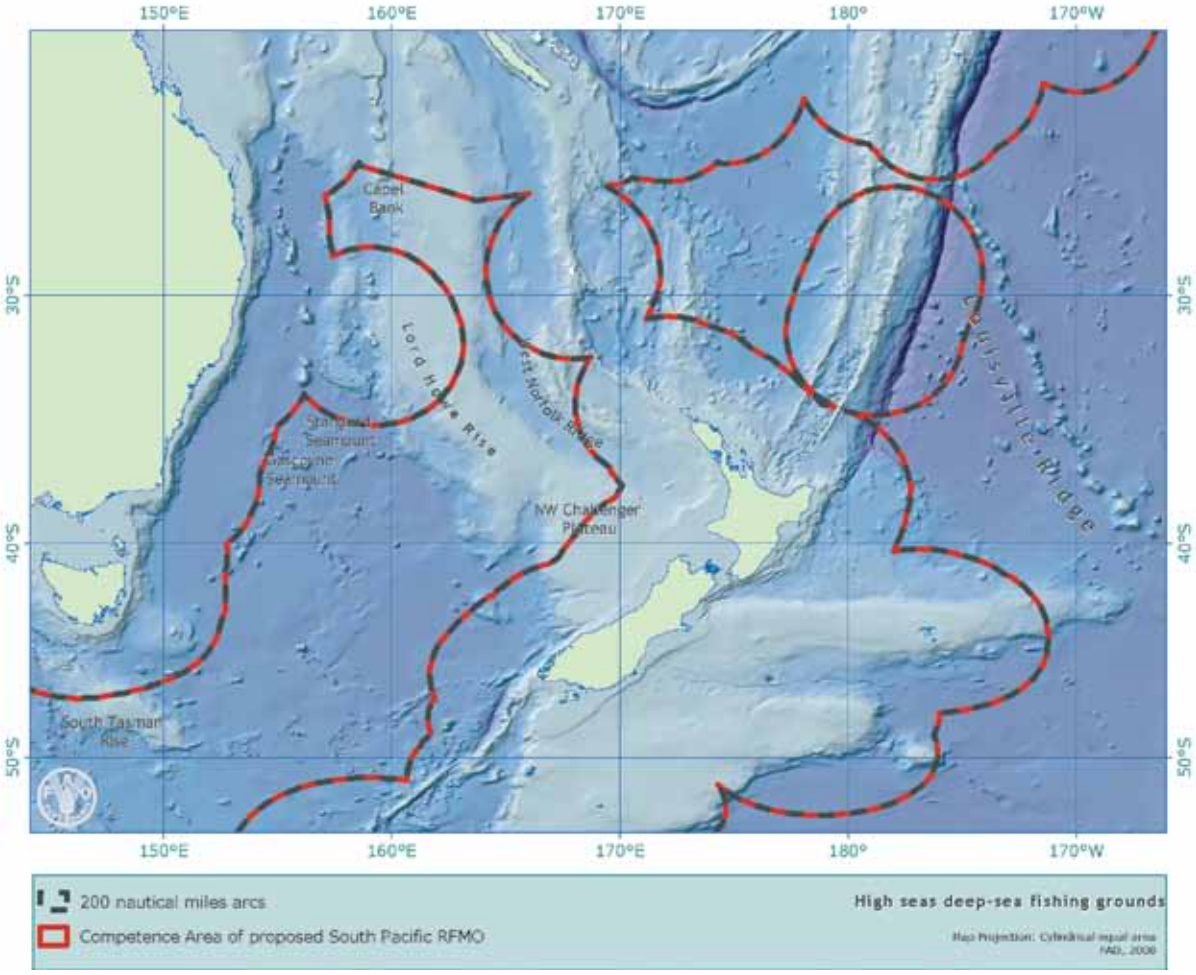
Table 2 provides an overview of the catch of the trawl fisheries between 2002 and 2006 in the South West Pacific.

Bottom longline fisheries

New Zealand reported that nine longline vessels targeted deep-sea species in 2006. They fished a total of 277 days (SPRFMO, 2007a). Australia reported eight longliners and three other vessels identified as "other types or multipurpose vessels".[7] The total catch in the 2005/2006 season for these vessels was 8 tonnes. Non-trawl fishing effort has been largely focused on the Gascoyne and Standards seamounts area, Capel Bank (Map 2) and a large area along the boundary of the Australian EEZ from the Great Australian Bight to 140°E. Most of the catch was taken in the Gascoyne and Standard Seamounts area (Sampaklis *et al.*, 2007).

The longline and related catch consists primarily of bluenose warehou, morwongs (king tarakihi) (*Nemadactylus* spp.), violet warehou (ocean blue-eye trevalla)

[4] Response from the Cook Islands to FAO Questionnaire.
[5] Response from Belize to FAO Questionnaire.
[6] Response from Ukraine to FAO Questionnaire.
[7] Response from Australia to FAO Questionnaire.



MAP 2
High seas areas just off the EEZs of Australia and New Zealand

(*Schedophilus velaini*), yellowtail amberjack (yellowtail kingfish) (*Seriola lalandi*) and hapuka (*Polyprion* spp.).

Other bottom fisheries

Other fishing gear reportedly used by bottom fisheries have included Dahn lines, trot lines and other line gears over the past few years, as well as pots, traps and Danish seines.

New Zealand reported an additional three vessels engaged in deep-sea fisheries on the high seas in 2006, two of which used Dahn lines and the third listed as "other". These vessels fished for a total of 26 days on the high seas in 2006. Over the past four years, several New Zealand flagged vessels have also used trot lines and fished with Danish seines in bottom fisheries on the high seas (SPRFMO, 2007a). As mentioned above, Australia reported three vessels as using gear other than trawl or longline.[8]

Belize reports two vessels engaged in deep-sea trap set fishing on the high seas of the South East Pacific targeting lobsters, with a catch of 65 tonnes in 2006.[9]

Catch and effort summary

Table 3 provides a summary of total catch and effort of the fisheries described above for 2006.

[8] Response from Australia to FAO Questionnaire.
[9] Response from Belize to FAO Questionnaire.

TABLE 3
Summary of available data, 2006

Country	No. of vessels	Catch (tonnes)
Trawl (mid- and bottom trawl) fishery		
Australia	4	452[a]
Belize	2	344
China[b]	/	570
Cook Islands	2	/
New Zealand[c]	15	1 930
Rep. of Korea	3	/
Ukraine	1	/
Bottom longline fishery		
Australia[a]	8	8[d]
New Zealand[e]	9	/
Other (gillnet, trap, Dahn line, drop line, trot line, pot)		
Australia[a]	3	/
Belize	2	65
New Zealand[e]	3	/

/ = Unknown
Note: there are discrepancies between different sources in terms of number of New Zealand and Australian vessels.
Source: country response to FAO Questionnaire, except where otherwise noted.
[a] Sampaklis *et al.*, 2007.
[b] SPRFMO, 2008.
[c] Penney *et al.*, 2007.
[d] The catch of 8 tonnes in 2005/2006 is for all non-trawl vessels combined.
[e] SPRMO, 2007a.

Illegal, Unreported and Unregulated (IUU) fishing

As there previously were no multilaterally agreed conservation measures in place, the high seas bottom fisheries in the South Pacific Ocean could not be considered illegal fishing as such. Prior to 30 September 2007, these fisheries could best be characterized as largely unreported and unregulated. However, from 30 September 2007, these fisheries have become subject to the voluntary multilateral Interim Measures Agreement adopted by the parties to the Third International Meeting on the Establishment of a South Pacific Regional Fisheries Management Organisation.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

Stock assessments have been attempted for several of the high seas orange roughy stocks based on catch per unit effort (CPUE) data. However, they have not been accepted as sufficiently robust because of the highly variable levels of effort and catch between years within each of the fisheries, which can make the use of CPUE as an index of abundance uncertain (O'Driscoll, 2003; Clark and Anderson, 2003). There are no available estimates of stock size, biomass or fishing mortality for bluenose warehou – the principal target species in the high seas bottom longline fishery (SPRFMO, 2007c).

Status of bycatch stocks

Over 100 species have been reported taken in both the New Zealand and Australian high seas bottom fisheries in the South Pacific. However, the amount taken of bycatch of non-commercial species is not known, nor is the status of most, if not all, bycatch species.

Impacts on Vulnerable Marine Ecosystems (VMEs)

The South West Pacific is one of the few areas in the world where considerable information has been gathered on the impact of deep-sea trawling on the sea bed. The information is based primarily on the impacts of fishing within the Australian and New Zealand EEZs, although some information is available for the fisheries on the high seas.

A recent assessment of the likely distribution of stony or hard cold-water corals in relation to seamounts worldwide concluded that they are likely to be found in association with seamounts at fishable depths throughout the South Pacific Ocean (particularly in FAO Statistical Areas 81 and 87) between 40° and 20°S latitude (Clark *et al.*, 2006). Biogeographic assessments of the likely distribution of other species potentially vulnerable to deep-sea bottom fisheries have yet to be conducted, both with respect to seamounts and other underwater features.

One example of trawling impacts related to a high seas bottom fishery in the region, is the orange roughy fishery on the seamounts of the South Tasman Rise. Large quantities of corals were taken as bycatch in the first year of this trawl fishery. Approximately 1.6 tonnes of coral per hour of towing a trawlnet during the 1997/1998 fishing season were estimated as bycatch by observers. In the 165 tows observed, a total of 1 762 tonnes of coral was estimated to have been brought up in the trawlnets. These figures do not include coral damaged but not brought to the surface by the nets. The authors of the study state that it is unknown as to whether such large rates of bycatch are taken in

other seamount fisheries, but that anecdotal evidence indicates that there have been large catches of coral in other high seas fisheries on the Northwest Challenger Plateau. (Anderson and Clark, 2003) Other examples of studies on the impacts of trawling are described in Koslow *et al.* (2001) and Clark and O'Driscoll (2003).

Changes in fishing patterns and, in particular, longer trawl duration and distance due to a preference for using long tows on flat bottoms, rather than short tows on hill features, were noted by Clark (2008) and SPRFMO (2007d) over the last decade. This has substantially increased the area of habitat affected by trawl gear in several seamount areas (e.g. Northwest Challenger Plateau).

CONSERVATION AND MANAGEMENT MEASURES

As mentioned in a previous section, participants in the negotiations to establish the new SPRFMO adopted a set of voluntary interim measures in May 2007 for bottom fisheries on the high seas of the South Pacific (see Box 1). These interim measures apply to the high seas of the South Pacific from the equator to the boundary of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Convention Area, and in the west from the boundary of the Southern Indian Ocean Fisheries Agreement south of Australia and the EEZ boundaries of Australia and Pacific Island nations in the Central West Pacific, across the South Pacific to the EEZ boundaries of Ecuador, Peru and Chile in the South East Pacific (see Map 1).

The participants in the negotiations that have adopted these interim measures for the South Pacific are as follows: Australia, Canada, Chile, the Cook Islands, China, Peru, Colombia, Ecuador, European Community, Faroe Islands, Federated States of Micronesia, France (on behalf of its overseas territories), Japan, New Zealand, Niue, Palau, Papua New Guinea, the Russian Federation, the Republic of Korea, Taiwan Province of China, Ukraine, the United States of America and Vanuatu (SPRFMO, 2007e).

Since the adoption of the interim measures for the South Pacific in 2007, at least one state (at the time of publication of this document), New Zealand, has adopted regulations to implement the measures. The New Zealand regulations are only a first step, since new legislation will be required for full implementation. Some measures will initially be applied through the New Zealand high seas fishing permits, required by all vessels flying the New Zealand flag on the high seas. Measures implemented through the fishing permits will include, *inter alia*, application of the "move on" rule (see Box 1) in some areas and spatial restrictions. New Zealand is closing all blocks ("the footprint" was defined through fishing activity in grid blocks of 20 minute resolution) that have been only lightly fished (31 percent of the total area) and another 10 percent of other areas to protect representative habitats. Bottom trawling, until 2010, is restricted to the current footprint (i.e. no expansion of fisheries). One hundred percent observer coverage is now required on all vessels while bottom trawling on the high seas. (Penney *et al*., 2008)

To date, it appears that there are still gaps in implementation of the SPRFMO interim measures by participants in the SPRFMO negotiations. Furthermore, parties other than New Zealand have yet to publicize measures that they have taken to implement the interim measures for bottom fisheries in the high seas.

Prior to 2007, some conservation and management measures were already in place, but on a country-by-country basis. For example, since 1999, the Australian Government has required Australian-flagged fishing vessels to be authorized to fish on the high seas. Among other things, operators using Australian-flagged vessels on the high seas are required to mark their vessels in accordance with the FAO standard specifications, facilitate the carriage of observers, complete catch and effort logs, and operate a VMS. Australian-flagged vessels are required to operate in a manner that does not contravene Australia's obligations under international agreements and

BOX 1

Interim measures adopted by participants in negotiations to establish South Pacific Regional Fisheries Management Organisation

The main elements of the Interim Measures Agreement, which came into effect on 30 September 2007, are summarized as follows:

- Limit bottom fishing to existing levels of fishing effort and areas fished within the last several years (2002–2006).
- No further expansion of bottom fishing activities until 2010 and only then on the basis of prior impact assessments and management measures in place to ensure no significant adverse impacts on VMEs in new areas.
- Establish conservation and management measures to prevent significant adverse impacts on VMEs, and ensure long-term sustainability of deep-sea fish stocks.
- Assess whether individual bottom fishing activities would have significant adverse impacts on VMEs and, if so, then bottom fisheries are not authorized to proceed unless they can be managed to prevent such impacts.
- Cooperate to map sites where VMEs are located.
- Close areas where VMEs are known or likely to occur to bottom fishing activities unless an assessment has been undertaken and management measures are in place to ensure no significant adverse impacts.
- Cease bottom fishing activities within 5 nautical miles (nm) of VMEs and where VMEs are encountered during the course of fishing operations and report the encounter to the Interim Secretariat to ensure that appropriate measures can be adopted in respect of that site.
- Ensure 100 percent observer coverage on all bottom trawl vessels and an appropriate level of observer coverage on vessels using other bottom fishing gears.

other arrangements to which Australia is a party. Furthermore, Australia reports that observer coverage occurs on an ad hoc basis on high seas bottom fishing vessels.[10]

INFORMATION AND REPORTING GAPS

There is a need for more accurate information on catch, bycatch and the locations of areas fished in relation to potential impacts on VMEs (e.g. seamounts), in particular from nations other than New Zealand engaged in high seas bottom fishing in the region. In addition, assessments are needed on the known or likely distribution of VMEs. There are also potential issues in relation to the confidentiality requirements of fisheries data in some countries. Furthermore, no reliable stock assessments have been conducted for fisheries for deep-sea species on the high seas, and there have been no systematic assessments of the impact of fisheries on non-target, associated and dependent species or vulnerable benthic ecosystems. These issues are in the process of being addressed through the SPRFMO negotiating process, i.e. the development of data standards by the Data and Information Working Group, the development of an Interim Benthic Assessment Standard by the Science Working Group, and the requirement that impact assessments for bottom fishing activities be conducted as a condition to authorize any bottom fishing activities on the high seas after 30 September 2007.

SOURCES OF INFORMATION

In their reply to the FAO Questionnaire, Australia, Belize, the Cook Islands, New Zealand, the Republic of Korea and Ukraine officially provided some information regarding deep-sea fishing in the high seas of the South Pacific Ocean. Other sources

[10] Response from Australia to FAO Questionnaire.

used include FAO reports, country submissions to the International Meetings on the Establishment of a South Pacific Regional Fisheries Management Organisation, and the Census of Marine Life.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Australia, Belize, Cook Islands, New Zealand, Republic of Korea and Ukraine
Estimated total number of vessels	52
Total reported catch (tonnes)	3 369

Main fisheries			
Gear	**Target species**	**Fishing grounds**	**Regional Area**
Bottom trawl/ mid-water trawl	Orange roughy, alfonsino	Lord Howe Rise, Northwest Challenger Plateau and West Norfolk Ridge in the Tasman Sea; South Tasman Rise south of the Australian EEZ; Louisville Ridge	FAO Area 81
Longline/other (gillnet, trap, Dahn line, drop line, trot line, pot)	Bluenose warehou, hapuka, morwongs, violet warehou, lobster	Gascoyne and Standard Seamounts area; Capel Bank and along the boundary of the Australian EEZ	FAO Areas 77, 81 and 87

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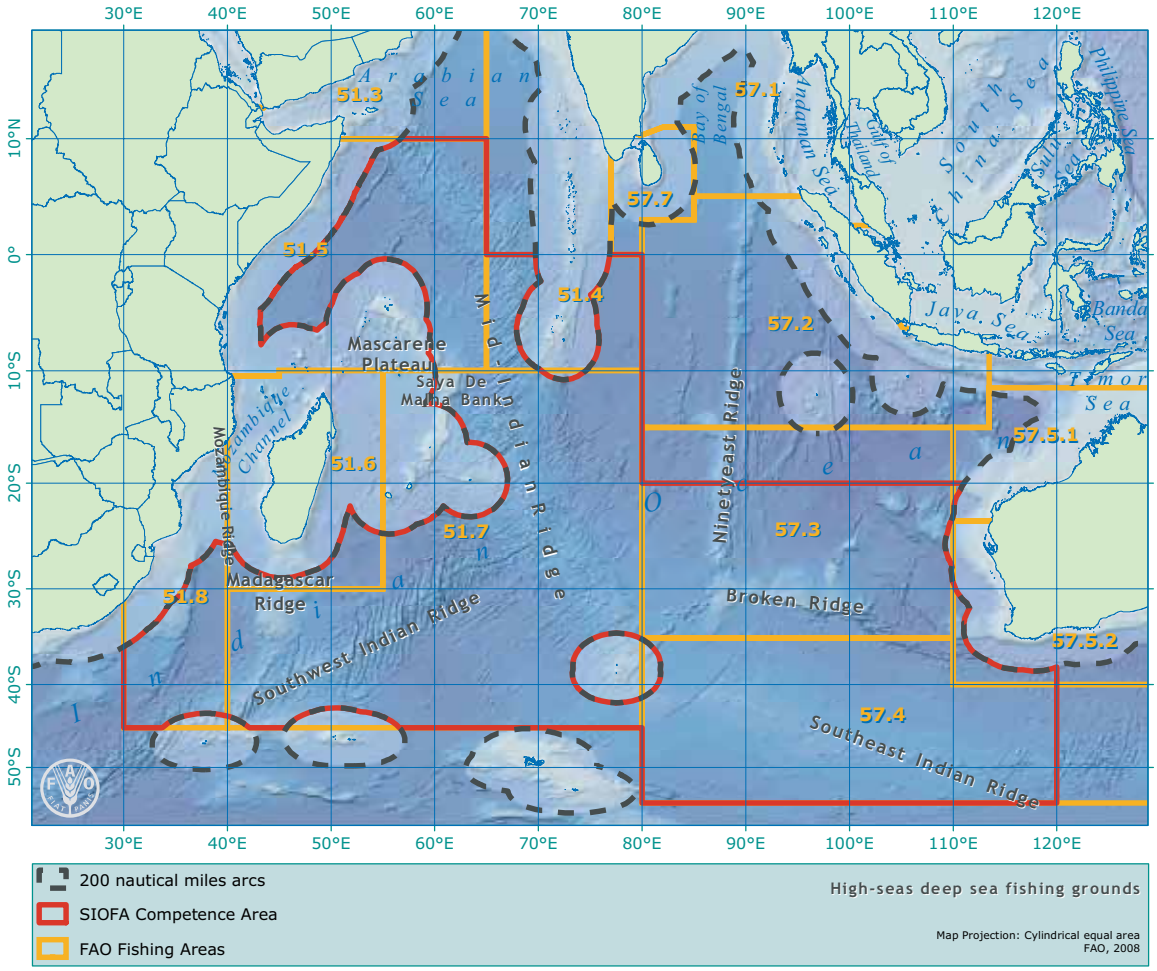
THE INDIAN OCEAN



MAP 1

Main high seas deep-sea fishing grounds in the Indian Ocean and area of competence of the Southern Indian Ocean Fisheries Agreement (SIOFA)

Indian Ocean

FAO Statistical Areas 51 and 57

GEOGRAPHIC DESCRIPTION OF THE REGION

The Indian Ocean is the third largest of the earth's five oceans. It is bounded to the west by Africa, to the north by Asia, to the east by Australia and the Australasian islands and to the south by the Southern Ocean. No natural boundary separates the Indian Ocean from the Southern Atlantic Ocean, but the 20°E meridian that connects Cape Agulhas at the southern end of Africa with Antarctica, 4 000 km distant, is generally considered to be the boundary.

The topography of the sea bed on the high seas of the Indian Ocean is characterized by large areas of abyssal plane with extensive ridge systems and numerous seamounts, banks, plateaus and other underwater features. Major deep-sea ridge systems, with peaks at fishable depths, include the South West Indian Ridge, Madagascar Ridge, Mid-Indian Ridge, Ninety East Ridge and Broken Ridge (Shotton, 2006). The Mascarene Ridge includes the Saya de Malha Bank, which in some areas is less than 20 metres (m) deep and is mostly in international waters between Mauritius and Seychelles (Goreau, 2002).

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

The Southern Indian Ocean Fisheries Agreement (SIOFA) – a regime for the management of non-highly migratory species – covers most high seas areas in the Indian Ocean, as indicated in Map 1. The southern boundary of SIOFA borders the Convention Area covered by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); the eastern boundary borders the South Pacific Regional Fisheries Management Organisation (RFMO) Convention Area currently under negotiation; and the western boundary borders the South East Atlantic Fisheries Organisation (SEAFO) Convention Area. The northern boundary is more complex as can be seen in Map 1. High seas areas of the Indian Ocean not covered by SIOFA or by any other agreement, include the high seas areas of the northern portion of the North Indian Ocean, the Bay of Bengal and west of Indonesia (FAO Statistical Subareas 51.3, northern part of 51.4 and 57.1, 57.2, and the northern part of 57.3). No deep-sea bottom fishing in these areas is at present known to occur.

SIOFA was concluded and opened for signature in July 2006. Signatories to the agreement are Australia, the Comoros, France, Kenya, Madagascar, Mozambique, Mauritius, New Zealand, Seychelles and the European Community. However, the agreement has not yet entered into force. As of October 2008, Seychelles (by ratification), the Cook Islands (by accession) and European Community (by approval) are parties to the agreement (FAO, 2007a).

The Resolution on Data Collection concerning the High Seas in the Southern Indian Ocean was adopted by the Fourth Intergovernmental Consultation on the Southern Indian Ocean Fisheries Agreement in 2004. While the resolution was only voluntary at that stage, the Conference on the Southern Indian Ocean Fisheries Agreement in July 2006 called on all states concerned to implement the resolution as a matter of urgency (FAO, 2007b). No data have yet been reported as requested by the resolution.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Deep-sea trawl fishing has taken place over the past several decades in the high seas of the South West Indian Ocean region, with exploratory surveys conducted by vessels from the former Union of Soviet Socialist Republics (USSR) beginning in the 1970s. Former USSR vessels conducted periodic deep-sea trawl research cruises on a commercial scale throughout the 1980s and 1990s with catches ranging from a high of over 6 000 tonnes of deep-sea species in 1980 to a low of only 10 tonnes in 1990. Throughout the 1990s, one to three Ukrainian deep-sea trawl vessels operated on the high seas each year, with each vessel fishing only part of the year. (Romanov, 2003; Clark *et al.*, 2007)

Deep-sea trawlers from both New Zealand and Australia were reportedly fishing in the region several years prior to 1999; however, in the period 1999–2001 there was a major increase in deep-sea trawling on the high seas with the discovery of orange roughy (*Hoplostethus atlanticus*) stocks by vessels from New Zealand (Japp and James, 2005). The combined catch of all deep-sea species in 2000 was estimated at approximately 40 000 tonnes, involving up to 50 vessels from over a dozen countries, although accurate catch data are unavailable, given the unreported and unregulated nature of the fishery. In 2001, only eight vessels reportedly participated in the fishery, although more were thought to have been involved and, in 2002, fishing activity declined even further (FAO, 2002).

In addition to the high seas trawl fisheries, there has been a high seas fishery for demersal species since at least the 1970s. This involves motherships and dories using handlines, which operate on the shallower portions of the Mascarene Ridge and the Saya de Malha Bank, between Mauritius and Seychelles in the Western Indian Ocean. The principal target species in this fishery is sky emperor (dame berri) (*Lethrinus mahsena*), with stocks straddling the Mauritian exclusive economic zone (EEZ) and the high seas (Christy and Greboval, 1985; Sanders, Sparre and Venema, 1988; Maguire *et al.*, 2006).

TABLE 1
Main species targeted by deep-sea fisheries in the Indian Ocean

Common name	Scientific name
Main target species – trawl fishery	
Alfonsino	*Beryx* spp.(mainly *Beryx splendens)*
Orange roughy	*Hoplostethus atlanticus*
Main target species – longline fishery	
Deepwater longtail red snapper (ruby snapper)	*Etelis coruscans*
Other deep-sea species	
Black oreo	*Allocyttus niger*
Bluenose warehou (blue-eye trevalla)	*Hyperoglyphe antarctica*
Pelagic armourhead (boarfish)	*Pseudopentaceros richardsoni*
Boarfishes nei	Caproidae
Cape bonnethmouth	*Emmelichthys nitidus*
Black cardinal fish	*Epigonus telescopus*
Rubyfish	*Plagiogeneion rubiginosum*
Rudderfish	*Centrolophus niger*
Smooth oreo dory	*Pseudocyttus maculatus*
Spiky oreo	*Neocyttus rhomboidalis*
Violet warehou (black butterfish)	*Schedophilus velaini (Schedophilus labyrinthica)*
Wreckfish	*Polyprion americanus*
Deep-sea sharks	
Other species	
Sky emperor (dame berri)	*Lethrinus mahsena*
Deep-sea lobster	*Palinurus barbarae*

Note: the accuracy of attributions to fishes in the family Centrolophidae in the Southern Indian Ocean is uncertain (R. Shotton, personal communication, 2008).

Current fisheries

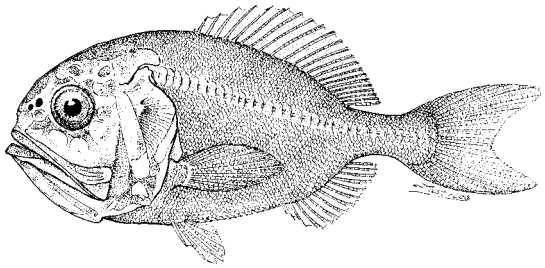
The dominant bottom fishery in the high seas of the South West Indian Ocean over the past several years has been the mid-water and bottom trawl fishery on or around seamounts for alfonsino (*Beryx splendens*) and orange roughy. Other deep-sea species caught in this fishery include black oreo (*Allocyttus niger*), spiky oreo (*Neocyttus rhomboidalis)*, smooth oreo dory (*Pseudocyttus maculatus*), black cardinal fish (*Epigonus telescopus*), bluenose warehou (blue-eye trevalla) (*Hyperoglyphe antarctica)*, boarfishes nei (Caproidae) and pelagic armourhead (*Pseudopentaceros richardsoni)*. For

an overview of the main species targeted, see Table 1 and Figure 1. Deep-sea trawlers primarily target orange roughy or alfonsino and take other species, including deep-sea sharks, as bycatch. These fisheries are a mixture of bottom trawl and mid-water trawl fisheries on deep-sea seamounts, ridge systems and other underwater features (e.g. shoals, escarpments) in the international waters of the South West Indian Ocean (Shotton, 2006). (Clark *et al.*, 2007; Sissenwine and Mace, 2007)

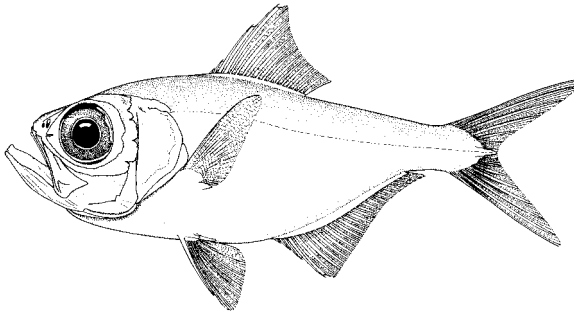
In addition to the trawl fishery, a deep-sea longline fishery on the high seas developed over the past several years targeting primarily deepwater longtail red snapper (ruby snapper) (*Etelis coruscans)*. Anecdotal evidence, including observation of vessels, indicates that there are directed deep-sea gillnet and longline fisheries on the high seas for sharks, but none were reported to FAO.

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the Indian Ocean

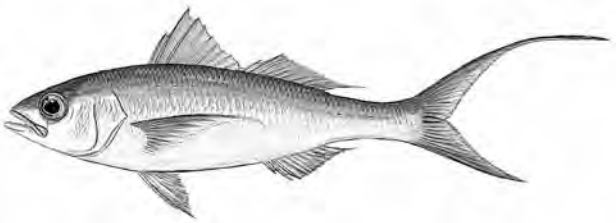
Orange roughy (*Hoplostethus atlanticus*)



Splendid alfonsino (*Beryx splendens*)



Deepwater longtail red snapper (ruby snapper) (*Etelis coruscans*)



Source: FAO.

Bottom and mid-water trawl fishery for alfonsino and orange roughy

Orange roughy are generally most abundant between 750 and 1 100 m where they often form large aggregations in association with seamounts and other underwater features. Bycatch species of commercial value in the orange roughy fishery includes oreo. Deep-sea sharks are also caught as bycatch.

The fishery for alfonsino generally operates at shallower depths – between 300 and 600 m. However, alfonsino school in mid-water and are usually caught with mid-water trawlnets. Commercial species caught with alfonsino include pelagic armourhead, black cardinal fish and bluenose warehou (FAO, 2002).

The Southern Indian Ocean Deepsea Fishers Association (SIODFA)[1] is an association of four fishing companies with vessels engaged in deep-sea trawl fisheries on the high seas. SIODFA indicated in a report published by FAO in 2006 that four deep-sea trawl vessels have regularly fished the high seas of the Southern Indian Ocean for orange roughy and alfonsino since 2003. The four vessels were flagged to Namibia, Australia and the Cook Islands. Not all of the vessels fish all year round. Fishing effort consists of approximately 1 500–2 000 tows a year for the four vessels combined. Of

[1] SIODFA is comprised of Austral Fisheries Pty Ltd, Perth, Australia; Bel Ocean II Ltd, Port Louis, Mauritius; Sealord Group, Nelson, New Zealand; and TransNamibia Fishing Pty Ltd, Walvis Bay, Namibia. SIODFA members have currently restricted the number of vessels fishing in the South Indian Ocean to four vessels (G. Patchell, SIODFA, personal communication, 2007).

these, approximately 50–60 percent are mid-water tows, largely targeting alfonsino, and 40–50 percent are bottom trawl tows targeting orange roughy (Shotton, 2006).

The Cook Islands report that one deep-sea trawler has also conducted fishing operations in the South West Indian Ocean (FAO Statistical Area 51) although they provide no information on the catch.[2] In response to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A), Australia reported that two trawlers fished on the high seas in the South West Indian Ocean (FAO Statistical Area 51) and three trawlers operated in the South East Indian Ocean (FAO Statistical Area 57) in 2004, 2005 and 2006. However, it is not clear whether one or more of these vessels fished in both areas and thus are counted twice. Australia did not provide information on the high seas bottom catch in the Indian Ocean.[3] The main fishing areas appear to be the South West Indian Ocean Ridge, Madagascar Rise (in particular Walters Shoal), the Mid-Indian Ridge, Ninety East Ridge and East Broken Ridge (Shotton, 2006).

No precise information on catch and effort has been reported for the bottom and mid-water trawl fisheries. The only information available on catch and effort in the high seas bottom fisheries in the Indian Ocean is that provided by China in aggregate form on catch and effort in the Chinese longline fishery (see following section).

Bottom longline fishery for deepwater longtail red snapper

In addition to the trawl fisheries, China reported that several longliners – four in 2005 and seven in 2006 – have begun operating in the North West Indian Ocean (FAO Statistical Area 51) targeting deepwater longtail red snapper (see Table 2).

It is not clear whether these vessels are fishing within or to the north of the boundary of the Southern Indian Ocean Fisheries Agreement. Altogether, these longline vessels caught a total of 970 tonnes during 150 fishing days in 2005/2006.[4] The Cook Islands report one longline vessel targeting deep-sea species operating in the South East Indian Ocean (FAO Statistical Area 57). Australia reports that five longliners and one multipurpose vessel have been bottom fishing on the high seas of the Indian Ocean in FAO Statistical Area 57 (South East Indian Ocean). Australia indicated that information on the catch of this fleet is confidential.[5]

TABLE 2
Catch in the Chinese longline fishery, North West Indian Ocean, 2005/2006

Species name	Catches (tonnes)
Deepwater longtail red snapper	756
Other	214

Other bottom fisheries

As indicated in the section on History of fisheries, there are high seas fisheries for demersal species operating on the shallower portions of the Mascarene Ridge and the Saya de Malha Bank between Mauritius and Seychelles, primarily involving vessels from Mauritius. However, this has been changing in recent years. These fisheries remain important for the Mauritian fishing industry. In 2006, a total of ten vessels fished on the shallow water banks of Saya de Malha, Nazareth and Albatross and in the Chagos Archipelago with a total of 2 612 tonnes of catch landed (frozen fish), which was mainly comprised of Lethrinidae (88.2 percent) and snappers/groupers (10.1 percent). However, only the Saya de Malha Bank lies largely in the high seas but the catch in 2006 from this area represented 62.9 percent of the total catch from the banks. It was also reported that an increase in the number of vessels and trips was observed in 2006. (Ministry of Agro Industry & Fisheries [Fisheries Division], Mauritius, 2006)

[2] Response from the Cook Islands to FAO Questionnaire.
[3] Response from Australia to FAO Questionnaire.
[4] Response from China to FAO Questionnaire.
[5] Response from Australia to FAO Questionnaire.

In 2006, a Spanish vessel offloaded deep-sea lobsters in Durban, South Africa, reportedly caught while fishing in the high seas on Walters Shoal on the Madagascar Ridge. The lobsters were identified as a new species, *Palinurus barbarae*. The fishing gear used by the vessel was not reported. (UCT, 2006)

As indicated earlier, anecdotal information suggests that several vessels may be fishing with deep-sea gillnets on the high seas of the South Indian Ocean, primarily for deep-sea sharks (G. Patchell, SIODFA, personal communication, 2007; Hareide *et al.*, 2006).

Catch and effort summary

Table 3 presents a summary of catch and effort by fishery and flag state.

TABLE 3
High seas deep-sea fisheries in the Indian Ocean – yearly catch and effort indicators by fishery for the period 2005/06

Flag state	No. of vessels	Catch (tonnes)	Effort
Trawl (mid- and bottom trawl) fishery targeting orange roughy and alfonsino			
Australia	3–5	4 000–5 000+ (overall estimate)	1 500–2 000+ (overall tows per year)
Cook Islands	1		
Mauritius	1		
Namibia	1		
Bottom longline fishery targeting deepwater longtail red snapper			
Australia	6*	/	/
China	7	970	150 days
Cook Islands	1	/	/

/ = Unknown.
* Five and one "other".

Illegal, Unreported and Unregulated (IUU) fishing

Very little information is known about IUU bottom fishing activities in the Indian Ocean. These fisheries are currently unregulated by a multi-lateral mechanism.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

The number of distinct target stocks and the status of these stocks are unknown. In the case of orange roughy, an FAO report states that the fishery targets "possibly a moderately large number of separate spawning stocks" and that possibly the only way to obtain accurate information on the catch since 1999 would be in a "confidential context", i.e. provided that the information would not be made publicly available (Shotton, 2006).

In terms of changes in catch in the fishery, after the increase in vessel numbers in 2001, average catch per vessel for the season is estimated to have dropped from 1 600 tonnes to under 300 tonnes per vessel. The following years saw reduced numbers of vessels and a shift from orange roughy to alfonsino and rubyfish targets on the Madagascar Plateau, Mozambique Ridge and Mid-Indian Ridge (Clark *et al.*, 2007).

Status of bycatch stocks

The stock structure and status of bycatch species are unknown. According to trawl industry sources, bycatch by weight in the current aimed-trawl fisheries is low (Shotton, 2006). However, in terms of numbers of species taken as bycatch, detailed information on the former USSR and Ukrainian deep-sea trawl fishery between 1972 and 2000 indicated that well over 100 species or species groups were recorded taken as bycatch in the deep-sea trawl fisheries for alfonsino and orange roughy in the region (although some of the species recorded as bycatch were pelagic species) (Romanov, 2003). This suggests that the impact on associated and dependent deep-sea species, in particular in non-aimed trawl fisheries, could be significant.

Impacts on Vulnerable Marine Ecosystems (VMEs)

The member companies of SIODFA have conducted extensive mapping of much of the deep-sea topography of the high seas of the South Indian Ocean where commercially valuable species of fish are likely to occur. SIODFA has probably produced the best information currently available on the locations of corals in association with

seamounts, ridge systems and other underwater features in the region. Shotton (2006) gives relatively detailed information provided by the industry on the topography and location of corals, particularly in the areas that SIODFA members have voluntarily agreed to set aside as areas closed to bottom fishing (further information can be found in SIODFA, 2007). Nonetheless, a comprehensive assessment of deep-sea areas affected by bottom fishing has not been carried out and the extent of the impacts is currently unknown (Shotton, 2006).

The fisheries for alfonsino and orange roughy are conducted on seamount and ridge systems across a wide area of the Southern Indian Ocean. SIODFA member companies note that coral bycatch (brain coral, black coral and branch coral) occurs in some areas, with little or no bycatch in other areas, and that skippers of the four vessels in this fleet try to avoid bottom areas where corals are present to prevent damage to their trawlnets (Shotton, 2006; SIODFA, 2007).

Based on the biogeography of the region, stony corals are likely to occur in association with seamount peaks throughout the Southern Indian Ocean between 20° and 60°S latitude, at depths where fishing currently takes place (Clark *et al.*, 2006). Corals have been reportedly taken in bottom trawl fishing operations in the region and, while the impact of the SIODFA fleet may be minimal, the impact of past bottom trawl fishing on seamount and ridge systems in the region, particularly in the 1999–2001 period, may have been significant (Butler *et al.*, 2001).

CONSERVATION AND MANAGEMENT MEASURES

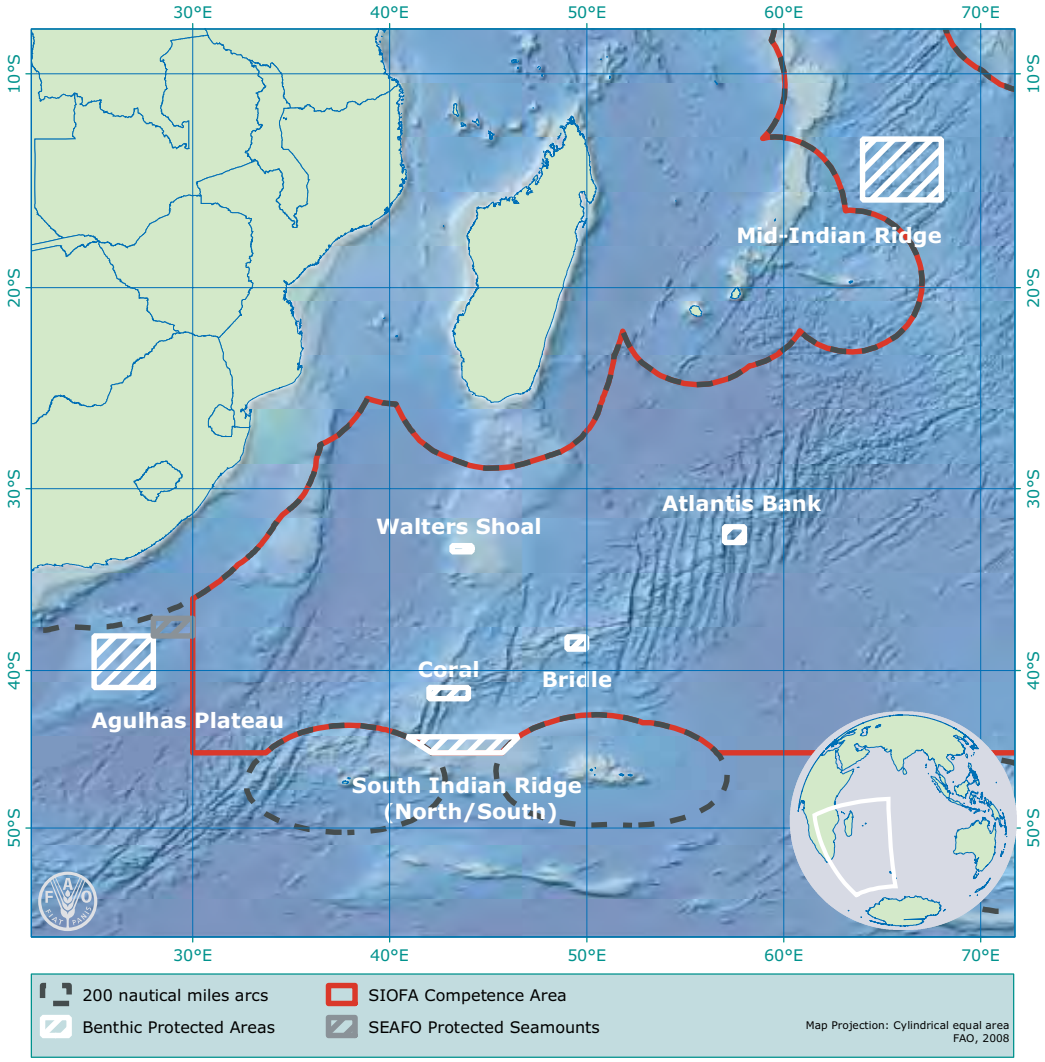
There are currently no conservation and management measures put in place by a regional fisheries body for the management of the high seas bottom fisheries in the Indian Ocean. However, in July 2006, SIODFA decided to refrain voluntarily from bottom trawl fishing in 11 deep-sea areas (Maps 2 and 3) in order to protect cold-water corals (IUCN and SIODFA, 2006). Two of the four vessels fishing for SIODFA member companies carry observers full time and all vessels, as of 2008, will carry video for visual observation of bottom fauna along trawl tow lines (G. Patchell, SIODFA, personal communication, 2008). In addition, the member companies of SIODFA have established a data collection and biological sampling programme for the vessels involved.

A number of national regulations also apply to high seas bottom trawl fisheries. For example, Australia reports that, since 1999, the Government requires Australian-flagged fishing vessels to be authorized to fish in waters outside the Australian Fishing Zone (AFZ). Australian-flagged vessels deep-sea fishing on the high seas are also required to accept the presence of observers, complete catch and effort logbooks and operate a vessel monitoring system (VMS), as well as operate in a manner that does not contravene Australia's obligations under international agreements and other arrangements to which Australia is a party.[6] Australia further reports that observer coverage occurs on an ad hoc basis on high seas bottom fishing vessels; observers collect data on catch, effort, discards, bycatch and wildlife interactions.[7] Vessels flagged in Nambia and the Cook Islands must use VMS and both countries have observer requirements.

INFORMATION AND REPORTING GAPS

There is a need for further information and reporting of catch, bycatch and areas fished in relation to potential impacts on VMEs. At the moment, little information is publicly available – no catch of deep-sea species has been reported to FAO for Areas 51 and 57 other than the catch reported by China (with regard to longline vessels fishing for deepwater longtail red snapper) and Australia (orange roughy in Area 57). However, it is not clear whether the figures represent the catch taken from within

[6] Response from Australia to FAO Questionnaire.
[7] Ibid.



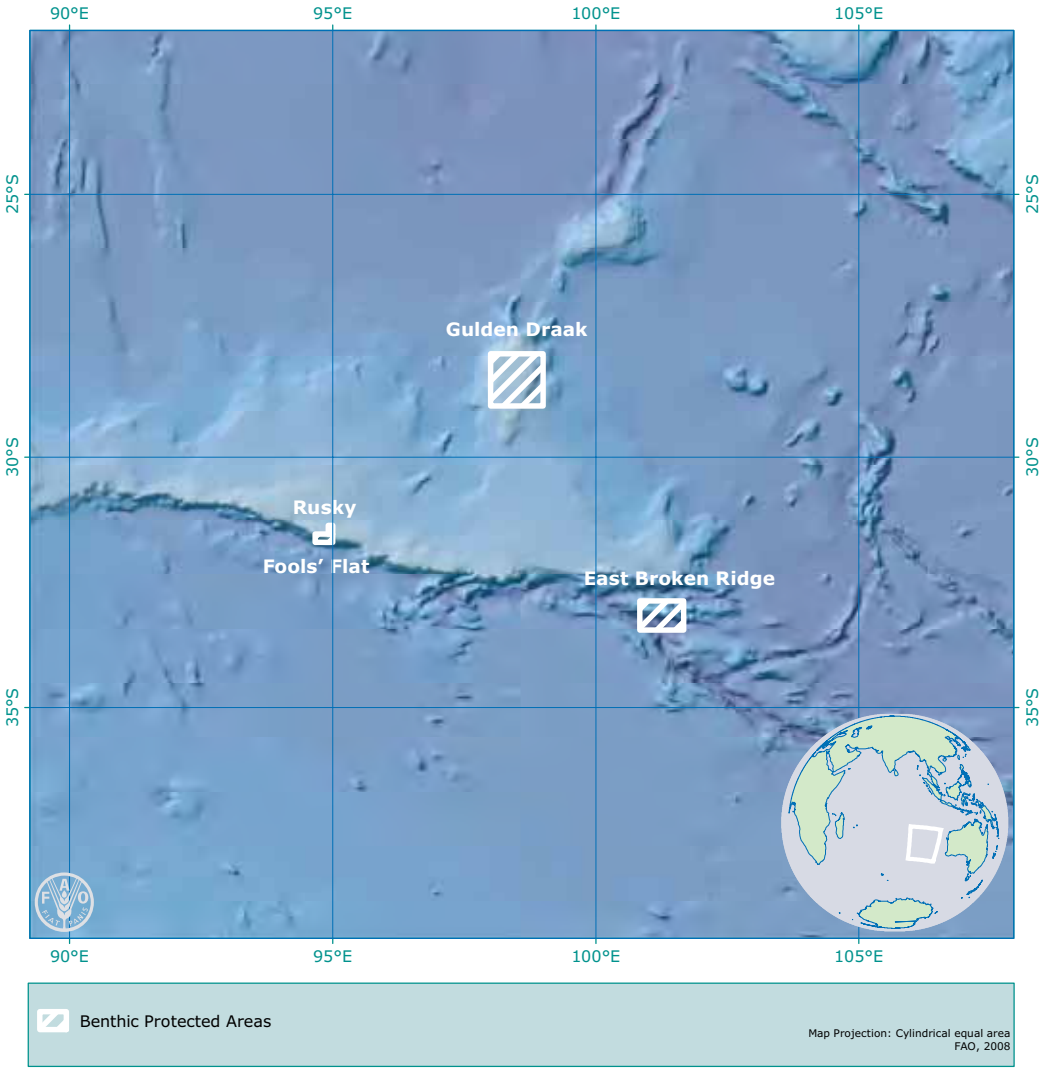
MAP 2
SIODFA benthic protected areas in the South West Indian Ocean

the EEZ, on the high seas, or both (FAO, 2008). Furthermore, no stock assessments have been conducted, or at least not been made publicly available, and there have been no systematic assessments of the impact of the fishery on non-target, associated and dependent species or vulnerable benthic ecosystems.

The data and information collected by the trawl fishing vessels operating in the region involved in SIODFA are likely to be of high quality, valuable and more comprehensive than information collected from or by deep-sea commercial fishing vessels in any other high seas region. A considerable amount of this information has been published in the FAO Report on the *Management of demersal fisheries resources of the Southern Indian Ocean* (Shotton, 2006). Once a management regime has been established for this region, including confidentiality arrangements, it will be important to ensure that the data generated by the fisheries are reported and effectively utilized.

SOURCES OF INFORMATION

The FAO Questionnaire was sent to states known as having a high seas deep-sea fishing fleet. Three countries – Australia, the Cook Islands and China – officially replied with some information regarding deep-sea fishing in the high seas of the Indian Ocean. Namibia also replied to the FAO Questionnaire and reported deep-sea fishing activity in the high seas, but did not indicate specific areas. In addition, reports from FAO, the Commonwealth Scientific and Research Organization (CSIRO) Australia, the United



MAP 3
SIODFA benthic protected areas in the South East Indian Ocean

Nations Environment Programme (UNEP)/Census of Marine Life, the International Union for the Conservation of Nature (IUCN), SIODFA and other sources have been used.

SUMMARY TABLE FOR 2006

Main flag states involved in fisheries	Australia, China, Cook Islands, Mauritius and Namibia
Estimated total number of vessels	20–22
Total reported catch (tonnes)	5 000–6 000

Main fisheries			
Gear	**Target species**	**Fishing grounds**	**Regional Area**
Mid-water trawl	Alfonsino	Madagascar Ridge, Walters Shoal, Southwest Indian Ocean Ridge, Mid-Indian Ridge, Ninety East Ridge and East Broken Ridge	FAO Areas 51 and 57
Bottom trawl	Orange roughy		
Longline	Deepwater longtail red snapper	Unknown	FAO Area 51 – North West Indian Ocean

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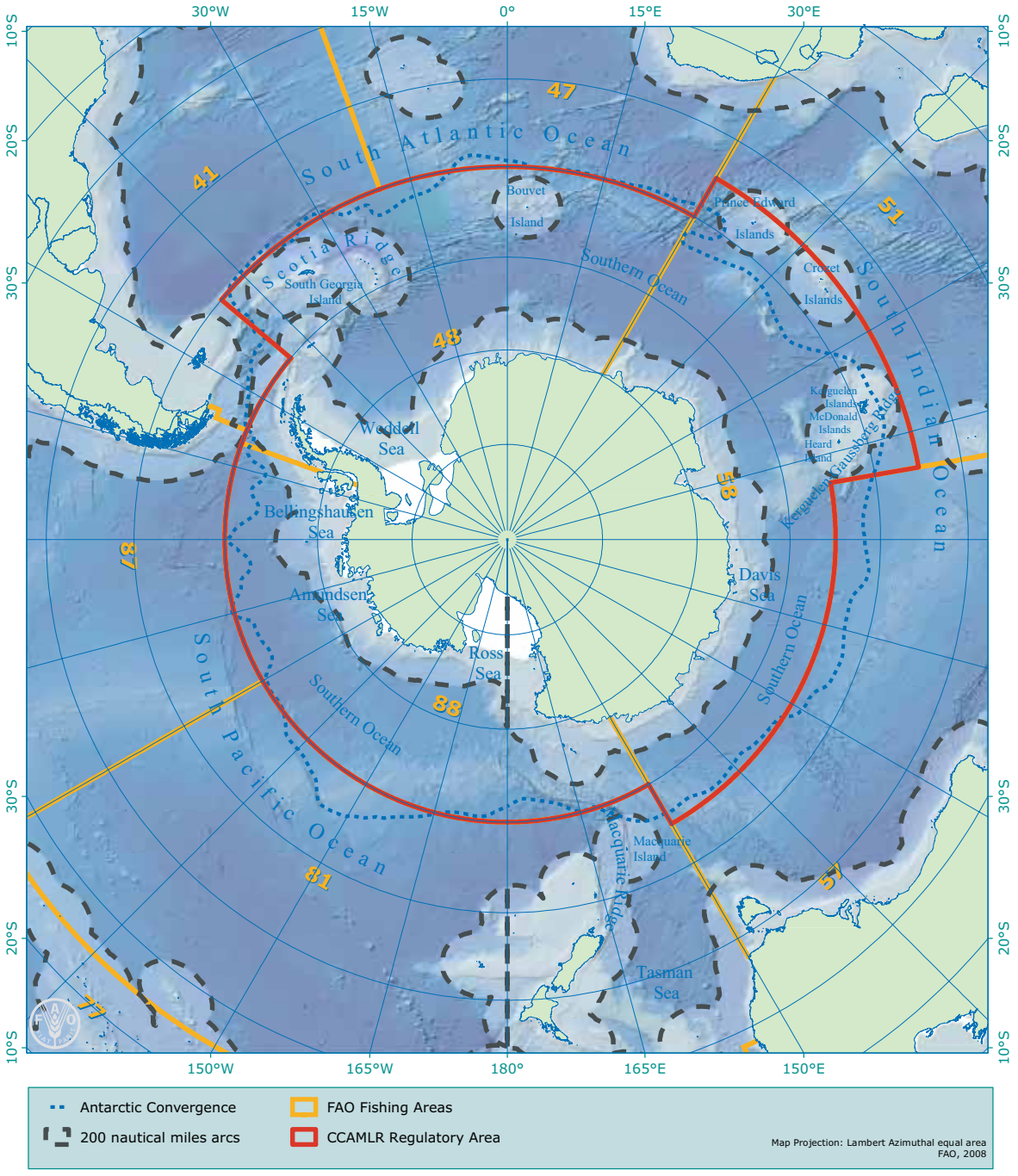
THE SOUTHERN OCEAN



MAP 1
The Southern Ocean

Southern Ocean

FAO Statistical Areas 48, 58 and 88

GEOGRAPHIC DESCRIPTION OF THE REGION

The Southern Ocean surrounds the continent of Antarctica, and constitutes about 15 percent of the world's total ocean surface (CCAMLR, 2000). Its northern boundary is the Antarctic Polar Front (or Antarctic Convergence) between 50°S to 60°S, where cold waters from the south encounter the relatively warmer waters of the Atlantic, Indian and Pacific Oceans. The sub-Antarctic regions of Macquarie Island, Heard and McDonald Islands, Kerguelen Islands, Crozet Islands, Prince Edward Islands, Bouvet Island and South Georgia lie south of, or near, the Antarctic Polar Front and are considered to be part of the Southern Ocean (Map 1).

The Southern Ocean consists of a system of deep basins separated by three large mid-oceanic ridges: the Macquarie Ridge south of New Zealand and Tasmania; the Kerguelen–Gaussberg Ridge at about 80°E; and the Scotia Ridge, or Scotia Arc, extending from the southern Patagonian shelf in an eastward arc to the South Shetland Islands and the Antarctic Peninsula.

The continental shelf is narrow, except in parts of the Weddell, Ross, Amundsen and Bellingshausen Seas: it accounts for only 3 to 5 percent of the total area of the Southern Ocean (CCAMLR, 2000). Sea ice covers vast regions of the Southern Ocean, spreading over 18 x 106 square kilometres (km^2) in winter, and recedes during summer to 3 x 106 km^2 at its minimum extent. September is frequently the month of maximum sea ice coverage, and February is almost always the month of minimum sea ice coverage (Parkinson *et al.*, 1992).

MANAGEMENT REGIME APPLICABLE TO DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

Regional Fisheries Management Organization/Arrangement

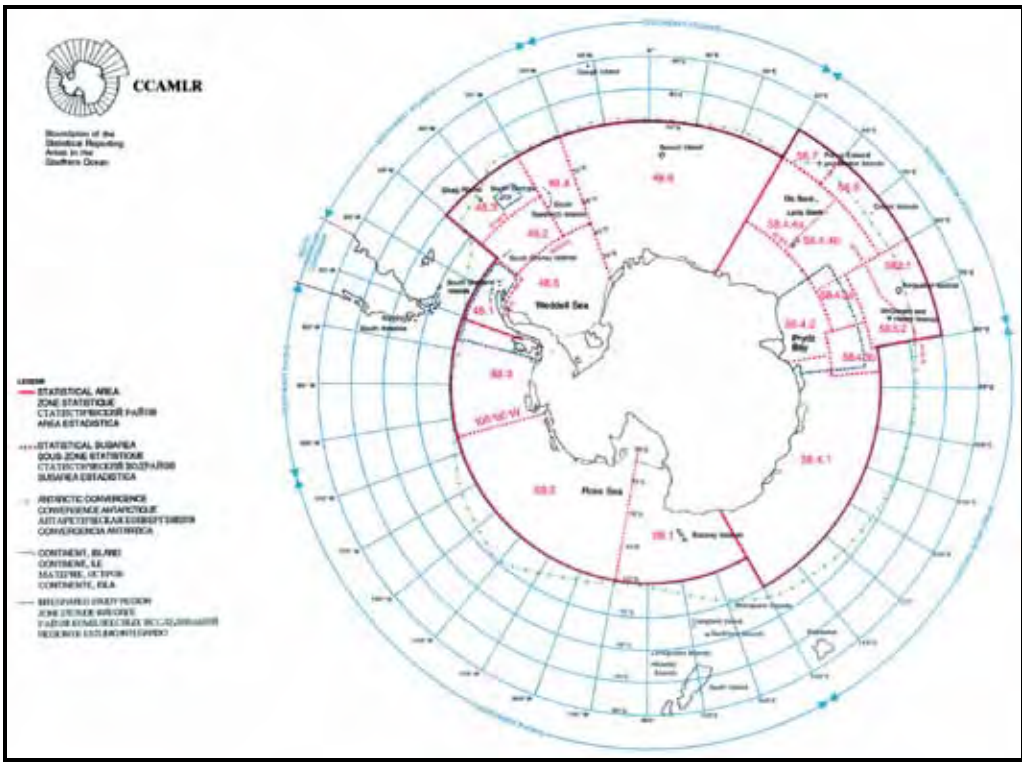
The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is the international organization responsible for the conservation and management of marine living resources in the Southern Ocean. CCAMLR was established by an international convention in 1982, and its Convention Area is delimited to the north by the Antarctic Polar Front, and to the south by the Antarctic continent (Map 2). The steep temperature gradient across the Antarctic Polar Front means that the Convention Area is substantially a closed ecosystem. CCAMLR is currently composed of 25 members[1] who are involved in fishing and/or scientific research in the Southern Ocean. These activities are coordinated and regulated by CCAMLR and the Scientific Committee to fulfil members' obligations under the Convention. Nine other states are also parties to the Convention but they are not members of the Commission.

DESCRIPTION OF DEEP-SEA BOTTOM FISHERIES IN THE HIGH SEAS

History of fisheries

Large-scale bottom trawl finfish fisheries began at the end of the 1960s, and were initially located around the sub-Antarctic islands of South Georgia and Kerguelen. Subsequently, they developed further south, around other island groups. Fishing along the coasts of the Antarctic continent started in the early 1980s but remained at an

[1] Members of CCAMLR: http://www.ccamlr.org/pu/e/ms/contacts.htm

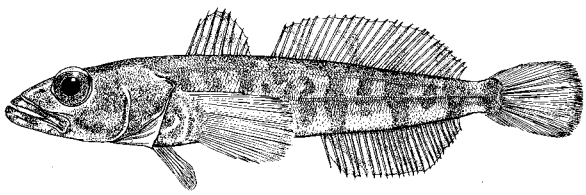


Source: CCAMLR (http://www.ccamlr.org)

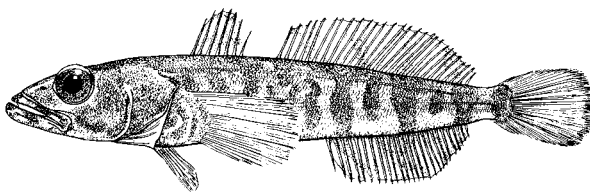
MAP 2
The CCAMLR Convention Area

FIGURE 1
Examples of species targeted by bottom fisheries in the high seas of the Southern Ocean

Patagonian toothfish *(Dissostichus eleginoides)*



Antarctic toothfish (*Dissostichus mawsoni*)



Source: FAO.

exploratory stage (CCAMLR, 2000). Many of the original targeted stocks such as marbled rockcod (*Notothenia rossii*) were overexploited and these fisheries ceased in the 1980s.

Fishing for Patagonian toothfish (*Dissostichus eleginoides*) began with exploratory fishing by Chile in the 1950s. In the 1980s, a commercial trawl fishery started around the Kerguelen Islands. Longline fishing was introduced in the mid-1980s (CCAMLR, 2000). The exploitation of the Antarctic toothfish (*Dissostichus mawsoni*) began only after 1998 (Fallon and Stratford, 2003).

Current fisheries

The main species currently targeted by bottom fishing gears in the Southern Ocean are the Patagonian toothfish (*D. eleginoides*) and the Antarctic toothfish (*D. mawsoni*) (see Figure 1).

D. eleginoides is widespread throughout the Southern Ocean and extends north into sub-Antarctic waters of the Atlantic, Pacific and Indian Oceans. In contrast, the closely

related *D. mawsoni* is endemic to the seas of Antarctica, with a circumpolar distribution, and is found in higher latitudes south of the Antarctic Convergence (Gon and Heemstra, 1990). The two species are known to overlap in the areas immediately to the south of the Antarctic Polar Front, particularly in the area to the north of the Ross Sea (Hanchet *et al*., 2003).

D. eleginoides grows slowly and matures at over ten years, at which stage it is about 80 centimetres (cm) long for males and 100 cm for females. This species has a longevity of over 35 years (Everson and Murray, 1999) and can reach 2 metres (m) in length. *D. mawsoni* has very similar biological characteristics, but is thought to grow more slowly than Patagonian toothfish (Agnew, 2000), and has a smaller maximum length (estimated at around 1.8 m). Growth rates may vary between gender and location.

TABLE 1
Main bycatch species in the bottom longline fisheries for *Dissostichus* spp. in the Southern Ocean

Common name	Scientific name
Macrourids or grenadiers	*Macrourus whitsoni*
	Macrourus carinatus
	Macrourus holotrachys
Rajids or skates	*Bathyraja eatonii*
	Bathyraja irrasa
	Bathyraja maccaini
	Bathyraja meridionalis
	Raja georgiana
Blue antimora (morid)	*Antimora rostrata*

Source: CCAMLR, 2007b.

The main bycatch species associated with the longline fisheries for *Dissostichus* spp. in the Southern Ocean are macrourids (grenadiers) and rajids (skates) (Table 1). Other species groups are also caught as bycatch (CCAMLR, 2006c).

Bottom longline fisheries for Dissostichus *spp.*

Currently, toothfish is mainly targeted by bottom longline fisheries in the CCAMLR Convention Area. The toothfish fishing grounds are distributed along the slopes, ridges and banks of the Antarctic continent and sub-Antarctic islands, and fishing depth generally ranges from 1 500 to 1 800 m.

In the high seas areas of its Convention Area, CCAMLR manages seven "exploratory"[2] deep-sea bottom longline fisheries targeting toothfish. The seven fisheries correspond to seven management areas in the South Pacific (Eastern Ross Sea Subarea 88.1, Western Ross Sea Subarea 88.2), the South Atlantic Ocean (Bouvet Subarea 48.6) and the South Indian Ocean (Ederby-Wilkes Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b). Other high seas areas in the CCAMLR Convention Area are closed to bottom fishing. The Ross Sea fishery in Subarea 88.1 is the southernmost fishery in the world (Hanchet, Horn and Stevenson, 2003). Most fishing in that area is concentrated between December and February, when vessels can fish around the sea ice.

The exploratory fisheries target *D. mawsoni* predominantly. As mentioned in the previous section, this species occurs in waters adjacent to the Antarctic continent, while *D. eleginoides* is mainly located in the northern areas of the CCAMLR Convention Area.

CCAMLR fishing seasons are from 1 December to 30 November of the following year (e.g. 2006/07: 1 December 2006 to 30 November 2007), and fishing is either permitted through that period, or during specified periods to minimize interactions

[2] In CCAMLR terms, a "new" fishery is one for a species and/or on a ground that has not previously been fished. It is also an established fishery where there is an intention to use a new fishing technique. There is a requirement at the "new" fishery stage to collect information on the target as well as dependent species, and the catch or effort (or both) may be limited. In CCAMLR parlance, a new fishery lasts for one year unless no catch is taken at which time it retains its classification. In the second year, the fishery becomes an "exploratory" fishery. Both CCAMLR's conservative approach and data collection requirements continue to allow for a full assessment of the fishery and stock(s) to be developed. A data collection plan must be followed and a research and fishery operation plan produced. All such plans are reviewed each year by the Scientific Committee (http://www.ccamlr.org/pu/e/e_pubs/am/man-ant/p4.htm#New%20and%20Exploratory).

TABLE 2
Catches of *Dissostichus* spp. reported from the CCAMLR Convention Area (Southern Ocean) in 2006/07

Region	Catch (tonnes)		
	High seas	National	Total
Atlantic	113	3 589	3 702
Indian	1 026	5 852	6 878
Pacific	3 443	0	3 443
Total	4 582	9 441	14 023

Source: CCAMLR, 2007b: Annex 5.

with breeding seabirds. During the 2006/07 season, 11 flag states and 20 vessels (Table 5) participated in the exploratory longline fisheries for *Dissostichus* spp. in the high seas areas of the CCAMLR Convention Area and a total of 4 582 tonnes of *Dissostichus* spp. was caught (Table 2).

Reported catches of toothfish in the high seas areas of the CCAMLR Convention, mainly in the Ross Sea, for the seasons 2003/04, 2004/05, 2005/06 and 2006/07 were around 4 600 tonnes per season (CCAMLR, 2007c). This represents about a quarter of the total catch of *Dissostichus* spp. reported in the CCAMLR Convention Area; the main fishing grounds for these species are located around the sub-Antarctic islands in areas where national measures are implemented (Miller, 2007).

Other fisheries in the CCAMLR Convention Area

Longline fisheries for *D. eleginoides* also occur in areas under national jurisdiction (Subareas 58.6, 58.7, 48.3 and 48.4, and Division 58.5.1 and 58.5.2). In its answer to the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries (hereinafter referred to as the FAO Questionnaire – see Appendix A), France provided detailed information (Table 3) regarding the activity of seven longliners fishing in the EEZ of Kerguelen and Crozet Islands (CCAMLR Subareas 58.5.1 and 58.5.2). Although this fishery occurs in areas under national jurisdiction, it gives a good indication of levels of catch, bycatch and fishing effort for this species in the region which is not readily available.

TABLE 3
French bottom longline fishery in the EEZ of Kerguelen and Crozet Islands, 2003–2006

Year	Number of vessels	Catch (tonnes)				Fishing days
		Total	*Dissostichus* spp.	*Macrourus* spp.	Rajids	
2006	7	8 310	2 550		5 760	1 388
2005	7	6 850	500	530	5 820	1 469
2004	7	7 130	830	450	5 850	1 600
2003	7	7 490	800	770	5 920	1 637

Source: response from France to FAO Questionnaire.

Currently, there are no bottom trawl fisheries in the CCAMLR Convention Area, except at Heard and McDonald Islands where a trawl fishery targets *D. eleginoides* in the Australian EEZ.

Pelagic fisheries for Antarctic krill (*Euphausia superba*) developed in the 1970s and the annual catches peaked at 500 000 tonnes in 1981/82. In recent years, the annual catch of krill has been around 100 000 tonnes (CCAMLR, 2000).

There is also a pelagic trawl fishery for mackerel icefish (*Champsocephalus gunnari*), which currently takes place in CCAMLR Division 58.5.2 (Heard Island) and Subarea 48.3 (South Georgia).

Other fisheries, not in operation in recent years, have included pelagic trawl fisheries for mackerel icefish in Division 58.5.1 and electron subantarctic (lanternfish) (*Electrona carlsbergi*) at South Georgia, bottom trawl fisheries for rockcod (*Notothenia* spp.) in Area 48, a pot fishery for crab and a squid fishery at South Georgia (CCAMLR, 2000; CCAMLR, 2006c).

Catch and effort summary

Table 4 lists catch of *Dissostichus* spp. in CCAMLR's exploratory bottom fisheries from 2003/04 to 2006/07 and Table 5 provides an overview of the reported number of

TABLE 4
Reported catch of *Dissostichus* spp. in CCAMLR's exploratory bottom fisheries from 2003/04 to 2006/07

Season	Catch (tonnes)							
	High seas Divisions or Subareas							
	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2	All exploratory fisheries
2003/04	7	<1	20	<1	7	2 197	375	2 605
2004/05	51	480	127	110	297	3 120	411	4 594
2005/06	163	421	164	89	361	2 969	514	4 680
2006/07	113	645	124	4	253	3 096	347	4 582

Source: CCAMLR, 2007b: Annex 5.

vessels per country targeting *Dissostichus* spp.

Illegal, Unreported and Unregulated (IUU) fishing

IUU fishing in the CCAMLR Convention Area was first detected in 1988/89, and estimates are derived from longlining and gillnetting activities. IUU fishing activities targeting *Dissostichus* spp. in the CCAMLR Convention Area peaked in the mid-1990s in areas which nowadays are patrolled. Routine surveillance in the sub-Antarctic Indian Ocean led to a gradual reduction in IUU fishing, from an estimated total of 32 673 tonnes of *Dissostichus* spp. in 1996/97, to 2 178 tonnes in 2003/04. Since 2003/04, the available information indicates that IUU fishing activities have moved to the high latitude regions of the Indian Ocean (Subarea 58.4) and have increased in intensity (see Table 6). The estimated total catch of *Dissostichus* spp. taken by IUU fishing in 2006/07 was 3 615 tonnes, most of which was taken in Division 58.4.3b (2 293 tonnes).

TABLE 5
Reported number of fishing vessels targeting *Dissostichus* spp. in CCAMLR's exploratory bottom fisheries from 2003/04 to 2006/07

Flag state	CCAMLR season			
	2003/04	2004/05	2005/06	2006/07
Argentina	2	1	1	1
Australia	1	1		
Chile		1	2	
Japan	1	1	1	1
Korea, Republic of	2	2	1	3
Namibia				1
New Zealand	5	4	4	4
Norway	1	1	1	1
Russian Federation	2	2	2	2
South Africa	1			1
Spain	1	2	2	1
United Kingdom	1	1	2	2
Ukraine	3			
Uruguay	2	2	3	3
United States of America	2			
Number of vessels	24	18	19	20
Number of flag states	13	11	10	11

Source: CCAMLR, 2006c; 2007b.

CCAMLR has developed a combined IUU list of vessels from both contracting and non-contracting parties. The list was adopted by CCAMLR from 2003 to 2007, and currently includes 25 vessels (CCAMLR, 2007a).

TABLE 6
Estimated catch of *Dissostichus* spp. taken by IUU fishing in the high seas of the CCAMLR Convention Area from 2003/04 to 2006/07*

Season	Catch (tonnes)													
	High seas Divisions or Subareas						Divisions or Subareas under national jurisdiction where national measures are implemented						Unknown	All areas
	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2	58.4.4	58.5.1	58.5.2	58.6	58.7	48.3		
2003/04		197		246	240	0	0	536	531	380	48	0		2 178
2004/05		86	98	1 015	23	0	220	268	265	12	60	23	508	2 578
2005/06	597	192	0	1 903	0	15	104	144	74	55	0	0	336	3 420
2006/07	612	197	0	2 293	0	0	109	404	0	0	0	0		3 615

Blank: no estimate; zero: no evidence of IUU fishing.
*IUU fishing was first detected in 1988/89, and estimates are derived from longlining and gillnetting activities.
Source: CCAMLR, 2007b: Annex 5.

STATUS OF THE STOCKS, BYCATCH AND IMPACTS ON VULNERABLE MARINE ECOSYSTEMS

Status of target stocks

CCAMLR annually reviews and updates integrated fishery assessments for *Dissostichus* spp. in Subareas 88.1 and 88.2, and assessments for *Dissostichus* spp. in Subarea 48.6 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b are being developed. The current status of target stocks is currently being assessed and precautionary catch limits for *Dissostichus* spp. and bycatch species are set in all exploratory fisheries.

Status of bycatch stocks

The need for assessments of the status of bycatch species or groups (particularly macrourids and rajids) has been raised as an important issue by the CCAMLR Scientific Committee in recent years. However, there is currently no information available on the status of bycatch species. Data collection and tagging programmes have been initiated for some bycatch species, in particular for rajids.

Impacts on Vulnerable Marine Ecosystems (VMEs)

Seamounts, hydrothermal vents, cold-water corals and sponge fields are considered to be VMEs in the CCAMLR Convention Area. Impacts of bottom longline fisheries on long-lived cold-water corals have been observed in some areas exploited by the toothfish fishery around South Georgia (Rice *et al*., 2007). In 2007, CCAMLR adopted Conservation Measure 22-06 (Bottom Fishing in the Convention Area) to mitigate the impacts of bottom fishing on VMEs (see following section).

CONSERVATION AND MANAGEMENT MEASURES

CCAMLR management of fisheries is based on a precautionary ecosystem approach. The conservation measures are revised annually for each fishing season (CCAMLR, 2006d). The seven exploratory longline fisheries for *Dissostichus* spp. in high seas areas are currently subject to the following requirements:

- annual notification of intent to fish;
- participation limited to members who have notified their intention to fish in a particular season;
- compliance requirements including licensing, inspections and VMS;
- participation in the Catch Documentation Scheme (CDS) for *Dissostichus* spp.;
- environmental protection;
- mitigation measures (seabirds);
- limited fishing season;
- precautionary catch limits for *Dissostichus* spp. by fishery and small-scale research units (SSRU);
- precautionary catch limits for bycatch species by fishery and SSRU;
- scientific observations appointed in accordance with CCAMLR's Scheme of International Scientific Observation (CCAMLR, 1992);
- quasi real-time (five-day) catch and effort reporting used for in-season monitoring of fishing in relation to precautionary catch limits;
- haul-by-haul catch and effort data;
- fishery-based research in SSRU;
- tagging programme for *Dissostichus* spp.

Measures are also in place to ensure minimal effects of other fisheries on the environment. Gillnetting is prohibited in the CCAMLR Convention area (Conservation Measure 22-04). Bottom trawling is currently restricted to areas for which CCAMLR has conservation measures in force for bottom trawling gear (Conservation Measure 25-04). This interim restriction entered into force for 2006/07 and 2007/08. These

measures do not apply to fishing for scientific research purposes, which is allowed under specific constraints and conditions.

In November 2007, CCAMLR adopted Conservation Measure 22-06, which aims to mitigate adverse effects of bottom fishing on VMEs. This measure limits bottom fishing until 30 November 2008 to those areas that were approved for the 2006/2007 fishing season. All bottom fisheries commencing 1 December 2009 and thereafter will be subject to an impact assessment. The measure also requires the immediate cessation of fishing in areas where VMEs are encountered in the course of fishing. This measure strengthens CCAMLR's existing monitoring and control measures for bottom fisheries, as well as requirements for data collection and research.

INFORMATION AND REPORTING GAPS

The CCAMLR Scientific Committee reports discrepancies between the data compiled by CCAMLR and the data reported by countries in STATLANT. However, detailed haul-by-haul, catch and effort, and biological data, including scientific observer data, are held by CCAMLR. These data, which are used in CCAMLR stock assessments, are confidential and subject to CCAMLR's rules for access and use (CCAMLR, 2006a; 2006b).

SOURCES OF INFORMATION

In their reply to the FAO Questionnaire sent to states known as having a high seas deep-sea fishing fleet, four countries (Japan, New Zealand, Norway and the Republic of Korea) officially replied with some information regarding deep-sea fishing in the high seas of the Southern Ocean. Other countries such as France and Australia reported fishing activity in the Southern Ocean, but limited to areas under their national jurisdiction. Various documents published by CCAMLR have been used for this review.[3] The CCAMLR *Report of the Twenty-Fifth Meeting of the Scientific Committee* and its annexes, in particular the Fishery Reports prepared by the Working Group on Fish Stock Assessment (WG-FSA), have been the main source of information for the description of the fisheries. The 2007 electronic version of the CCAMLR Statistical Bulletin has also been used. Responses to the FAO Questionnaire from Ukraine and others have provided additional information.

Limited information on fishing effort was available in STATLANT data published in CCAMLR's Statistical Bulletin (CCAMLR, 2007c).

SUMMARY TABLE FOR 2006/7

Main flag states involved in fisheries*	Argentina, Australia, Chile, Japan, Republic of Korea, Namibia, New Zealand, Norway, Russian Federation, South Africa, Spain, Ukraine, United Kingdom, United States of America, Uruguay
Estimated total number of vessels*	20
Total reported catch (tonnes)*	4 582

Main fisheries				
Gear	**Target species**	**Fishing grounds**	**Regional area**	**Jurisdiction**
Bottom longline	Antarctic toothfish Patagonian toothfish	Slopes, ridges and banks of the Antarctic continent and sub-Antarctic islands	Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, and Subareas 48.6, 88.1 and 88.2	High seas

* The seven exploratory bottom longline fisheries (see section on Current fisheries).

[3] http://www.ccamlr.org/pu/e/e_pubs/intro.htm

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Conclusions

This final chapter presents overall estimates of the catch, number of vessels, and the ex-vessel value of the catch in high seas bottom fisheries worldwide. An analysis of the information presented in this chapter shows that in 2006, 285 vessels were involved in high seas bottom fisheries, catching 252 000 tonnes. This catch had an estimated landed value of EUR 447 million. These numbers must be taken as indicative and possibly minimum estimates due to the factors described in detail below and in the regional chapters of the report. No attempt was made to derive maximum estimates. However, the information provided in the regional chapters indicates that the range between a minimum and a maximum estimate is likely to be limited. This chapter also discusses the various challenges to be addressed in order to gain an improved understanding of these fisheries in future reviews.

GLOBAL ESTIMATES OF THE CATCH AND NUMBER OF VESSELS IN 2006

An overview of the catch and number of vessels involved in high seas bottom fisheries in 2006 is presented in Table 1. The numbers in this table have been estimated based on the information provided in the regional reviews in this document and thus these should be referred to for more details regarding sources of information.

The following considerations must also be taken into account:

- information collected through the 2007 FAO Questionnaire on High Seas Deep-sea Fisheries is incomplete, especially with regard to the level of detail required;
- some vessels fishing in different fisheries within a region or fishing in more than one region may have been counted more than once;
- information about illegal, unreported and unregulated (IUU) fishing and IUU vessels has not been included in the table;
- vessels and catch in the Mediterranean and Central Atlantic have not been included in this table;
- there are discrepancies in the information available on catch and numbers of vessels in some regions depending on the source of information used although there has been a steady improvement in the information available in a number of regions as states and regional fisheries management organizations/arrangements (RFMOs/As) have undertaken efforts to implement the United Nations General Assembly (UNGA) Resolution 61/105; and
- the catch estimates do not include estimates of discards, with discards likely to constitute a substantial portion of the catch in at least some high seas bottom fisheries.

With regard to the number of fishing vessels, it is recognized that many of the vessels engaged in high seas bottom fisheries in 2006 were not doing so on a full-time basis. For example, some bottom fishing vessels operating on the high seas in the North Atlantic also operate within exclusive economic zones (EEZs) during the course of the year. The bottom trawl fisheries for hake and squid in the South West Atlantic represent approximately 40 percent of the catch of high seas bottom fisheries globally. Similarly, many of the vessels involved in this fishery also fish within the zones of neighbouring states within the same year.

Answers to the FAO Questionnaire provided insufficient information to fully estimate the extent to which high seas bottom fishing vessels also fish within EEZs and the relative amount of time spent fishing in both areas.

TABLE 1
Summary of total catch and number of vessels per region in 2006

Region	Principal target species	Total catch (tonnes)	Total number of vessels
North East Atlantic	Roundnose grenadier, Baird's slickhead, black scabbardfish, leafscale gulper shark, Portuguese dogfish, deepwater sharks, Greenland halibut, ling, tusk, beaked redfish, golden redfish, haddock, hake, monkfish, deep-water red crabs, orange roughy and blue ling	59 978	66–70
North West Atlantic	Northern shrimp, Greenland halibut, redfish and skates	56 523	67
South East Atlantic	Orange roughy, alfonsino, Patagonian toothfish and deep-sea red crabs	747.3	6
South West Atlantic	Argentine hake and Argentine short-fin squid	110 983	55
North Pacific	Alfonsino and slender armourhead	10 331	16
South Pacific	Orange roughy and alfonsino	3 369	52
Indian Ocean	Alfonsino, orange roughy, deepwater longtail red snapper	5 000–6 000	20–22
Southern Ocean	Toothfish	4 582	20

The total global catch of bottom fisheries, based on the total catch of approximately 60 species, on the high seas is estimated to be circa 252 000 tonnes for 2006. This represents 0.31 percent of the total marine capture (including fish, crustaceans, molluscs, etc.) that year. Although this total is indicative only, it still constitutes only a minor share portion of the global catch in marine capture fisheries. The sum of the vessels fishing on a region-by-region basis is in the range of 302-308 (Table 1). However, as noted, some vessels fish in more than one region.

Number of vessels involved in bottom fisheries in the high seas, 2006

Figure 1 provides an overview of the number of vessels, as well as the types of vessels, operating in the different regions. Trawlers, including both mid-water and bottom trawlers, make up the majority of the global vessel total, as well as in many of the regions. A notable exception is the Southern Ocean, where fishing for toothfish by bottom longliners constitutes the main high seas bottom fishery.

Figure 2 presents an estimate of vessels per flag state operating in bottom fisheries in the high seas; 285 vessels from 27 flag states were operating in 2006. The European Community (EC) as a whole has the largest number of vessels (103), with the majority

FIGURE 1
Number of vessels involved in high seas bottom fisheries per region in 2006

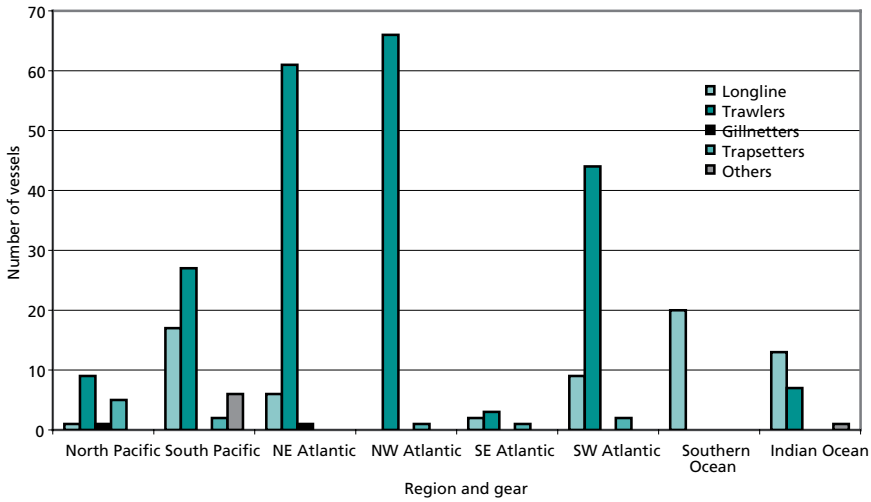
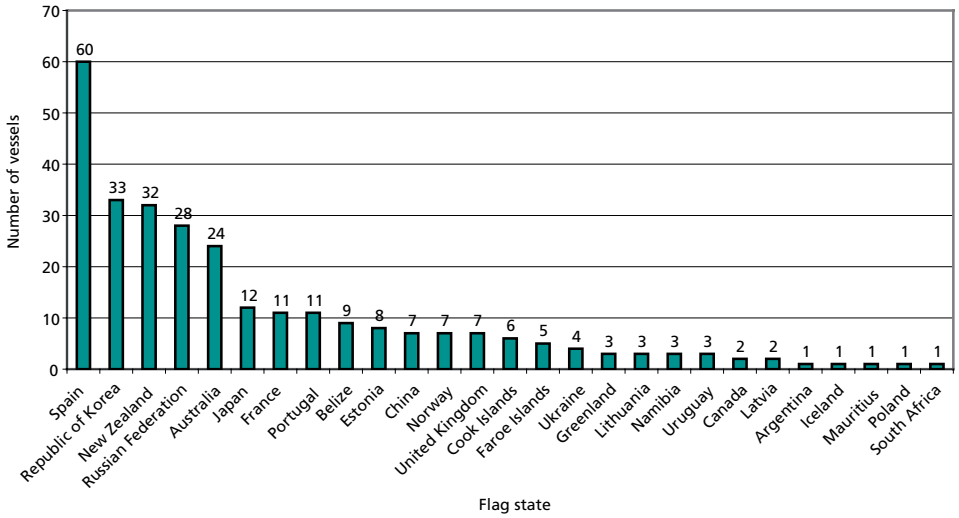


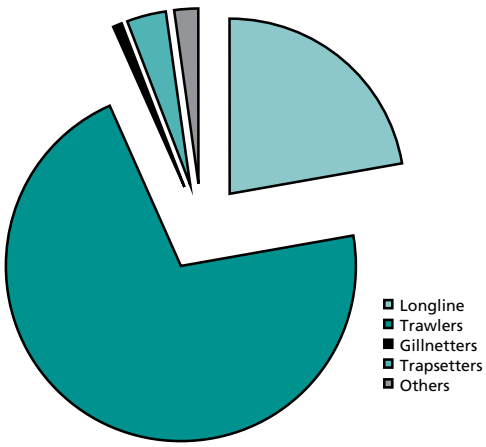
FIGURE 2
Number of vessels per flag state involved in high seas bottom fisheries in 2006



of these being flagged to Spain, which has vessels fishing primarily in the North East Atlantic, North West Atlantic and the South West Atlantic. The Spanish fleet makes up 21 percent of the global high seas bottom fisheries fleet and 58 percent of the EC fleet. Of the EC fleet, Spain is followed by France and Portugal in terms of number of vessels. Non-EC flag states with a relatively large number of vessels are New Zealand, fishing primarily in the South Pacific and Southern Ocean; the Republic of Korea, fishing primarily in the South West Atlantic; the Russian Federation, fishing primarily in the North East and North West Atlantic; and Australia, fishing primarily in the South Pacific and the Indian Ocean.

The majority of the vessels operating in the bottom fisheries in the high seas are trawlers (mid-water and bottom trawlers). This is shown in Figure 3. Bottom longliners are the second most common type of vessel in these fisheries. In total, 285 vessels were reported to operate in bottom fisheries in the high seas in 2006. This figure is lower than the sum of the vessels fishing on a region-by-region basis (302-308) as some vessels fish in more than one region (e.g. many Spanish vessels fish in both the North East and North West Atlantic).

FIGURE 3
Global overview of vessel types used in high seas bottom fisheries, 2006



Global catch in bottom fisheries in the high seas

The scope of this report must be taken into consideration when examining total catch. Although this report focuses primarily on fisheries that target demersal and benthic species, other fisheries have been included, where appropriate, such as those conducted with deep-sea pelagic gears that may or are likely to have occasional contact with the sea floor; those targeting species mainly distributed in shallow waters, but where bycatch includes deep-sea species; or those with fishing grounds mainly located within national jurisdictions, but potentially overlapping the high seas.

FIGURE 4
Global total catch of main species (>500 tonnes), 2006

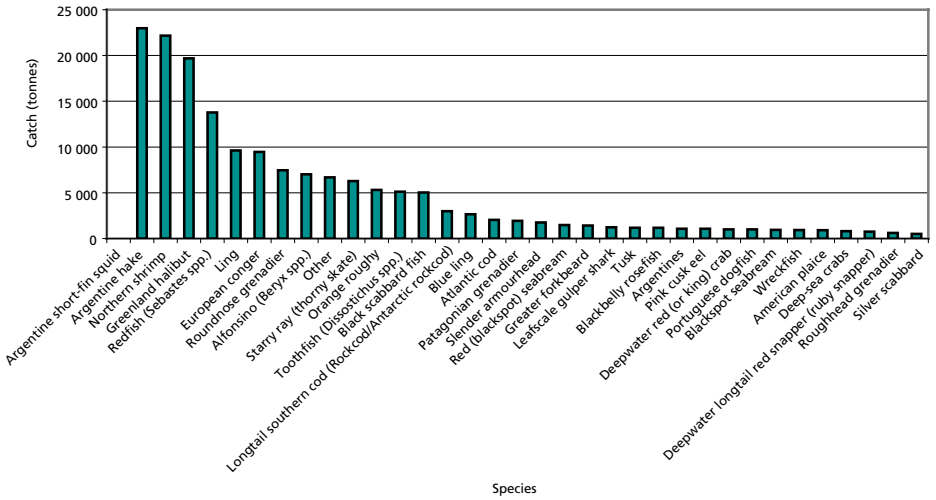


FIGURE 5
"Deep-sea" species (> 500 tonnes catch)

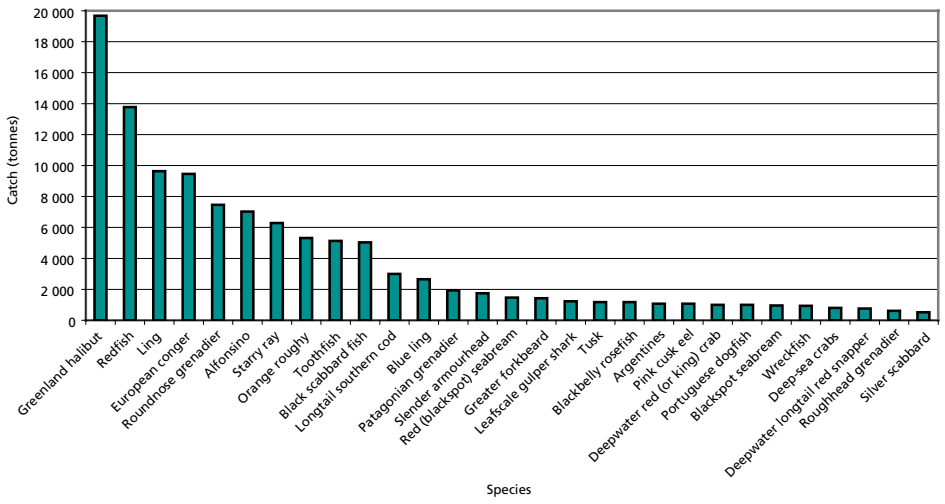


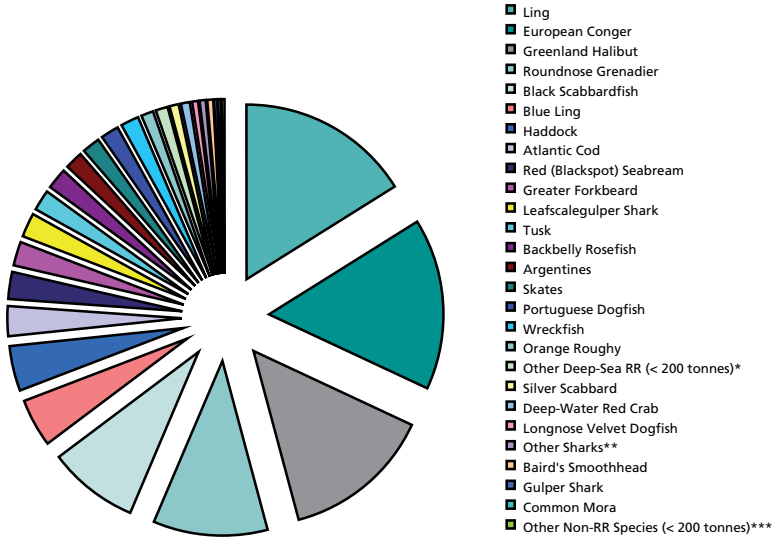
Figure 4 presents the total catch of the main species caught globally in high seas bottom fisheries in 2006. Species with more than 500 tonnes of total catch in 2006 are represented in the graph, but more than 60 species are included in the total figure presented above. Argentine short-fin squid represents the highest catch in terms of weight (79 742 tonnes in 2006), with other higher productivity species following at more than 20 000 tonnes including Argentine hake and Northern shrimp.

There are no internationally agreed definitions of deep-sea species or clear definitions and categorical distinctions between high, medium and low productivity species. Nevertheless Figure 5 presents the total catch of species generally categorized as "deep-sea" (i.e. those with lower productivity levels) in 2006.

Regional catch composition

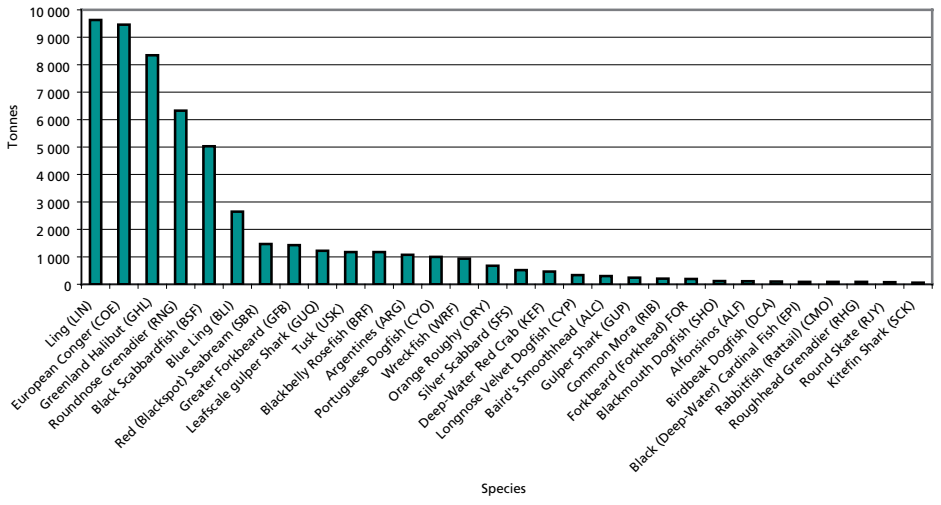
Figures 6 to 12 provide the species composition of the 2006 catch in the North East and North West Atlantic as well as in the North and South Pacific.

FIGURE 6
Catch composition of bottom species in the North East Atlantic, 2006



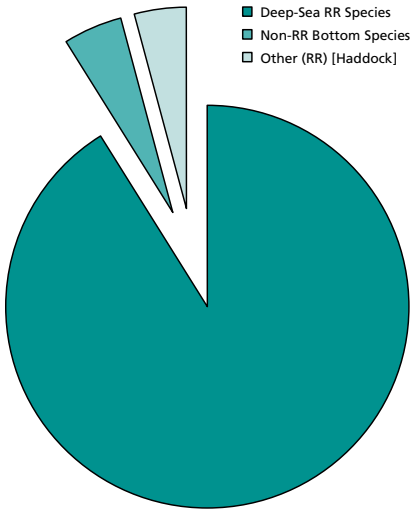
* Other Deep-Sea RR (< 200 tonnes) = Alfonsino, Rabbitfish (Rattail), Cardinal Fish, Forkbeard (Forkhead), Roughhead Grenadier, Round Skate, Small Redfish (Norw.Hadd.), Spiny (Deep-Sea) Scorpionfish
** Other sharks = Black Dogfish, Birdbeak Dogfish, Greenland Shark, Blondnose Six-Gilled Shark, Kitefin Shark, Blackmouth Dogfish, Knifetooth Dogfish
*** Other Non-RR Species (< 200 tonnes) = Wolffish, Altlantic Halibut, American Plaice, Northern Prawn

FIGURE 7
Catch of "deep-sea" species in the North East Atlantic, 2006



The North East Atlantic region is one of the most diverse in terms of the variety of species taken in bottom fisheries. In the North East Atlantic (Figure 6) when considering all species caught with bottom gear in the high seas, ling, European conger, Greenland halibut, roundnose grenadier, black scabbardfish, blue ling, haddock, and Atlantic cod constitute the largest amounts of catch (> 1 500 tonnes). The largest amount of catch for deep-sea species in the bottom fisheries of the high seas (Figure 7) represents nearly the same group of species with the first six species mentioned above remain the top catch, but are followed by slightly smaller catches (> 1 000 tonnes) of red (blackspot) seabream, greater forkbeard, leafscale gulper shark, tusk, blackbelly rosefish and argentines.

FIGURE 8
Catch of NEAFC Regulated and Non-Regulated species in 2006



RR= Regulated species; Non-RR = Unregulated species

Figure 8 shows the relative catch of "deep-sea" species regulated by the North East Atlantic Fisheries Commission (NEAFC), other regulated species that are not categorized as "deep-sea", and those bottom species that are not regulated by this RFMO.

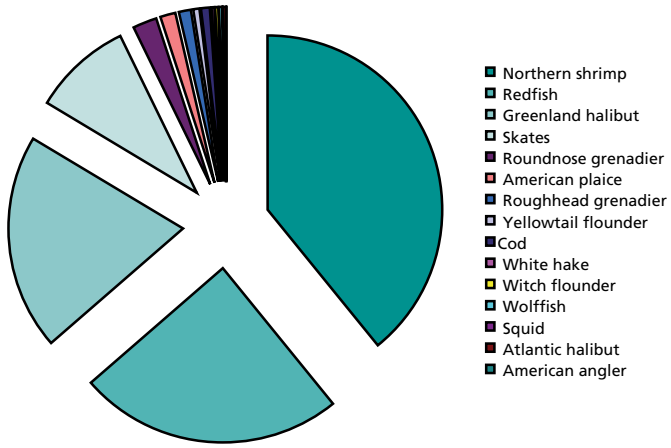
In the North West Atlantic, the four main target species in the bottom fisheries – Northern shrimp, redfish, Greenland halibut and skates – made up the majority of the catch in 2006, in terms of weight (Figure 9–10). Grenadiers and flat fishes represent smaller catches and are usually bycatch in these fisheries.

In the North and South Pacific, deep-sea species represent the main species in the catch reported. In the North Pacific, alfonsino and slender armourhead make up the largest individual amounts of catch in 2006 (Figure 11), and orange roughy constituted the majority of the catches in the South Pacific in the same year (Figure 12).

Estimates of value of catch of high seas bottom fisheries in 2006

A recent report[1] prepared for the European Commission estimated that the total high seas catch by EC vessels using bottom gears averaged around 71 000 tonnes per year from 2004 to 2006. The average value of the catch was approximately EUR 126 million per year – with an average ex-vessel price of EUR 1 775 per tonne. An IUCN report[2], published in 2004, reviewed bottom trawl fisheries in the high seas for the year 2001. The report estimated that the total high seas bottom trawl catch in 2001 was in the range of 175 000–210 000

FIGURE 9
Species composition of bottom fisheries in the North West Atlantic, 2006



[1] MRAG, MG Otero & PolEM. 2008. *Analysis of the economic and social importance of Community fishing fleet using bottom gears in the high seas*. London: MRAG Ltd. 250p. Table 80.

[2] Gianni, M. 2004. *High seas bottom trawl fisheries and their impacts on the biodiversity of vulnerable deep-sea ecosystems: options for international action*. International Union for the Conservation of Nature (IUCN), Gland, Switzerland.

FIGURE 10
Catch composition of four main species in the North West Atlantic, 2006

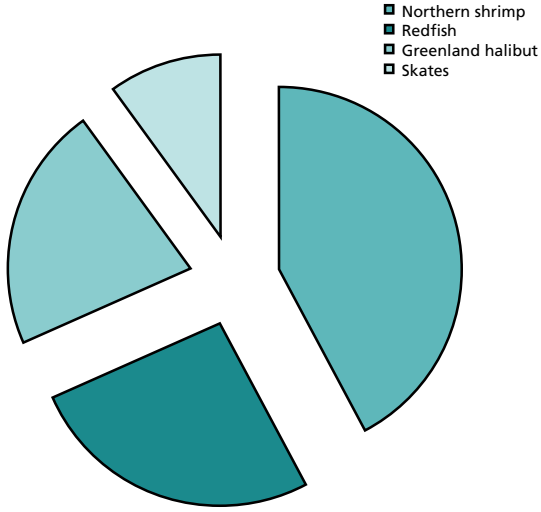


FIGURE 11
Catch composition in the North Pacific, 2006

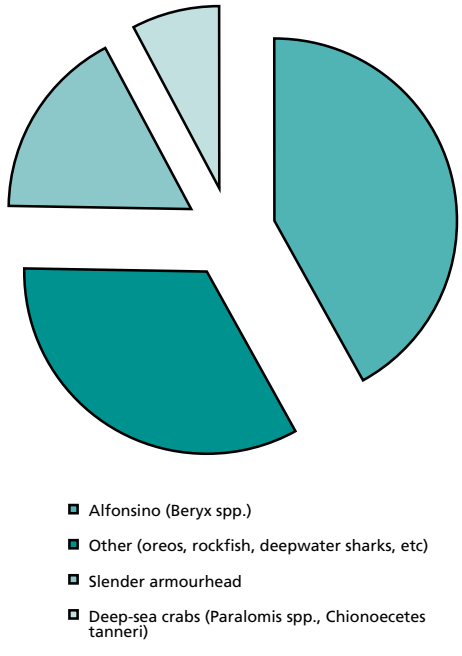
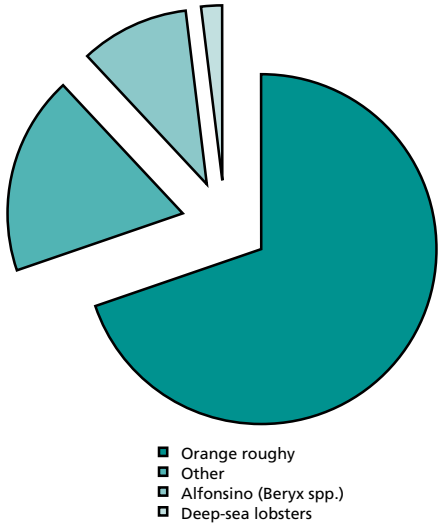


FIGURE 12
Catch composition in the South Pacific, 2006



tonnes (excluding the South West Atlantic and Mediterranean Sea) with a total value of USD 280–320 million and an ex-vessel price of USD 1 540 (or EUR 1 720) per tonne.[3]

Using an average ex-vessel price of EUR 1 775 per tonne for the catch in high seas bottom fisheries, the value of the global high seas bottom catch in 2006 would be about EUR 447 million (for the estimated total catch of 252 000 tonnes).

[3] www.oanda.com Average rate 2001: USD 1 = EUR 1.11691. www.oanda.com/convert/fxhistory

ASSESSMENT AND SUMMARY OF INFORMATION GAPS PRESENTED IN EACH REGION

Gaps in data and information concerning target and bycatch stock status

This section summarizes gaps in data and information identified in the regional chapters. In terms of basic fisheries data – volume of catch, species composition of catch, number of vessels involved in high seas bottom fisheries – there are numerous discrepancies between the information sent by countries in response to the FAO Questionnaire, the information in the FAO FishStat database and information publicly available from RFMOs, their Scientific Committee or Science Working Groups reports and other information publicly available. More accurate and consistent reporting of information on high seas bottom fishing activities is needed.

Further work needs to be done in assessing the status of target species in high seas bottom fisheries in many regions. Often the most basic information on the total catch and life history of target species taken in deep-water fisheries on the high seas is not sufficient to establish conservation and management measures. It is essential that such assessments be conducted if fisheries management is to be effective in ensuring the long-term sustainability of fish stocks.

Similarly, much more work needs to be done to assess the status of bycatch species, including those of non-commercial value. There are indeed indications, in at least some regions, that significant numbers of species may be taken as bycatch.

Furthermore, for better analysis of data, reporting must be on a finer scale; for example, more frequent reporting intervals of vessel monitoring system (VMS) data would greatly enhance data quality. In many cases, fishing activity in the high seas is not clearly distinguished from that taking place in the EEZs, whereas a distinction is essential for an analysis of fishing activities in the high seas. Efforts to resolve this issue have been initiated in some regions (e.g. NEAFC and the South East Atlantic Fisheries Organisation [SEAFO]) but, in many cases, it is difficult to separate catch and vessel activity data from the two jurisdictions.

Collection of historical and other currently unpublished or unavailable data will be important for the assessment of the status of target and bycatch stocks, as well as the overall impact of deep-sea fisheries on vulnerable habitats and ecosystems.

Gaps in data and information concerning impacts on, and location of, vulnerable marine ecosystems (VMEs)

In terms of data and information concerning impacts on, and location of, VMEs for the various regions, the situation ranges from little knowledge and no systematic assessments having been carried out on the impact of fishing on such ecosystems, nor on the location of these ecosystems, to measures being implemented (e.g. areas being closed) to mitigate impact. The latter is taking place as part of a precautionary management approach as well as following on from identified impacts.

However, overall, more precise information on the location of fishing in relation to underwater features is needed, in particular to better assess the potential impact of fishing activities on VMEs. The most precise information in this regard has been collected from fisheries conducted by New Zealand vessels fishing on the high seas in the South West Pacific and the Tasman Sea.

There is also a need to better map locations of VMEs on the high seas and to consolidate this information into a single global database accessible to states and RFMOs. Work of this nature, in particular the mapping of locations of cold-water corals, is already under way in some regions (e.g. the Hatton and Rockall Bank areas in the North East Atlantic), but greater effort is required to determine the locations of such areas effectively in order to assess the extent to which bottom fisheries may be impacting VMEs.

Equally important is the need to identify areas where VMEs are *likely* to occur. An example of the type of work needed in this regard is a recent assessment of the likely occurrence of stony corals in relation to large seamounts worldwide conducted by the Census of Marine Life on Seamounts (CenSeam), published by United Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO)/Intergovernmental Oceanographic Commission and others in November 2006.[4]

This assessment was the first of its kind to specifically address this need and essentially entails a biogeographic assessment of the likely association of stony, reef building, cold-water corals (such as *Lophelia pertusa*) with large seamounts (defined as those over 1 000 metres (m) from base to peak) throughout the world's oceans, using predictive modelling, based on the best scientific information currently available.

Additionally, similar global biogeographic assessments should be conducted to determine the likely extent and distribution of soft corals, sponges and other species, particularly habitat-forming species, and ecosystems vulnerable to bottom fisheries in relation to large seamounts, as well as in relation to other underwater features such as seamounts of lesser elevations (e.g. hills, knolls and rises), canyons and continental slope/margin areas of the high seas.

All assessments mentioned in the two sections above would be useful to RFMOs and flag states in the implementation of the *FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (adopted on 29 August 2008) (the FAO Guidelines) and the UNGA Resolution 61/105.

DATA AND REPORTING RECOMMENDATIONS

Workshop on Data and Knowledge in Deep-Sea Fisheries in the High Seas

A workshop on Data and Knowledge in Deep-Sea Fisheries in the High Seas was held in Rome, Italy (5–7 November 2007) to discuss the current state of knowledge in these fisheries. The recommendations that resulted from the discussions are summarized below. As a preface to the recommendations, the participants first agreed to endorse the following statement:

> *"the obligation to provide data for management purposes must be accepted as non-negotiable on the part of governments of the flag States and the industry itself and that it should be fully implemented as a matter of priority. Governments must provide moral and legal support to ensure that the data needed for management are provided and undertake the necessary coordination to ensure this happens."* (DEEP SEA, 2003)[5]

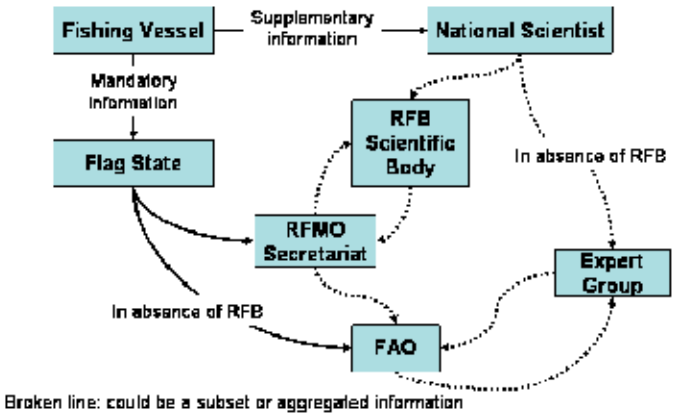
Participants considered the following types of data collection necessary for the management of deep-sea fisheries:

- catch and effort logbooks (including fishing operations, catch, gear and vessel type, effort statistics, fishing locations, depth and date and time fished);
- vessels' position and movements through a satellite-based VMS;
- information from scientific and benthic habitat surveys, in particular surveys that identify areas where VMEs occur or are likely to occur;
- samples of biological characteristics of catch;
- registers of vessels authorized to fish (length, tonnage, gear, areas fished, target species, and

[4] Clark, M.R., Tittensor, D., Rogers, A.D., Brewin, P., Schlacher, T., Rowden, A., Stocks, K. & Consalvey, M. 2006. *Seamounts, deep-sea corals and fisheries: vulnerability of deep-sea corals to fishing on seamounts beyond areas of national jurisdiction.* United Nations Environment Programme (UNEP)–World Conservation Monitoring Centre (WCMC), Cambridge, United Kingdom.

[5] FAO. *Report on DEEP SEA 2003, an International Conference on Governance and Management of Deep-Sea Fisheries*. Queenstown, New Zealand 1–5 December 2003. FAO Fisheries Report 772. Rome. 2005. 84pp.

FIGURE 13
Data reporting schema



- current activities of the vessel);
- vessels' permanent ID numbers (which all vessels in deep-sea fisheries should have);
- socio-economic data.

Furthermore, participants recommended that standardized and consistent data collection procedures and protocols be adopted and published – electronic data reporting systems are preferred. It was also noted that 100 percent observer coverage should be required on vessels in these fisheries.

Similar to issues referred to in the gaps in data, the participants mentioned the importance of gathering historical data from both fisheries and non-fisheries sources, as well as the improvement of catch identification and biological data collection on marine resources through national and international training programmes for fishers and scientific observers.

Also important for the implementation of the FAO Guidelines is the need for better and more relevant data on VMEs and the impact of fishing. Such information could be gathered from fisheries and fisheries independent sources. Further studies should also be undertaken on the impact of various types of fishing gear on VMEs.

The critical need for accurate and complete data was noted, as well as the importance of verifying and comparing information from different sources. Participants called for the collection and reporting of data to be on as fine a temporal and spatial scale as possible, noting that data reporting and analysis should also be as transparent as possible. Arrangements for data submission, where RFMOs exist and where they do not, should be on the finest possible scale and might follow the data reporting schema prepared by participants (Figure 13).

The participants echoed the *Worldwide review of bottom fisheries in the high seas* initiative and recommended its regular updating, as well as a review of data and knowledge available and management approaches. A source of dissemination of information on the status and trends of bottom fisheries in the high seas could be the FAO Fishery Resources Monitoring System (FIRMS) partnership.

FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas

The FAO Guidelines are a voluntary instrument that represents one of the first such tools to address both sustainable fisheries and conservation of marine biodiversity.

The FAO Guidelines are specifically for fisheries that are beyond national jurisdiction and have the follow characteristics: "the total catch (everything brought up by the gear) includes species that can only sustain low exploitation rates; and the fishing gear is likely to contact the seafloor during the normal course of operations". The aim of the instrument is to "facilitate and encourage the efforts of states and RFMO/As towards sustainable use of marine living resources exploited by deep-sea fisheries, the prevention of significant adverse impacts on deep-sea vulnerable marine ecosystems and the protection of marine biodiversity that they contain."

The FAO Guidelines specifically request standardized and consistent data collection procedures; data from all stages of a fisheries development to be reported; socio-economic data from these fisheries; data reported at appropriate scale resolution for stock assessments and evaluation of impacts on VMEs; and monitoring on as close to real time as possible. Training programs for both scientific observers and fishers are recommended to improve catch identification and biological data collection. The importance of adaptive management is noted and information necessary for such information requested. The need for international cooperation on collation of biogeographic information is also noted. Finally, there is a call for transparent processes when analysing and reporting data from these fisheries to facilitate review of management effectiveness.

This report presents a current overview of the fisheries concerned and provides information and guidance for the implementation of the FAO Guidelines. It also highlights the need for better reporting of data on these fisheries and the ecosystems in which they operate.

FUTURE DIRECTIONS

Much remains to be done in terms of developing the state of knowledge that is required for the management of deep-sea fisheries in the high seas. This review should only represent a first step in what should be a comprehensive and regular global process to gather new information, address gaps and develop a full analysis of these fisheries. The report has primarily focused on fishing activities and targeted species, but associated, impacted and related species as well as potential impacts on VMEs have also been discussed. In close collaboration with states and RFMOs, future reviews must address the identified gaps in knowledge, including the gathering of historical information. Future reviews should also include more in depth consideration of VMEs and the management measures adopted by flag states and RFMO/As to sustainably manage deep-sea fisheries in the high seas.

In addition to enhancing the state of knowledge of these fisheries, it is also important to use this knowledge, and the recommendations resulting from further analysis, to promote the implementation of the FAO Guidelines and related "best practices".

APPENDIX A

Questionnaire on deepwater fisheries in the high seas: national information

OBJECTIVES

- The objective of the questionnaire is to contribute to a global review of deepwater benthic, demersal, and bentho-pelagic fisheries in the high seas. The review is to document the main fishing practices from a global perspective.
- The review is intended to assess the main characteristics and trends of these fisheries over the last 3-4 years. This requires information on the fleet and associated fishing effort as well as on catches. This information would be most useful if presented by main fishing grounds.

SCOPE

- Fleet involved in fisheries targeting deepwater benthic, demersal and bentho-pelagic resources in the high seas.
- Resources involved include all deepwater resources centred at depths greater than 200 metres exploited primarily on the high seas.
- As the fleet may include a number of vessels operating on straddling stocks, differentiation between fishing activities occurring in EEZs and high seas is required, as noted in some sections of the questionnaire.

INFORMATION REQUIREMENTS

1. Description of the fleet

*1.1. **Register of fishing vessels.*** For vessels that have been involved in deepwater high seas fishing activity during 2006 (or most recent year available). For each vessel, the following information is required:

- Vessel name
- Registration number
- Call sign
- Vessel type (e.g. trawler, longliner, etc.)
- Fishing gear(s) (e.g. bottom trawl, midwater trawl, shrimp trawl, gillnet, deep water gill net, line, long line, bottom long line, trap/pot, jig, other...)
- Overall length (LOA)
- Gross Registered Tonnage (GRT)
- Engine power (in kW)
- Beam (if available)
- Depth (if available)
- Year and place of construction

Note: Many countries have submitted a list of high seas fishing vessels with similar information to FAO as part of the information requirements under the Compliance Agreement. However, in most instances, it is not possible to identify from this register which are the vessels involved in deepwater fisheries because data on vessel and gear type is not provided.

1.1. Aggregated information on deepwater high seas fishing fleets:

Number and total GRT of fishing vessels that have been involved in deepwater high seas fishing activity, by year and vessel type

Vessels type		**2003**	**2004**	**2005**	**2006**
Trawlers	*Nb. vessels*				
	Total GRT				
Gillnetters	*Nb. vessels*				
	Total GRT				
Long liners	*Nb. vessels*				
	Total GRT				
Trap setters	*Nb. vessels*				
	Total GRT				
Other types or multi-purpose fishing vessels	*Nb. vessels*				
	Total GRT				

List of vessel types included in the category "Other types": _____
_____

2. Location of main high seas fishing areas and fishing grounds for the fleet involved in deepwater fishing activity (as described in section 1)

Minimum requirement:

For 2006 (or most recent year available):

- FAO fishing area and fishing grounds (e.g. reference to seamounts, banks, ridges, continental slopes, seas, etc...)
- Number of fishing vessels by vessel type that have been involved in deepwater fishing activity in this area during the reporting year

Additional information if available:

Same information by year for the period 2003 - 2005

Year: _____

Fishing Area	Fishing areas and fishing grounds		EEZs overlapping the fishing ground (e.g. Azores, Ireland)	Number of fishing vessels				
	FAO Fishing area (e.g. area 27 – North East Atlantic)	**Specific fishing grounds (e.g. mid Atlantic ridge; Hatton bank)**		**Trawlers**	**Gillnetters**	**Longliners**	**Trap setters**	**Other types or multi-purpose vessels**
1								
2								
3								
4								
5								

Note: if more than 5 fishing areas, please add rows to the table

List of vessel types included in the category "Other type or multi-purpose": _____

3. Catches of the fleet involved in high seas deepwater fishing activities (as described in section 1)

3.1 Total catches by fishing area

Minimum requirement:

For 2006 (or most recent year available): fishing area, catches of deepwater demersal and bentho-pelagic species, % of catches in high seas and within EEZs when the fishing area overlap the 2 zones

Additional information if available:

Same information by year for the period 2003–2005

Year: _____

FAO Fishing area or sub-areas	Total catches of the fleet (in mt)	% in the high seas	% within EEZs
Area 1:			
Area 2:			
Area 3:			
Area 4: ...			
Area 5: ...			
TOTAL for all areas:			

Note: if more than 5 fishing areas, please add rows to the table

3.2 Catches by species

Minimum requirement:

For 2006 (or most recent year available):
– Catches by main targeted species, with % of catches in high seas and within EEZs
– Catches of minor species, with % of catches in high seas and within EEZs

Additional information if available:

Same information by year for the period 2003 - 2005

Year: _____

Species name (up to 10)	Catches (in mt)	% in the high seas	% within EEZs
1 -			
2 -			
3 -			
4 -			
5 -			
6 -			
7 -			
8 -			
9 -			
10 -			
Other deepwater species			
TOTAL catch of the fleet			

List of species included in the category “Other deepwater species”:

_____

4. Fishing effort of deepwater fishing fleet

4.1 Fishing effort by fishing area

Minimum requirement:

For 2006 (or most recent year available) by fishing area: number of fishing days for vessels involved in deepwater demersal and bentho-pelagic fisheries in the high seas, with % of effort in high seas and within EEZs when the fishing area overlaps the 2 zones.

Additional information if available:

Same information by year for the period 2003 - 2005

Year: _____

FAO fishing area or sub-area	Effort (Number of fishing days)	% in the high seas	% within EEZs

Note: if more than 5 fishing areas, please add rows to the table

4.2 Fishing effort by gearl type

Minimum requirement:

For 2006 (or most recent year available): number of fishing days by fishing gear type for vessels involved in deepwater demersal and bentho-pelagic fisheries in the high seas, with % of effort in high seas and within EEZs when their fishing areas overlap the 2 zones

Additional information if available:

Same information by year for the period 2003 - 2005

Year: _____

Type of fishing gear	Number of fishing days	% in the high seas	% within EEZs
Bottom Trawl			
Midwater trawl			
Gillnet			
Long line			
Traps/pots			
Other gear type			

APPENDIX B

List of countries that replied to the FAO Questionnaire on deep-sea fisheries in the high seas

Country	Type of reply
Australia	Formal
Bahamas	Formal – no vessel involved
Belize	Formal
Cambodia	Formal – no vessel involved
Canada	Formal
China	Formal
Cook Islands	Formal
Estonia	Formal
France	Formal
Germany	Formal
Guinea	Formal
Honduras	Formal
Japan	Formal
Lithuania	Informal
Namibia	Formal
New Zealand	Formal
Norway	Formal
Republic of Korea	Formal
Russian Federation	Formal
Spain	Informal
Thailand	Formal – no vessel involved
Togo	Formal
Ukraine	Formal
United Kingdom	Formal
Unites States of America	Formal – no vessel involved

This document, the *Worldwide review of bottom fisheries in the high seas*, is intended to provide states and other interested parties with a summary of the current status of high seas bottom fisheries worldwide based on the best information available. This review contains information on the fleets and their fishing activities across nine major oceanic areas. It also informs the implementation of the *FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* by providing background information and highlighting gaps in the available information.

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