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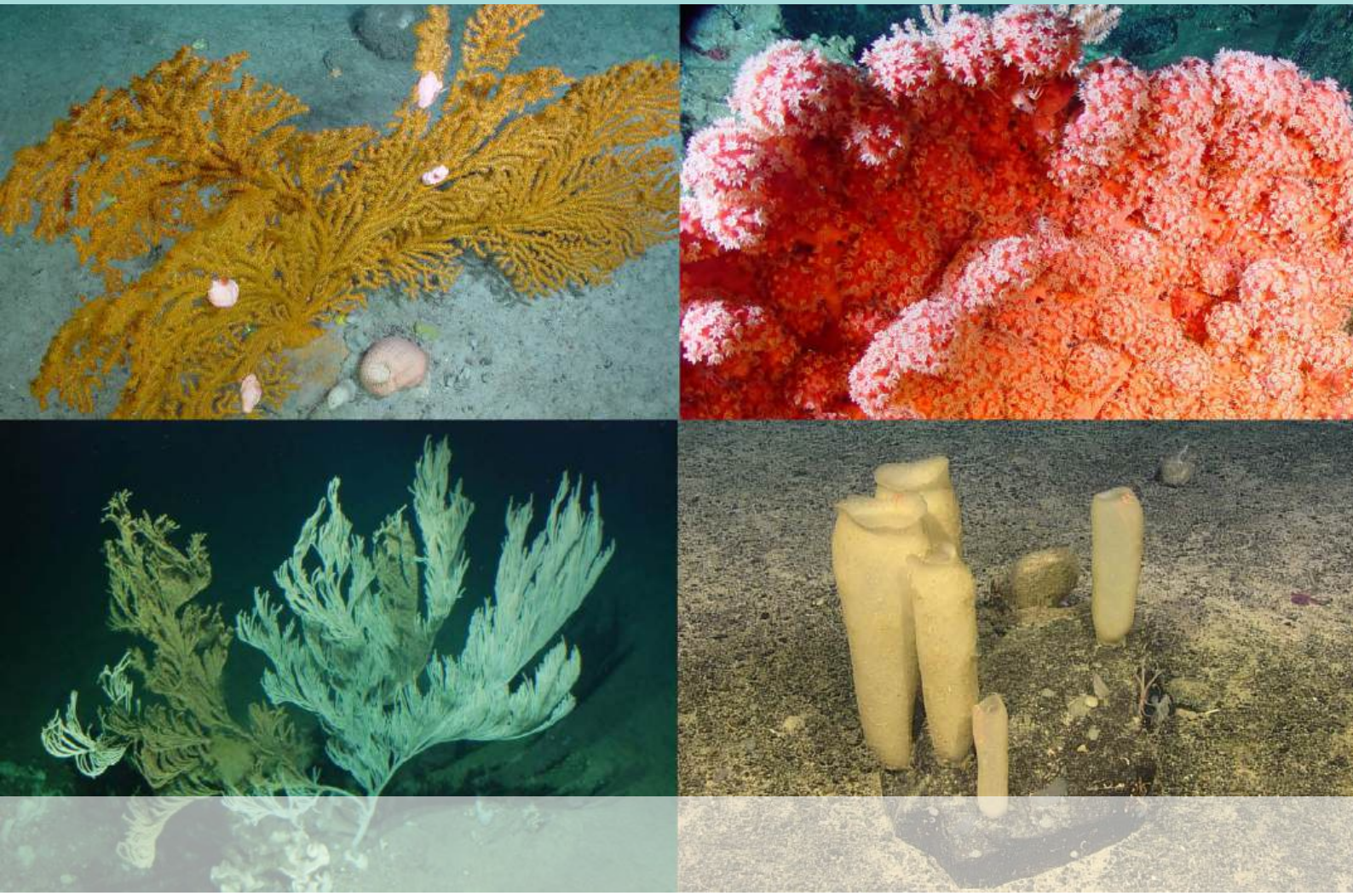
Vulnerable marine ecosystems

Processes and practices in the high seas



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Preparation of this document

This document, the *Vulnerable Marine Ecosystems: Processes and Practices in the High Seas*, was prepared as a sister publication to the *Worldwide Review of Bottom Fisheries in the High Seas* (2009). This document catalogues progress made towards the identification and protection of vulnerable marine ecosystems (VMEs) since the adoption of UNGA Resolution 61/105 in 2006 and the FAO *International Guidelines for the Management of Deep-sea Fisheries in the High Seas* in 2008. It is, in many respects, a consolidated output of the FAO VME Portal and DataBase[1] that was requested by UNGA in Resolution 61/105 (Paragraph 90) to support States and regional fisheries management organisations and arrangements (RFMO/As) in protecting VMEs.

The document was conceived and coordinated by FAO and initial drafts of the text and illustrations were made principally by FAO. The regional chapters were reviewed by expert representatives from the regions at a three-day workshop convened in Swakopmund, Namibia, on 2–4 March 2015. The individual chapters were further developed by selected authors throughout 2015.

FAO would like to extend its gratitude to the assistance provided by the regional bodies and particularly to the co-authors of the regional chapters. Each chapter was initially written by Anthony Thompson. Special thanks go to Stefán Ásmundsson, Odd Aksel Bergstad, Ellen Kenchington, Terje Lobach, and Luis José López-Abellán, for the drafting of various sections and support generally throughout the preparation of this document. We are also grateful to José Luis Castilla Civit for the desktop publishing layout of this document.

[1] www.fao.org/in-action/vulnerable-marine-ecosystems/en/.

Abstract

The *Vulnerable Marine Ecosystems: Processes and Practices in the High Seas* catalogues the achievements that have been made since 2006 on the identification and protection of vulnerable marine ecosystems (VMEs) from significant adverse impacts caused by fishing with bottom contact gears in the high seas. It is a consolidated output of the FAO VME Portal and DataBase (www.fao.org/in-action/vulnerable-marine-ecosystems/en/), which was requested by the UNGA in Resolution 61/105 (Paragraph 90) to support States and regional fisheries management organisations and arrangements (RFMO/As) in protecting VMEs.

The introductory chapter explains the international instruments applicable to the management of bottom fisheries in the high seas, the regional conventions and agreements establishing regional fisheries bodies, and the UNGA Resolutions pertaining to VMEs. This provides the global framework for managing certain fisheries to safeguard VMEs.

The main chapters describe the actions taken in the following ten regions: Atlantic Ocean (northwest, northeast, western central, central eastern, southwest and southeast), Mediterranean and Black Sea, Pacific Ocean (north and south), Indian Ocean, and Antarctic and Southern Ocean. These are divided into separate chapters. The regions approximate to the areas covered by RFMO/As, but also include regions where there are no regional management bodies. The seabed features are broadly described in each chapter to provide an indication as to where VMEs may be present and where they may overlap spatially with bottom fisheries. The functions and responsibilities of RFMO/As are described, as are detailed accounts of measures adopted and implemented to protect VMEs from significant adverse impacts by fisheries using bottom contact gears. The measures implemented by each regional body are divided into general measures that mostly apply to the whole region and are typically precautionary in nature to allow sustainable fisheries to continue in certain areas and to identify VME areas, and specific measures typically involving the closure of areas to bottom fishing that are known or likely to contain VMEs. Domestic measures applied by States to their flagged high seas fishing vessels are included when particularly relevant, such as in areas where there are no current measures from a regional body.

The final chapter synthesises the regional measures into a global summary and thus provides an overview of the various approaches that have been taken.

FAO. 2016. *Vulnerable Marine Ecosystems: Processes and Practices in the High Seas*, by Anthony Thompson, Jessica Sanders, Merete Tandstad, Fabio Carocci and Jessica Fuller, eds. FAO Fisheries and Aquaculture Technical Paper No. 595. Rome, Italy.

Contents

Acronyms and abbreviations

ABNJ	Areas Beyond National Jurisdiction
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ACCOBAMS	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic Area
AIS	Automatic Identification System
ARK	Association of Responsible Krill harvesting companies
ASFA	Aquatic Sciences and Fisheries Abstracts
ASOC	Antarctic and Southern Ocean Coalition
ATLAFCO	Ministerial Conference for African countries bordering the Atlantic Ocean
BFIAS	SPRFMO Bottom Fishery Impact Assessment Standard
BPA	Benthic Protected Area (SIOFA)
CAF	Committee on Administration and Finance (GFCM)
CAQ	Scientific Advisory Committee on Aquaculture (GFCM)
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAS	Convention for the Conservation of Antarctic Seals
CCBSP	Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CECAF	Fishery Committee for the Eastern Central Atlantic
CFMC	Caribbean Fisheries Management Council of the United States Department of Commerce
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CM	Conservation Measures (CCAMLR)
CMM	Conservation and Management Measure (SPRFMO)
CNCP	Cooperating non-Contracting Party (SPRFMO)
CoC	Committee on Compliance (GFCM)
COLTO	Coalition of Legal Toothfish Operators
COMNAP	Council of Managers of National Antarctic Programs
COREP	Fishery Committee for the Central Gulf of Guinea
CPCs	Contracting Parties and Cooperating non-Contracting Parties (GFCM)
CPPS	Permanent Commission for the South Pacific
CRFM	Caribbean Regional Fisheries Mechanism
CTC	Compliance and Technical Committee (SPRFMO)
CWP	Coordinating Working Party on Fishery Statistics
DIWG	Data and Information Working Group (SPRFMO)
EBSA	Ecologically or Biologically Significant Area
EEZ	Exclusive Economic Zone
EU	European Union
FAC	Finance and Administration Committee (SPRFMO)
FAO	Food and Agriculture Organization of the United Nations
FCWC	Fishery Committee for the Western Central Atlantic
FFA	Pacific Islands Forum Fisheries Agency

FIGIS	Fisheries Global Information System
FRA	Fisheries Restricted Area (GFCM)
GFCM	General Fisheries Commission for the Mediterranean
GSA	Geographical subarea (GFCM)
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ICNAF	International Commission for the Northwest Atlantic Fisheries
IEO	Spanish Institute of Oceanography
IFREMER	French Research Institute for Exploitation of the Sea
IGO	Inter-Governmental Organisation
IMO	International Maritime Organization
INFOSAMAK	Centre for Marketing Information & Advisory Services for Fishery Products in the Arab Region
IOC	Intergovernmental Oceanographic Commission
IOTC	Indian Ocean Tuna Commission
IPHC	International Pacific Halibut Commission
ISA	International Seabed Authority
IUCN	International Union for Conservation of Nature
IUCN-Med	IUCN Centre for Mediterranean Cooperation
IUU	Illegal, Unreported, and Unregulated
IWC	International Whaling Commission
JICA	Japan International Cooperation Agency
LOS	1982 United Nations Convention on the Law of the Sea (LOS Convention)
MAP	Mediterranean Action Plan
MAR	Mid-Atlantic Ridge
MCS	Monitoring, Control, and Surveillance
MedPAN	Network of Marine Protected Area Managers in the Mediterranean
MoU	Memorandum of Understanding
MPA	Marine Protected Area
NAFO	Northwest Atlantic Fisheries Organisation
NCEM	NAFO Conservation and Enforcement Measures
NEAFC	North East Atlantic Fisheries Commission
NEREIDA	NAFO Potential Vulnerable Marine Ecosystems-Impacts of Deep-sea Fisheries
NGO	Non-Governmental Organization
NPAFC	North Pacific Anadromous Fish Commission
NPFC	North Pacific Fisheries Commission
NRA	NAFO Regulatory Area
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSPESCA	Organization of Fisheries for the Central American Isthmus
PECMAC	Permanent Committee on Monitoring and Compliance (NEAFC)
PECMAS	Permanent Committee on Management and Science (NEAFC)
PFE	Participating Fishing Entities (SIOFA)
PICES	North Pacific Marine Science Organization
RAC/SPA	Regional Activity Centre for Specially Protected Areas
RAC-MED	Regional Advisory Council for the Mediterranean
RECOFI	Regional Commission for Fisheries

RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organisation
RFMO/A	Regional fisheries management organisation/arrangement
ROV	Remotely operated underwater vehicle
RPOA-IUU	South East Asia Regional Plan of Action (RPOA) to Promote Responsible Fishing Practices Including Combating Illegal, Unreported and Unregulated Fishing
SAC	Scientific Advisory Committee on Fisheries (GFCM)
SAG	Scientific Advisory Group (WECAFC)
SCAR	Scientific Committee on Antarctic Research of the International Council of Scientific Unions.
SCMEE	Subcommittee on Marine Environment and Ecosystems (GFCM)
SCOR	Scientific Committee on Oceanic Research (CCAMLR)
SEAFO	South East Atlantic Fisheries Organisation
SG-ASAM	Subgroup on Acoustics, Surveys and Analysis Methods (CCAMLR)
SIODFA	Southern Indian Ocean Deepsea Fishers Association
SIOFA	Southern Indian Ocean Fisheries Agreement
SPAMI	Specially Protected Areas of Mediterranean Importance
SPC	Secretariat of the Pacific Community
SRFC	Sub-regional Fisheries Commission
SPRFMO	South Pacific Regional Fisheries Management Organisation
STACREC	NAFO Standing Committee on Research Coordination
SWG	Scientific Working Group (NPFC)
SWIOFC	South West Indian Ocean Fisheries Commission
TAC	Total allowable catch
ToR	Terms of Reference
UNCLOS	1982 United Nations Convention on the Law of the Sea (LOS Convention)
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
UNFSA	United Nations Fish Stocks Agreement
USSR	Union of Soviet Socialist Republics
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
WCPFC	Western and Central Pacific Fisheries Commission
WECAFC	Western Central Atlantic Fishery Commission
WGDEC	ICES/NAFO Working Group on Deep-water Ecology
WGDEEP	Working Group on the Biology and Assessments of Deep-sea Fisheries Resources (NEAFC)
WGEAFFM	Working Group on Ecosystem Approach Framework to Fisheries Management (NAFO)
WGEAFM	Working Group on Ecosystem Approach to Fisheries Management (WGESA since 2014) (NAFO)
WG-EMM	Working Group on Ecosystem Monitoring and Management (CCAMLR)
WGESA	Working Group on Ecosystem Science and Assessment (WGEAFM prior to 2014) (NAFO)
WGFMS-VME	Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems (NAFO)
WG-FSA	Working Group on Fish Stock Assessment (CCAMLR)
WG-SAM	Working Group on Statistics, Assessments and Modelling (CCAMLR)
WGStats	Working Group on Fisheries Statistics (NEAFC)
WWF	World Wildlife Fund

Introduction

This publication, *Vulnerable Marine Ecosystems: Processes and Practices in the High Seas*, was prepared to document the work undertaken in the high seas to address the requirements of United Nations General Assembly (UNGA) Resolution 61/105[2] (adopted in 2006) and the FAO *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas*[3] (adopted in 2008) in relation to vulnerable marine ecosystems (VMEs). This publication catalogues the processes and practices that have been developed by regional fisheries management organizations or arrangements (RFMO/As) with a mandate to manage deep-sea fisheries in the high seas, and to adopt measures that reduce or eliminate the impact of bottom fishing gears on VMEs. Also included are the regional advisory bodies that assist States to implement national measures for their flagged vessels undertaking bottom fishing in the high seas. Following the adoption of UNGA Resolution 61/105 in 2006, and subsequent supporting resolutions, many States and RFMO/As have developed processes to identify VMEs, and adopted management measures to protect them. This has produced important knowledge, information, and good practices that are valuable for the ongoing discussions on the development of protective measures towards significant adverse impacts on VMEs from bottom fishing activities in the deep-sea high seas. This publication is intended to provide a range of stakeholders with an understanding of these processes and practices.

Further information on regional measures can be found in the FAO VME DataBase (Box 1), which presents all the current and historical measures to protect VMEs adopted by RFMO/As, as maps and factsheets. Together, this publication and the

BOX 1

The VME portal and database

The VME Portal and DataBase* is a compilation of information on management measures taken to reduce significant adverse impacts on areas where VMEs are known or likely to occur. It was developed in collaboration with the regional bodies with mandates to manage deep-sea fisheries in the ABNJ, in response to a request from the UNGA (Resolution 61/105, Paragraph 90) to create a database of information on VMEs in the ABNJ. The VME DataBase is embedded in the VME Portal, which contains additional VME-related information such as on the FAO Deep-sea Fisheries Guidelines, Regional Fishery Bodies, VME Tools, and relevant research.

The VME Portal and DataBase contains information from 2006 to the present. It serves both as a repository and an information source. The primary objective of the VME Portal and DataBase is to assist States in managing impacts from bottom fisheries on VMEs. The target audience includes fisheries managers and scientists, but is also aimed at informing

* www.fao.org/in-action/vulnerable-marine-ecosystems/en/

[2] Formally *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* (2006).

[3] FAO. International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome, FAO. 2009. 73p.

BOX 1 (CONTINUED)

the wider public of the work undertaken by States, usually through RFMO/As, to support sustainable deep-sea fisheries and reduce or eliminate significant adverse impacts.

The map and factsheet display interfaces of the VME DataBase allow for easy searching, access, and viewing of information that is fully referenced to its source.

Screen-captures of the FAO VME Portal (top) and DataBase (bottom)

VME DataBase contribute to the understanding of actions taken globally to manage significant adverse impacts on VMEs through the sharing of global experiences. The VME DataBase contains considerably more information that has been possible to include in this overview publication, and readers are urged to browse the VME Portal and DataBase to acquire further information.

VULNERABLE MARINE ECOSYSTEMS: POLICY CONTEXT

Since the VME concept first entered UNGA discussions in 2002, when the UNGA adopted Resolution 57/141, this topic has remained high on the international agenda. These discussions were aligned with the trend in more recent decades to concurrently address biodiversity and fisheries issues. Since the early 1990s, international concern about the need for fisheries management to more explicitly address broader ecological consequences of fishing, as well as the economic and social aspects associated with fisheries, has led to the development of more holistic approaches, such as the ecosystem approach to fisheries[4].

UNGA Resolution 57/141 called for a halt to marine biodiversity loss (Article 51), an end to destructive fishing practices and the establishment of marine protected areas (Article 53), and the protection of VMEs (Article 62a). The call specifying the protection of VMEs was developed in the "Sustainable fisheries" resolutions, starting in 2003 with UNGA Resolution 58/14 (Article 46). Subsequently, UNGA Resolution 61/105 set specific targets and deadlines for action by 31 December 2008, calling on States, either individually or through RFMO/As, to manage bottom fisheries on the high seas in order to prevent significant adverse impacts on VMEs (Article 83), among other things. Later Resolutions, such as 64/72 and 66/88, have called for further actions to protect VMEs from significant adverse impacts and ensure sustainable management of bottom fisheries.

These discussions and early resolutions also spurred further activities at the technical level, and based on guidance from preceding expert workshops and two sessions of a FAO Technical Consultation, the FAO *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas* (FAO Deep-sea Fisheries Guidelines) were adopted in 2008. The Guidelines were developed for fisheries in the high seas in which the fishing gear contacts the seafloor and the catch includes species that can sustain only low exploitation rates. The Guidelines also elaborate and provide further guidance on key concepts such as what constitutes a VME or significant adverse impact. The Guidelines have since been used by RFMO/As in the development of their measures to protect VMEs and sustainably manage bottom fisheries, as part of their adherence to the relevant UNGA resolutions.

THE INTERNATIONAL FRAMEWORK FOR FISHERIES

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) is the only comprehensive international treaty for the oceans, and establishes the legal framework for all uses of the oceans, as well as their superjacent air space and subjacent seabed and subsoil. UNCLOS addresses rules of navigation, the settlement of disputes, definitions of maritime zones (such as territorial seas, exclusive economic zones [EEZs], continental shelves, and the high seas), scientific research, the conservation and utilization of living marine resources, the protection and preservation of the marine environment, and a regime for the deep seabed in areas beyond national jurisdiction (ABNJ). Under UNCLOS, the ABNJ includes the water column outside EEZs and the seabed beyond the limits of the continental shelf. The water column beyond the EEZs including those above the continental shelf is referred to as the high seas.

[4] FAO. 2003. *The ecosystem approach to fisheries*. FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome, FAO. 112 pp.

Several additional international instruments have been adopted over the last twenty years for the conservation and management of world fisheries resources. Some of these, such as the 1995 UN Fish Stocks Agreement (UNFSA), the FAO Compliance Agreement[5], and most recently the FAO Port State Measures Agreement[6] that entered into force in 2016, impose legally binding obligations to their Parties.

Other important, non-binding, instruments include the FAO Code of Conduct for Responsible Fisheries (1995) and its four International Plans of Action (on IUU fishing[7], seabirds[8], sharks[9], and capacity[10]), and a broad range of Technical Guidelines (including on the ecosystem approach to fisheries[11]) as well as International Guidelines (on the management of deep-sea fisheries in the high-seas, and bycatch management and reduction of discards[12]) and Voluntary Guidelines (on flag State performance[13], and securing sustainable small-scale fisheries[14]). These are intended as guides and tools for the conservation and management of fisheries; and while they are implemented on a voluntary basis, they include specific options for States and RFMO/As.

The UNGA addresses fisheries issues annually in its resolutions that support the implementation of UNCLOS and the UNFSA, which call upon States, individually, or through RFMO/As, to address specific topics in order to achieve sustainable fisheries. Likewise, several declarations have called for specific actions to address the conservation and management of fisheries and the ecosystem in which they operate. These include the outcomes of the world summits on sustainable development and the targets of the sustainable development goals (SDGs).

FAO contributes to the promotion, discussion and solution of issues related to fishing by, among other things, disseminating information through publications, convening workshops, seminars, and consultations, and through the FAO Committee on Fisheries (COFI), which meets biennially and addresses a wide range of fisheries issues. FAO also coordinates and manages a range of programmes and projects to support its objectives.

Other global instruments, which partly deal with fisheries related issues, include the Convention on International Trade and Endangered Species of Wild Fauna and Flora (CITES), the International Whaling Commission (IWC), the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and the Convention on Biological Diversity (CBD).

MANAGEMENT OF DEEP-SEA FISHERIES IN THE HIGH SEAS

Regional fisheries management organizations or arrangements are regarded as the appropriate mechanism for cooperation in managing high seas fisheries through which States respond to their duties set out in UNCLOS. The role of RFMO/As has been clarified and significantly strengthened in recent years, in particular with the provisions of the UN Fish Stocks Agreement (UNFSA). The RFMO/As with a mandate to manage deep-sea fisheries in the high seas have integrated principles and provisions from the UNFSA and other global instruments into the development and adoption of

[5] Formally the *Agreement to promote compliance with international conservation and management measures by fishing vessels on the high seas* (1993).
[6] Formally the *Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing* (2009).
[7] *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing* (2001).
[8] *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries* (1995).
[9] *International Plan of Action for the Conservation and Management of Sharks* (1999).
[10] *International Plan of Action for the Management of Fishing Capacity* (1999).
[11] *FAO Technical Guidelines for Responsible Fisheries: ecosystem approach to fisheries*, No. 4, Suppl. 2 (2003).
[12] *International Guidelines on Bycatch Management and Reduction of Discards* (2011).
[13] *Voluntary Guidelines for Flag State Performance* (2014).
[14] *Voluntary Guidelines for Securing Small-Scale Fisheries in the Context of Food Security and Poverty Eradication* (2014).

conservation and management measures within their areas of competence, which also include measures related to VMEs.

At the time of publication, eight regional bodies exist with the mandate to manage deep-sea fisheries in the ABNJ (Figure 1). The principal objective of these organizations has traditionally been to maximize the long-term catches of targeted fish species and minimize impacts on non-target species and the ecosystem, and these objectives also include biodiversity protection targets. In order to achieve these objectives, the RFMO/As coordinate the collection and analysis of fisheries information and data, principally catch and effort data, for application to stock assessment models. Scientific research is also undertaken by governments, academia and other research institutes, often in collaboration with the fishing industry, to improve knowledge on the biodiversity of the RFMO/A area. The resulting stock assessments and biodiversity information are then used by the RFMO/As as a basis for developing conservation and management measures.

The adoption of the UNGA Resolution 61/105 asked States and RFMO/As to, among other actions, reduce the impact of bottom fisheries on deep-sea VMEs. The Resolution noted, in particular, that some groups of animals are slow growing, fragile and attached to the seafloor, and specifically mentioned habitats where these animals are likely to be found, such as seamounts, hydrothermal vents and cold water corals. This new focus on vulnerable benthic species in the deep seas and the potential impact from fisheries ushered in a new working modality for the RFMO/As managing deep-sea fisheries. The FAO Deep-sea Fisheries Guidelines provide frameworks and criteria that assist RFMO/As and States to develop and adopt measures to protect VMEs and sustainably manage bottom fisheries to address the calls made in the applicable UN resolutions and the obligations set out in UNCLOS and the UNFSA.

As a result, responding to the call by the UNGA and using the FAO Deep-sea Fisheries Guidelines, RFMO/As with a mandate for deep-sea fisheries began to broaden their management measures and to increase scientific research to improve understanding of the significance of any impacts by bottom fisheries. Several RFMO/As have listed species and elements that are indicator organisms and features suspected to contain VMEs and have described characteristics of actual or possible VMEs. The RFMO/As have relied on scientific advice based on best available regional knowledge and expert judgment in this process.

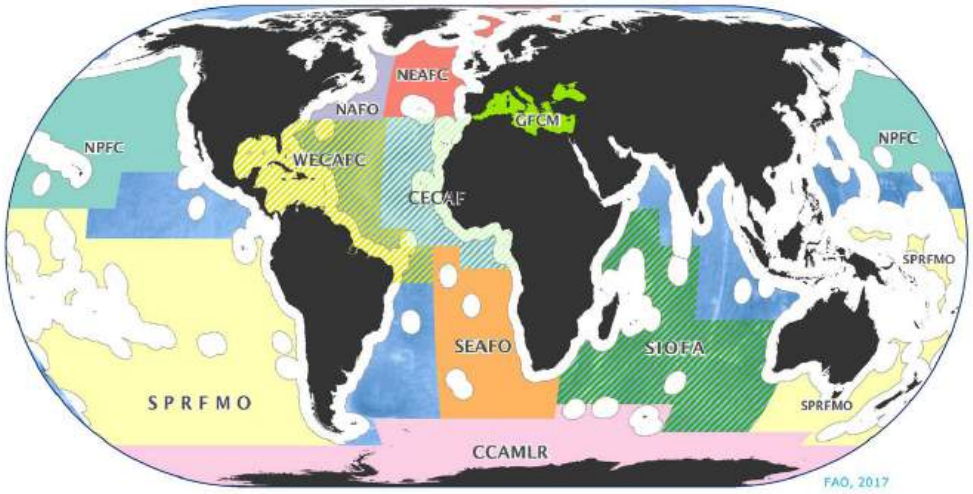
Since 2006, there has been a marked increase in the adoption of measures relating to impacts of fishing. This is reflected in the application of different kinds of measures, including fishing closures where VMEs occur or are likely to occur.

Additionally, RFMO/As began identifying areas where bottom fishing has occurred (existing bottom fishing areas) and adopted strict protocols to manage both the expansion of these existing fisheries and the commencement of new fisheries outside of these areas.

Underlying the measures introduced by RFMO/As is a recognition and interpretation of what the FAO Deep-sea Fisheries Guidelines refer to as significant adverse impacts. The objective of the fishery regulations introduced by RFMO/As is to reduce the risk of such significant adverse impacts, i.e. those leading to lasting structural damage to VMEs. Closures have been introduced both in areas previously fished and in areas not known to have been fished, which are supposed to protect the VMEs known to date. New closures may be implemented should scientific advice suggest a necessity for such. Rules aimed at reducing the risk of significant adverse impacts on VME areas where bottom fishing operations take place have been developed to mitigate for potential VME encounters.

Fisheries management by RFMO/As is designed to be adaptive so that measures are reviewed and updated to reflect changes in the fisheries, the target species, bycatch, and the ecosystem. Measures also evolve as scientific understanding improves and as more information is gathered from scientific surveys and commercial fisheries.

FIGURE 1
Map showing the competence areas of regional fishery bodies* with the mandate to manage deep sea fisheries in the ABNJ**



* CCAMLR is a conservation organization with a mandate to manage fisheries within its area of competence.

** NPFC: North Pacific Fisheries Commission; SPRFMO: South Pacific Regional Fisheries Management Organisation; NAFO: Northwest Atlantic Fisheries Organization; NEAFC: North East Atlantic Fisheries Commission; GFCM: General Fisheries Commission for the Mediterranean; SEAFO: South East Atlantic Fisheries Organisation; SIOFA: Southern Indian Ocean Fisheries Agreement; and CCAMLR: Commission for the Conservation of Antarctic Marine Living Resources. WECAFC (Western Central Atlantic Fishery Commission) and CECAF (Fishery Committee for the Eastern Central Atlantic) are regional advisory bodies that cover fishery resources in the ABNJ.

DEEP-SEA FISHERIES, VULNERABLE MARINE ECOSYSTEMS, AND SIGNIFICANT ADVERSE IMPACTS

Various depth limits have been used to define what constitutes deep-sea fisheries. The FAO Deep-sea Fisheries Guidelines characterizes deep-sea fisheries as those in which the total catch includes species that can only sustain low exploitation rates and where the gear is likely to contact the sea floor during the normal course of fishing. The FAO *Worldwide review of bottom fisheries in the high seas*[15] included deep-sea fisheries that target demersal and benthic species with gear that are likely to contact the sea floor during the course of fishing operations. Fishing depth is not considered a major criterion, but the review generally included fisheries conducted entirely or principally below 200 m on the continental shelf and slope or isolated topographic features such as seamount, ridge systems, and banks. Typical bottom fishing depths are in the 400–1 000 m range but can go deeper, though commercial fishing below 2 000 m is rare, therefore this is usually taken as the lower depth limit for deep-sea fishing.

The FAO Deep-sea Fisheries Guidelines provide guidance on deep-sea fisheries, VMEs, and significant adverse impacts, for use and operationalization by States and RFMO/As. The Guidelines describes VMEs, using vulnerability as a key characteristic (Paragraph 14):

> *14. …related to the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and the likelihood that it would recover and in what time frame. These are, in turn, related to the characteristics of the ecosystems themselves, especially biological and structural aspects. VME features may be physically or functionally fragile. The most vulnerable ecosystems are those that are both easily disturbed and very slow to recover, or may never recover.*

[15] Bensch, A.; Gianni, M.; Gréboval, D.; Sanders, J.S; Hjort, A. Worldwide review of bottom fisheries in the high seas. *FAO Fisheries and Aquaculture Technical Paper.* No. 522. Rome, FAO. 2008. 145 pp.

The Guidelines include recommendations on the identification and management of VMEs (Paragraphs 42-46), provide examples of species groups, communities, and habitats that often display characteristics consistent with possible VMEs in the Annex (e.g.: certain cold water corals and hydroids, and some types of sponge-dominated communities), and include examples of features that potentially host VME species, such as seamounts, submerged edges and slopes, hydrothermal vents, and cold seeps. In all examples, the Guidelines note that merely detecting the presence of a species category or an element is not sufficient to identify or confirm the presence of a VME, and that identification should be made on a casebycase basis through the application of relevant provisions of the Guidelines, particularly Sections 3.2 and 5.2.

Furthermore, the Guidelines provide factors to consider when determining the scale and significance of any impact on VMEs (Paragraph 18), and notes that flag States and RFMO/As should conduct assessments to establish if deep-sea fishing activities are likely to produce significant adverse impacts in a given area (Paragraph 47). The assessments should include, *inter alia*: a harvesting plan (i.e. type of fishing and details of gear, intended effort, and likely catch of target and bycatch species), a review of the current state of the fishery resource and baseline information on the ecosystem of the fishing area, identification of VMEs known or likely to occur in the fishing area, identification and description of the scale and duration of likely impacts (including cumulative impacts), risk assessment of likely impacts by the fishing operations, and proposed mitigation and management measures to prevent significant adverse impacts on VMEs. Significant adverse impacts compromises the long term integrity and function of VMEs as structurally complex communities and habitats. Merely detecting impacts is not sufficient, the scale and character of the impact must also be evaluated to determine whether an impact is to be regarded as significant.

OTHER ACTIVITIES THAT MAY IMPACT VULNERABLE MARINE ECOSYSTEMS

Other existing or emerging activities in the deep-seas include exploration for, and mining of, seabed mineral resources such as metals in polymetallic nodules and sulphide deposits, oil, and gas. Deep-sea mining and drilling could impact VMEs as it can generate sediment plumes and, in some cases, mobilizes heavy metals, which may affect larger areas of the seabed. Other sources of impacts may come from shipping, whose risks include pollution from accidental spills and intentional discharges; the laying of cables and pipelines, which may generate pollution and sedimentation, while the cable-laying operation and the heavy anchors used during such operations can cause physical damage to corals; dumping of wastes and other matter, where the physical impact (sedimentation, etc.) can damage or destroy habitats; and bioprospecting, whose bottom-sampling equipment can also negatively affect habitats. Marine scientific research may also impact habitats depending on the sampling gear and techniques used. Additionally, emerging activities may eventually impact VMEs, including, for example, the injection of carbon dioxide into deep ocean waters, ocean fertilization, and energy generation, among others, as well as environmental changes such as global climate change.

SCOPE

The content of this publication focuses mainly on the binding measures for VMEs adopted by the RFMO/As and other regional management bodies with mandates to manage, among other things, fisheries that use bottom-contact gears, in the regions under their jurisdiction. The widest remit is that of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), whose objective is to conserve Antarctic marine life, which includes managing the sustainable harvest of fisheries. In general, the other RFMO/As included in this publication have mandates to manage fisheries within an ecosystem approach (i.e. a holistic form of fisheries management).

National measures have been included for regions where there are no regional measures in place (i.e. areas of the ocean where no management body exists), or where RFMO/As have requested this as part of their own measures. However, this publication does not provide an exhaustive overview of national measures.

In general, the science supporting the measures are not described, although summaries are provided of some of the surveys undertaken in particular regions, which may provide an insight into some of this baseline work.

This publication does not cover the fisheries management aspects in relation to the commercially targeted fish and shellfish species that are also included within the FAO Deep-sea Fisheries Guidelines. These aspects will be covered in an update to the *Worldwide review of bottom fisheries in the high seas* (2009), to be published in 2017.

METHODOLOGY

Temporal coverage

The publication covers the period from 2006 to September 2016, during which the VME concept was developed and actions were implemented in response to UNGA Resolution 58/14 (2003), the specific targets and deadlines in Resolution 61/105 (2006), later UNGA Resolutions, and the FAO Deep-sea Fisheries Guidelines.

Regional approach

The publication is organized around the areas currently covered by regional fisheries bodies with a mandate that encompasses issues relating to deep-sea bottom fisheries in the high seas, coinciding, to a large extent, to the world's major ocean regions (Table 1). Some of these regional fisheries bodies have management responsibilities and can adopt measures that are binding on their members, whereas others can only adopt non-binding measures or recommendations, and have an advisory role to their member States. All regional fisheries bodies have a coordinating function and provide a forum for discussion. Regions that do not have such bodies are also included. For all of the above, it is the responsibility of the States, either individually or through RFMO/As, to ensure that high-seas fisheries are managed sustainably. The geographical areas covered in this report include all the fishable high seas parts of the world's oceans, divided as follows: northwest, northeast, western central, central eastern, southwest, and southeast Atlantic, north and south Pacific, Indian and Southern Oceans, each of which is the subject of a separate chapter.

Each chapter includes a description of the region's topography and ecosystems, the identifying features of potential importance to VMEs, the regional management regime, and details of general and specific regional measures that are applied to bottom fisheries (fisheries that use gears that contact the sea floor), including the closing to such fisheries of areas known or likely to contain VMEs. National regulations are only included for areas of the high seas where no regional management body exists.

TABLE 1
Ocean regions and regional fisheries management bodies included in this report

Region	Body	Acronym	Type	Established	Convention adopted – in force (and amendments*)	Area of competence
Northeast Atlantic Ocean	North East Atlantic Fisheries Commission	NEAFC	RFMO	1959	1959 1982 (2004, 2006)	Marine waters High seas and national waters
Northwest Atlantic Ocean	Northwest Atlantic Fisheries Organization	NAFO ICNAF	RFMO RFMO	1979 1949-1979	1979 (1980, 1987, 1996, 2007) 1949	High seas and national waters Marine waters
Eastern central Atlantic Ocean	Fishery Committee for the Eastern Central Atlantic	CECAF	RFB (FAO Article VI)	1967	1967 (1992, 2003)	High seas and national waters
Western central Atlantic Ocean	Western Central Atlantic Fishery Commission	WECAFC	RFB (FAO Article VI)	1973	1973 (1978, 2006)	High seas and national waters
Southeast Atlantic Ocean	South East Atlantic Fisheries Organisation	SEAFO	RFMO	2003	2001-2003	High seas
Southwest Atlantic Ocean	None	-	-	-	-	-
Mediterranean and Black Seas	General Fisheries Commission for the Mediterranean	GFCM	RFMO (FAO Article XIV)	1949	1949-1952 (1963, 1976, 1997, 2014)	High seas and national waters
North Pacific Ocean	North Pacific Fisheries Commission	iNPFC NPFC	Interim RFMO	2006-2015 2015	- 2012-2015	 High seas
South Pacific Ocean	South Pacific Regional Fisheries Management Organisation	iSPRFMO SPRFMO	interim RFMO	2006-2012 2012	- 2009-2012	 High seas
Indian Ocean	Southern Indian Ocean Fisheries Agreement	SIOFA	RFMA	2012	2006-2012	High seas
Antarctic and Southern Oceans	Commission for the Conservation of Antarctic Marine Living Resources	CCAMLR	Regional body	1982	1980-1982	High seas and national waters

* Amendments adopted by the organisation, but not necessarily in force.

THE ATLANTIC OCEAN AND ADJACENT SEAS

Northeast Atlantic Ocean

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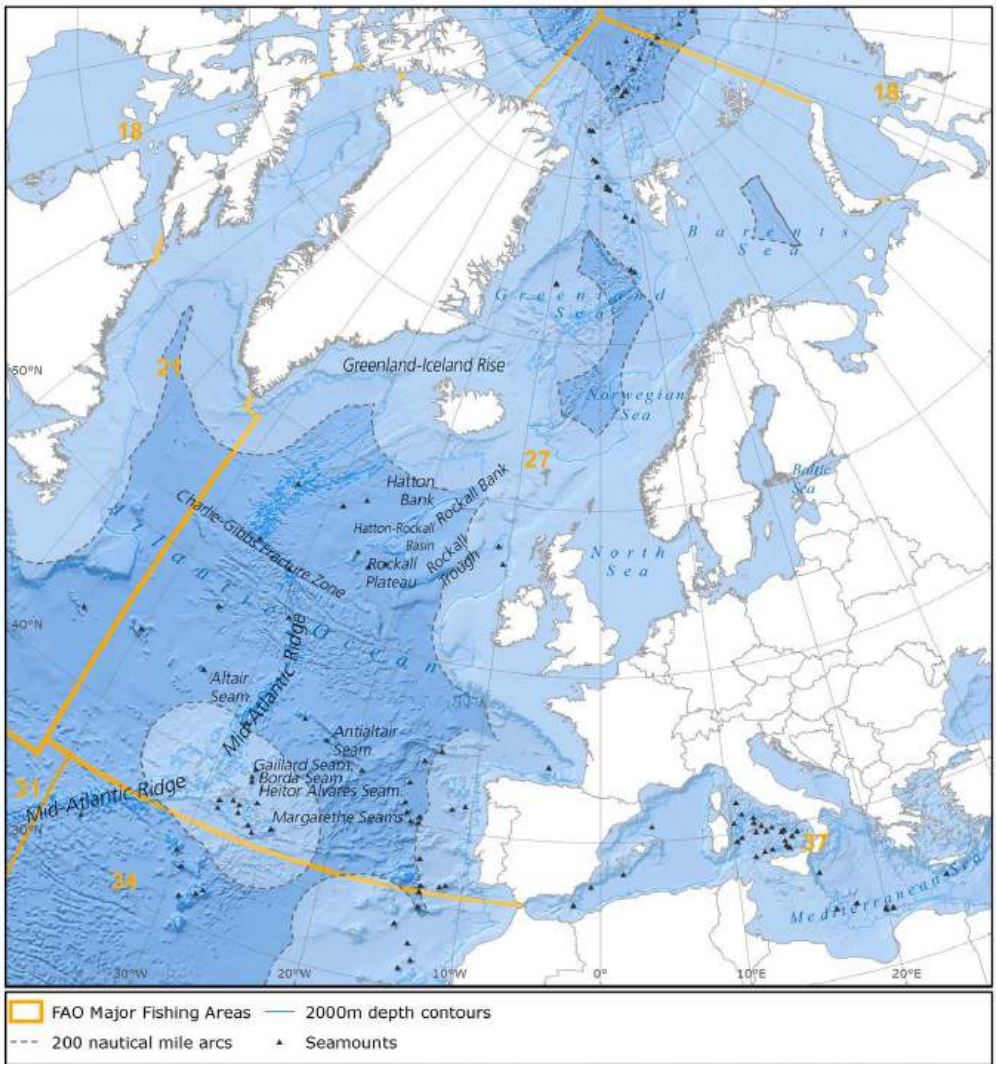
REGIONAL GEOGRAPHY AND BATHYMETRY

The northeast Atlantic lies within FAO Major Fishing Area 27, which includes the eastern part of the North Atlantic Ocean (to the east of the meridian corresponding to the southern tip of Greenland, and north of the latitude of Gibraltar). Also included is the oceanic area between Iceland, Norway, and Greenland comprising the Greenland and Norwegian Seas. Comparatively shallow continental shelf areas (marginal seas) of the northeast Atlantic are the Irish, North, Baltic, and Barents Seas. In the extreme north the northeast Atlantic borders the Arctic Ocean.

Geomorphological features of the northeast Atlantic include the major ocean basins with their vast abyssal plains, the Mid-Atlantic Ridge (MAR), and the generally wide continental shelves of the Eurasian continent and Greenland (Figure 2). The continental shelves, including some moderately deep shelf channels of the North Sea and Barents Sea, are mostly within Exclusive Economic Zones (EEZs), as are major deep oceanic portions of the Greenland and Norwegian Seas. The subareas beyond national jurisdiction comprise 3 000–4 000 m deep basins and portions of the MAR in the north Atlantic proper and in the Norwegian-Greenland Seas. The MAR is a major geologically young spreading zone, which is formed and maintained by geological processes different from those dominating along the continental shelves and slopes. Other major features of the MAR are the ridge-associated seamount complexes and islands (Azores, Iceland, Jan Mayen), and the transverse fracture zones such as the west-east running Charlie-Gibbs fracture zone half-way between Iceland and the Azores. The depths of ridge-associated seamounts vary and many have peaks that are shallower than 1 000 m. The fracture zones may form deep abyssal troughs through the MAR which on average is around 2 000 m deep. Interesting off-ridge features are the relatively shallow Greenland-to-Scotland ridges that run across the MAR via Iceland. Very different features from those associated with the MAR are the multitude of seamounts and knolls rising from the abyssal plains in the major ocean basins, for instance, the Altair and Antialtair seamounts on either side of the MAR, and many seamounts north and east of the Azores archipelago in the south.

Further prominent features of the northeast Atlantic area, largely beyond national jurisdiction, are the very extensive Hatton and Rockall Banks to the west of the British Isles. These features are separated from the European continental shelf by channels that are 1 100–1 500 m deep. The Greenland and Norwegian Seas have no similar features beyond national jurisdiction, also no seamounts similar to those found south of the Greenland-Scotland ridges. The limited subareas beyond national jurisdiction in the Norwegian Sea comprises a minor portion of the MAR north of Jan Mayen, and abyssal subareas, and a small shelf sea area in the Barents Sea.

FIGURE 2
Northeast Atlantic Ocean showing the FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



NORTH EAST ATLANTIC FISHERIES COMMISSION

Mandate

The North East Atlantic Fisheries Commission (NEAFC) is a regional fisheries management organization (RFMO) established under Article 118 of the United Nations Convention on the Law of the Sea to promote cooperation of States in the conservation and management of living marine resources in the high seas. There are currently five Contracting Parties (Denmark in respect of the Faroe Islands and Greenland, the European Union, Iceland, Norway, and the Russian Federation), and five Cooperating Non-Contracting Parties[16] (Bahamas, Canada, Liberia, New Zealand, and St. Kitts and Nevis). NEAFC's objective is "to ensure the long-term conservation and optimum utilisation of the fishery resources in the Convention Area, providing sustainable economic, environmental and social benefits". To this end, NEAFC adopts management measures for various fish stocks, and control measures to ensure that they are properly implemented. NEAFC also adopts measures to protect other parts of the marine ecosystem from potential negative impacts by fisheries.

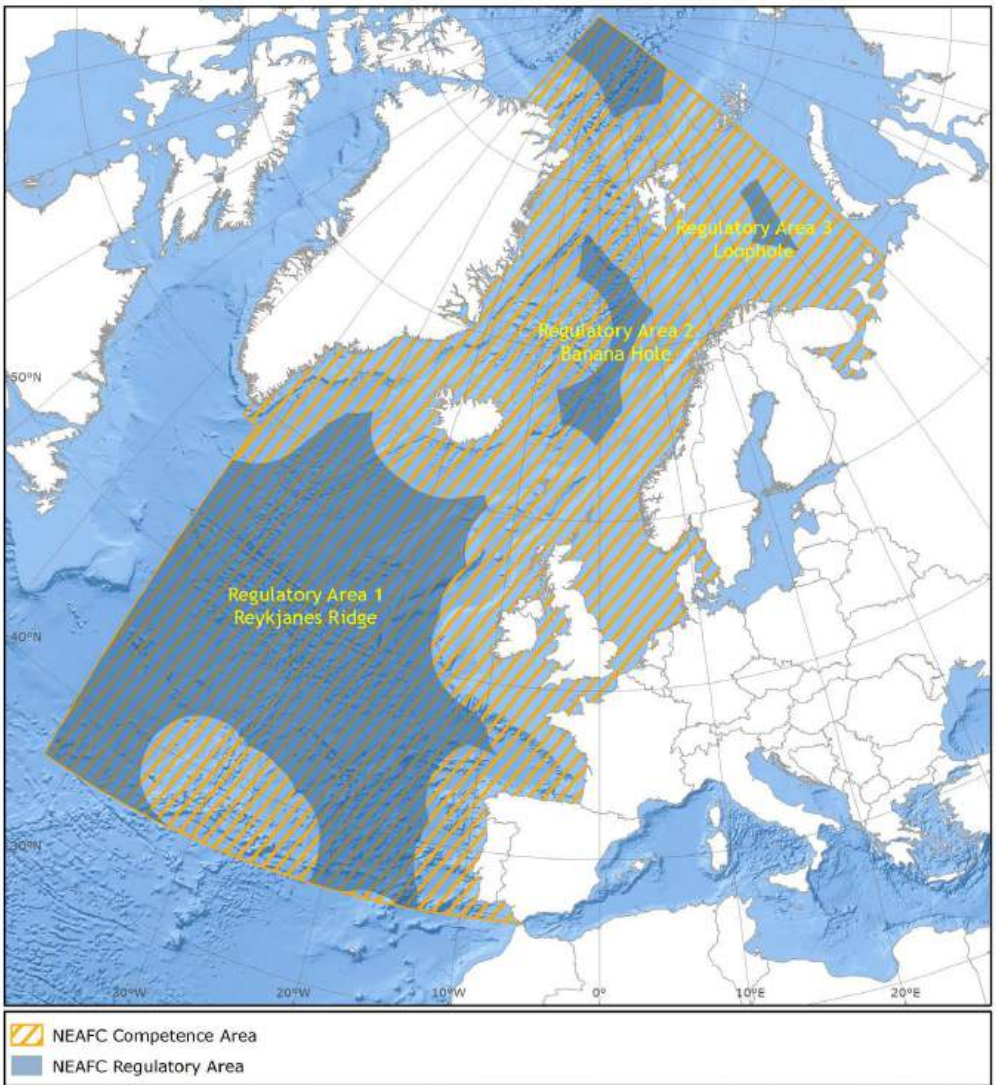
[16] Cooperating Non-Contracting Parties adhere to NEAFC measures and may received a quota, but do not participate in the adoption of NEAFC measures.

NEAFC was originally established in 1959, but in 1982 a new Convention, with broadly similar objectives, entered into force. Amendments to the 1982 Convention adopted in 2004 and 2006 formed the "New" Convention, which, among other things, modernised the 1982 Convention to bring it in line with current approaches to managing fisheries, including applying an ecosystem approach to fisheries. To date, the 2004 amendment regarding dispute settlement procedures has not yet entered into force, whereas the 2006 amendments, which include all the other changes and had been implemented on a provisional basis since their adoption, entered into force in 2013.

Regulatory capacity

NEAFC can adopt legally-binding measures for the conservation and management of fisheries resources under its mandate in all parts of its Convention Area. However, management of areas under national jurisdiction is conditional on the relevant coastal State proposing and supporting such measures, and in practice NEAFC is largely focused on the portions of the Convention Area that are beyond national jurisdiction, collectively known as the Regulatory Area. The Regulatory Area comprises four separate areas (Figure 3) but the northernmost (Arctic) area is almost permanently ice-covered, and there are no fisheries there. There are therefore three high-seas areas

FIGURE 3
NEAFC Competence and Regulatory Areas in the northeast Atlantic Ocean



where NEAFC regulates the fisheries: one in the Atlantic Ocean between Iceland and the Azores (RA1: Reykjanes Ridge), one in the Norwegian Sea (RA2: Banana Hole), and one in the Barents Sea (RA3: Loophole). However, all measures that apply generally, rather than to particular fisheries, also apply to the Arctic area. This includes measures for the protection of VMEs.

NEAFC can consider measures for, among others, fishing gears, net mesh sizes, size limits for fish in the catch, closed seasons and areas, total allowable catches (TACs), and effort. The decisions seek to be consistent with measures applied by Contracting Parties within areas under their jurisdiction and, upon request from a Contracting Party, NEAFC may also adopt measures for such areas. Measures become binding after 50 days, subject to an objection procedure that can result in the measure not being binding on the objecting Contracting Party. Each Contracting Party is also required to provide the Commission with the scientific and statistical information needed for the purposes of implementing the Convention.

The amended NEAFC Convention clarifies the aspects that need to be considered by the Commission when making its decisions on the fishery and the fisheries resources. Specifically, these decisions are to: (a) be based on the best scientific evidence available; (b) apply the precautionary approach; (c) take account of the impact of fisheries on other species and marine ecosystems, and minimise harmful impacts on living marine resources and marine ecosystems; and (d) take account of the need to conserve marine biological diversity.

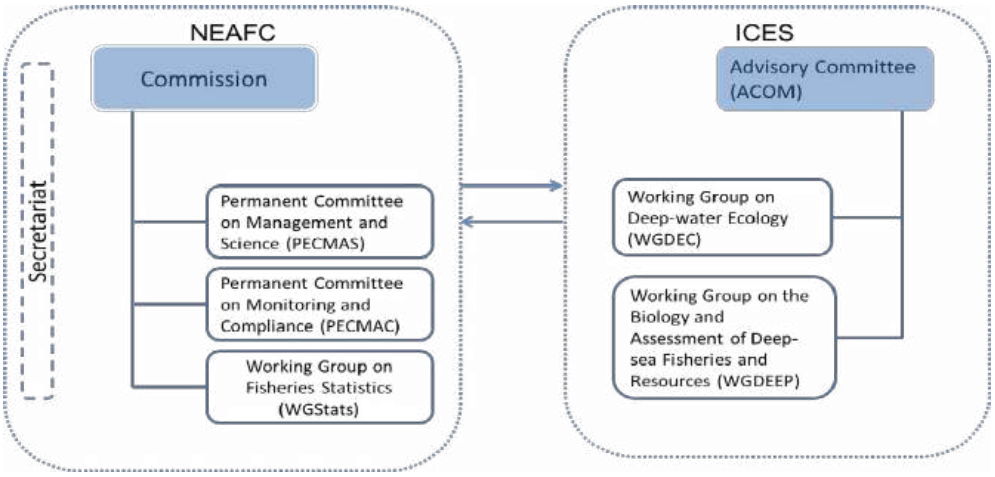
Structure

NEAFC is an organization comprised of Contracting Parties that have ratified the Convention on Multilateral Cooperation in North-East Atlantic Fisheries. The governing body, called the Commission, consists of not more than two representatives from each Contracting Party, who may be accompanied by experts and advisors. The head of the Commission is the President, who is responsible for convening, presiding, opening and closing, and running regular meetings of the Contracting Parties, and ensuring that the business of the Commission is carried out effectively and in accordance with its decisions. Unlike most other RFMO/As, NEAFC has not established an internal scientific body but, pursuant to its Convention, seeks information and advice from the International Council for the Exploration of the Seas (ICES), with which NEAFC has a Memorandum of Understanding (MoU).

The Commission is further assisted by three permanent internal committees, a number of working groups, and a Secretariat, which is based in London, United Kingdom. Three of these subsidiary bodies are relevant to the management of VMEs. The Permanent Committee on Management and Science (PECMAS) liaises with ICES and proposes and reviews measures, informs the Commission of new relevant advances in science, and advises the Commission on measures related to area management, including the closing of areas to fishing. The Working Group on Fisheries Statistics (WGStats) is responsible for the collection and communication of statistics relating to the fisheries regulated by NEAFC, to ensure that NEAFC has timely information on fishing activities and quota utilization. The Permanent Committee on Monitoring and Compliance (PECMAC) is responsible for the work on monitoring, control, enforcement, and compliance also related to area management (Figure 4).

ICES is a global intergovernmental science organization that conducts and facilitates scientific research and assessments and provides advice to support the sustainable use of the oceans. The main objective of ICES is to increase scientific knowledge of the marine environment and its living resources, and to use this knowledge to provide unbiased, non-political advice to competent authorities. It was established in 1902 by an exchange of letters between the participating countries, but a formal Convention that gave ICES a legal foundation and full international status did not enter into

FIGURE 4
Structure diagram showing the main NEAFC and ICES Committees responsible for vulnerable marine ecosystems in the high seas portion of the northeast Atlantic Ocean. Note that ICES is an independent organization



force until 1964. ICES provides NEAFC with scientific information and assessments of fish stocks exploited in the Regulatory Area, and the environment in which they occur. The ICES Advisory Committee provides scientific advice to NEAFC based on assessments carried out by expert working groups and an internal peer-review and drafting process. The assessments most relevant to VME issues are undertaken by the ICES–NAFO (Northwest Atlantic Fisheries Organization) Joint Working Group on Deep Water Ecology (WGDEC). Other relevant expert groups dealing with deep-sea and bottom fisheries partly conducted in the Regulatory Area are the Working Group on the Biology and Assessments of Deep-sea Fisheries Resources (WGDEEP), and groups mandated to assess for example, deep-sea fisheries on redfish, Greenland halibut, shrimp, and Rockall haddock.

Decision process

Proposals for action by the Commission are submitted to the Commission by a Contracting Party or a subsidiary body. The action could be the adoption of a conservation and management measure, which as a rule is based on scientific advice from ICES, or an administrative decision. Proposals are either submitted in advance of a meeting, or developed at a meeting in the light of discussions. Proposals are also regularly made intersessionally for decisions by correspondence.

Requests for scientific advice take one of two forms: requests for recurring advice (mostly included in the MoU) and requests for non-recurring advice. The former are usually the same, or similar, each year, whereas the latter are typically ad hoc and address new items or exceptional circumstances. Requests are formally submitted to ICES by the Commission; ICES reviews these requests and submits its advice back to NEAFC and publishes it in its annual ICES Advice publication and makes it publicly available on its website. ICES also presents the advice to PECMAS and the Commission.

PECMAS, on receiving the advice from ICES , discusses it and, if necessary, makes a proposal to the Commission for appropriate action. PECMAS proposals may include drafts of conservation and management measures, proposals for TACs for assessed stocks, or simple references to the advice requiring further consideration by the Commission, which then takes the necessary decisions.

Relationships with other bodies

NEAFC works collaboratively with the NAFO, its counterpart in the Northwest Atlantic Ocean. All NEAFC Contracting Parties are also parties of NAFO. Recently these RFMOs formed a joint advisory group on data management and agreed to a joint Deployment Plan to coordinate control and inspection activities. Some NEAFC Contracting Parties are also members of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR). OSPAR is a regional body whose Contracting Parties cooperate to protect the marine environment of the northeast Atlantic. It started in 1972 with the Oslo Convention against dumping, and in 1974 was broadened by the Paris Convention to cover landbased sources and the offshore industry. These two conventions were unified, updated, and extended by the 1992 OSPAR Convention, and in 1998 a new annex on biodiversity and ecosystems was adopted to cover non-polluting human activities that can adversely affect the sea. OSPAR does not have the mandate to adopt any program or measures related to the management of fisheries, but it cooperates with NEAFC in the context of area management. In 2008, NEAFC and OSPAR entered into formal cooperation through an MoU; this was expanded in 2014, when they agreed a Collective Arrangement, which strengthened the dialogue with regard to areabased management in particular.

There are other international marine conservation and management bodies operating in the Northeast Atlantic: the International Commission for the Conservation of Atlantic Tuna, the International Whaling Commission, the North Atlantic Marine Mammal Commission and the North Atlantic Salmon Conservation Organization. NEAFC does not assess or manage any of the species managed by these other bodies. Activities managed by other international bodies, such as the International Maritime Organization and the International Seabed Authority, may also have an impact on marine ecosystems, and initiatives have been taken to formalise cooperation among all relevant international organizations operating in the northeast Atlantic Ocean.

OVERVIEWS

Bottom fisheries

NEAFC divides its fisheries into those that target pelagic species (including redfish, mackerel, herring, and blue whiting) which use pelagic gears, and those for haddock and "deepsea species" (listed in NEAFC, 2016) which use demersal fishing gears. Demersal gears include not only gears that touch the bottom during normal operation, but also benthopelagic gears targeting grenadier (mainly roundnose grenadier *Coryphaenoides rupestris*) and alfonsino (*Beryx splendens* and *B. decadactylus*) that may not touch bottom but catch fish resources just off the seabed. As defined by NEAFC, deep-sea fisheries are those that land species appearing on the NEAFC list of deep-sea species, regardless of fishing method. However, some bottom fishing not satisfying this definition of deep-sea fisheries also occurs in the NEAFC Regulatory Area, e.g. the fisheries targeting Rockall haddock, shrimps and crabs in the Barents Sea.

The total catch of deep-sea species in 2012 in the Regulatory Area, as recorded by NEAFC, was 2 082 tonnes, principally Greenland halibut (*Reinhardtius hippoglossoides*) (463 tonnes) and roughhead grenadier (1 139 tonnes). For the entire Convention Area (Regulatory Area and national waters), landings of deep-sea species in 2012 were 173 000 tonnes; the landings from the Regulatory Area were therefore a small proportion (1.2 percent) of the total landings from the northeast Atlantic. Independently of NEAFC, ICES compiles national landings statistics for use in assessments and management advice, and there are often discrepancies between figures submitted to NEAFC by individual Contracting Parties and the ICES figures derived from national sources. In 2014, WGDEEP mandated to update statistics on deep-sea species (excluding Greenland halibut) presented total landings in the Convention Area

for 2013 of deep-sea species of 122 779 tonnes (WGDEEP, 2014). Of this, 6 792 tonnes (5.5 percent) was from the Regulatory Area. The predominant species caught in the Regulatory Area were ling (*Molva molva*), tusk (*Bromse bromse*) and grenadiers, plus a few hundred tonnes of Greenland halibut.

Both sources of landings data suggest that recent catches from the Regulatory Area have declined to low levels compared with the 1980s and 1990s, when the deep-sea fisheries expanded and were largely unregulated. Unfortunately, it is difficult to reconstruct the full historical time series of effort and catches for deepwater fisheries.

In 2005, the WGDEC reviewed the deep-sea fisheries in the northeast Atlantic, and noted that longlines, bottom trawls, and deep-water gillnets were used in fisheries on and around the seamounts of the MAR (around ICES Division XIVb1), the Reykjanes Ridge, around the Azores, and also around the Hatton and Rockall Banks. More directed analyses around certain closed areas, using position information from Vessel Monitoring Systems (VMS), showed that during 2003–2005 fishing occurred on and around the Altair, Antialtair, and Faraday seamounts, and on the Reykjanes Ridge; however, it was not possible to differentiate pelagic and bottom gears (WGDEC, 2006). The 2014 report of the WGDEEP provided a more extensive review of deep-sea fisheries, and included a section that covers the fisheries of the MAR, which started in 1973 and in 1975 landed around 30 000 tonnes of roundnose grenadier (*Coryphaenoides rupestris)* alone. Later, aggregations of alfonsino *(Beryx splendens)*, orange roughy *(Hoplostethus atlanticus)*, cardinal fish *(Epigonus telescopus)*, tusk, 'giant' redfish (*Sebastes marinus)* and blue ling (*Molva dypterigia*) were found. Since then the catches of these fisheries have fallen to comparatively low levels, but have stabilised at reduced levels on continental slopes. An expansion of grenadier fisheries on the MAR was observed after 2010, and resulted in the current precautionary NEAFC regulation, which added to the existing NEAFC and European Union (EU) regulations. The main deep-water fisheries in the Regulatory Area are currently conducted on the upper slopes of Hatton and Rockall Banks. Deep-sea fishing has been conducted by the Faroese, Icelandic, Latvian, Polish, Spanish and Russian trawl and Norwegian longline vessels throughout the Northeast Atlantic in ICES Subareas X, XII, XIV and V.

Vulnerable marine ecosystems

In the early 2000s, NEAFC started to implement measures to address the possible adverse impacts of bottom fisheries for deepsea species. These measures were directed at conserving the target and bycatch deep-sea fish species, whilst also addressing the effects of bottom fisheries on other components of the marine ecosystem, in particular epifauna susceptible to lasting damage from bottom-contact fishing gear such as is found in VMEs. The term VME, as used by NEAFC, has the same meaning and characteristics as in Paragraphs 42 and 43 of the FAO Deep-sea Fisheries Guidelines.

Scientific advice to NEAFC on probable and actual locations of VMEs is provided by ICES. PECMAS uses this advice as a basis for discussion and to propose actions, including closures. The Commission then adopts the necessary measures to ensure protection of VMEs from any possible significant adverse impacts caused by fishing with bottom gears. Initially, the work accomplished in NAFO was used as a basis for formulating the general approach for NEAFC. Areas within both 'existing' and 'new' bottom fishing areas have been closed to bottom fishing to prevent significant adverse impacts on VMEs. The parts of 'existing' bottom fishing areas that are not closed are subject to various measures, including reporting duties and encounter protocols. An encounter with a VME results in a temporary closure of the relevant area. Similar encounter provisions apply to exploratory fisheries in 'new' fishing areas, and vessels are required to carry observers. From 2009 to 2013, NEAFC bottom fishing measures stated that an encounter with VME indicator species, or the mere presence of a VME element, is not sufficient to identify a VME. This wording was modified in the current

measure (adopted in 2014) to indicate that encounters above threshold levels are considered an encounter with a possible VME. From 2009 to 2013, NEAFC bottom fishing measures stated that an encounter with VME indicator species, or the mere presence of a VME element, is not sufficient to identify a VME. This wording was modified in the current measure, adopted in 2014, where encounters above threshold levels are considered an encounter with a possible VME.

An extensive review of NEAFC's actions concerning protection of VMEs was carried out in 2012 (NEAFC, 2012). It concluded that the measures in place were sufficient for NEAFC to be acting consistently with the relevant UNGA resolutions and the FAO Deep-sea Fisheries Guidelines. However, it also suggested various improvements to NEAFC's regime. This led to the adoption of a new comprehensive measure in 2014 (Recommendation 19/2014), which replaced previous measures to protect VMEs.

The measures currently in force ensure that the only areas where bottom fisheries can legally take place in the Regulatory Area, apart from restricted exploratory fisheries, are in areas that are well-known bottom fishing areas where the best available scientific advice has suggested that VMEs do not, or are unlikely to, occur. As the possible fishing areas where VMEs are known or likely to occur have either been closed to bottom fishing or lie in 'new' bottom fishing areas that will probably remain largely unfished, fishing vessels are not expected to encounter VMEs. The areas open to commercial fishing are therefore those areas where the best available scientific information indicates that there are unlikely to be significant adverse impacts by bottom fishing on VMEs.

REGULATIONS AND MEASURES

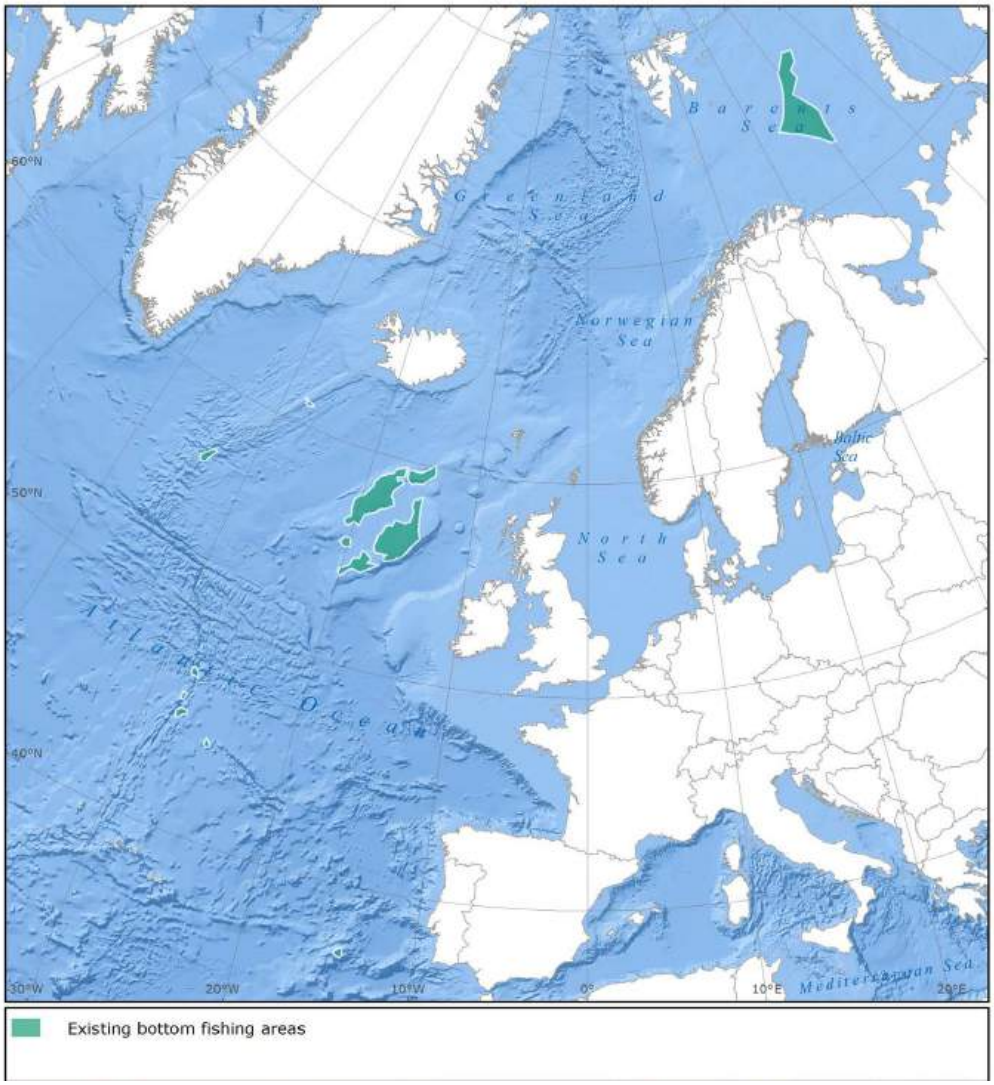
Bottom fishing areas

The mapping of bottom fishing areas commenced with discussions in PECMAS in June 2008, when certain broad concepts were proposed, including the clarification that a fished area would mean that fishing had taken place at least twice in a two-year period. The Commission held an extraordinary meeting in July 2008 to discuss NEAFC's approach in response to UNGA Resolution 61/105, especially with regard to bottom fishing areas and encounter protocols, and at its annual meeting later in 2008 it adopted a resolution that led to NEAFC's first general measures on bottom fishing in its Regulatory Area (Recommendation 13/2009). This resolution defined the terms "bottom fishing activities", "existing bottom fishing areas", and "new bottom fishing areas", and required Contracting Parties to submit, by 1 September 2009, data on their bottom fishing activities during 1987–2007, at a resolution of 5' latitude x 10' longitude, for the following gear categories: bottom trawls, longlines, gillnets, benthopelagic (i.e. grenadier and alfonsino fishery), and others (i.e. other gears that have bottom contact during normal operation). The Secretariat also compiled maps of bottom fishing from VMS records, although it was not always possible to identify the type of fishery from those records. The first map of existing bottom fishing areas was adopted in 2009, and improved and modified in 2010 and 2014; the current map is shown in Figure 5. The current measure (Recommendation 19/2014) does not define or use the term "new fishing area", but refers to fishing "outside area closures and existing bottom fishing areas".

Exploratory fishing protocols

An exploratory fishing protocol was first adopted in 2008 related to fishing in "new bottom fishing areas" (i.e. outside the "existing bottom fishing areas"). Since 1 January 2009, all bottom fishing activities in new bottom fishing areas, or with bottom gear not previously used in the area concerned, are considered exploratory fisheries and must be conducted in accordance with an Exploratory Bottom Fisheries Protocol. An interim protocol was adopted as part of that measure, and established that exploratory fisheries cannot commence unless a harvesting plan, mitigation plan,

FIGURE 5
Current existing bottom fishing areas in the NEAFC Regulatory Area



catch-monitoring plan, and data collection plan have been submitted. Vessels involved in exploratory fisheries must also carry an observer, who must follow the interim VME data collection protocol. Exploratory fisheries are assessed by ICES and PECMAS after two years, and the Commission takes a decision regarding the future of the fishery.

The current measure, adopted in 2014 (Recommendation 19/2014), clarified and expanded the exploratory bottom fishing measures. Contracting Parties are still required to submit a "Notice of Intent" for any fishing they wish to undertake outside the existing bottom fishing areas, or within an existing bottom fishing area if there are significant changes in the conduct and technology of bottom fishing activities within existing bottom fishing areas. As noted above, the term "new fishing area" is no longer used. In addition to the four plans required by the 2008 measure, vessels are required to collect information on a fine spatial scale, preferably by tows or sets, and to use additional technology on the vessel (e.g. sea-bed mapping programmes using echo- or multi-beam sounders) or on the gear (e.g. cameras) to identify where VMEs do, or are likely to, occur. The assessment process is specified in detail; ICES provides guidance to PECMAS on how to undertake the assessment, and the Commission makes the final decisions as to whether the proposed bottom fishing should proceed.

Vulnerable marine ecosystems

NEAFC's work to protect VMEs began a few years before the adoption of UNGA Resolution 61/105 in 2006. However, both the UNGA Resolution and the FAO Deep-sea Fisheries Guidelines were important for the continued development of NEAFC's regulations From 2005 to 2014, the stated purpose of the NEAFC bottom closures to protect benthic habitats was the protection of VMEs, with the exception that in 2007 and 2008 the closures on and around the Hatton and Rockall Banks were originally to protect deep-water corals. Depending on the wording in the regulation, the closures applied to either: (1) bottom trawling and fishing with static gear, including bottom gillnets and longlines, or (2) fishing with gear that is likely to contact the seafloor during the normal course of fishing operations. The current measure (Recommendation 19/2014) uses the latter definition, terming them "bottom fishing activities". This definition protects VMEs by closing areas to bottom-contact fishing gears regardless of target species, but allows fishing with pelagic and benthopelagic gears, and also fishing targeting deep-sea species, to continue.

NEAFC, on the advice of ICES, has regularly reviewed the boundaries of its closed areas, and has modified them as appropriate to protect newly-identified VMEs. The first set of closures in 2005 was precautionary, with very little biological information available to support the decision. However, further information has been collected by Contracting Parties, mainly through surveys, and provided to ICES. The WGDEC reviews this information annually, and ICES provides advice to NEAFC. WGDEC recently developed a central portal for data on the distribution and abundance of VMEs across the North Atlantic, and contains observations of VME indicators and habitats.

Area closures have been seen as a primary tool to protect VMEs, but also as an integrated element of a more general comprehensive approach. This approach includes: 1) defining 'existing' bottom fishing areas, i.e. areas that have been recently fished and where fisheries could continue relatively unrestricted, and 2) ensuring that bottom fishing outside these areas (i.e. in 'new' bottom fishing areas) are only exploratory fisheries subject to various restrictive conditions. These conditions now include a pre-assessment of the proposed activities; proposed exploratory bottom fisheries can commence only after having been assessed by PECMAS and approved by the Commission.

Following the initial closures in 2005, and some additions in the following years, NEAFC's biggest step in adopting area closures to protect VMEs was taken in 2009, when several new closures were adopted, including very large areas on the MAR.

NEAFC has now closed the areas where it has concluded, on the basis of the best available scientific information, that VMEs occur or are likely to occur. No bottom fisheries should therefore be taking place in the Regulatory Area that will result in significant adverse impacts on VMEs. Furthermore, the provisions on 'new' bottom fishing areas ensure that bottom fisheries only expand into previously unfished areas on the basis of exploratory fisheries that are subject to various conditions, including pre-assessments, and that can only commence after having been assessed by PECMAS and approved by the Commission. Additionally, several of NEAFC's closures are not based on the identification of specific individual VMEs, but rather on the likelihood of there being VMEs, e.g. the large closed areas on the MAR.

However, NEAFC continues to develop its management in this context, and has a recurring request for scientific advice from ICES regarding any new information on the occurrence of VMEs in the Regulatory Area.

Similarly, from 2009 to 2013 measures established that VMEs should be identified on a case by case basis through assessment by relevant bodies: ICES for the advice, and PECMAS for the recommendation. The current measure specifies that area closures for the protection of VMEs must be based on advice from ICES and the procedures

set out in NEAFC measures regulating fisheries in the Regulatory Area. VMEs can be identified by either current or historical research survey work, or through an examination of the temporary closures following encounters and the subsequent assessment and advice from ICES.

Currently, NEAFC protects VMEs, and areas likely to have VMEs, by regulations that include bottom fishing closures, and in this way significant adverse impacts from bottom fisheries are mitigated. The closed areas are defined by a set of coordinates that delineate a boundary within which bottom fishing activities are prohibited.

Encounter protocols

One of the tools used for protecting unidentified VMEs from significant adverse impacts are encounter protocols for vessels actively fishing with bottom-contact gears within the Regulatory Area. The first encounter protocol in 2008 required Contracting Parties to require their flag vessels to cease bottom fishing in a prescribed area following an encounter. In essence the obligation was for the vessel, regardless of its fishing gear, to move two nautical miles radius around the most likely position of the encounter. Encounter protocols have been expanded and clarified several times since then, and now require a temporary closure to be applied in all instances of encounters above a threshold level. The size of the closed area is dependent on the gear used: for bottom trawls it is 2 nm on each side of the trawl track, and for other gears it is 2 nm radius around the most likely position of the encounter. The position of the encounter and extent of the possible VME is assessed using sea-bed mapping, and the results submitted to ICES for evaluation. Subsequent management action, and the possible lifting of the temporary closure or notification of a VME closure, is based on the subsequent advice by ICES and recommendations by PECMAS. The temporary closure remains in place until such action has been decided.

Vulnerable marine ecosystem indicators

VME indicators, which indicate the occurrence or likely occurrence of VMEs, have evolved within NEAFC since 2008 as measures have developed. Initially, the measures did not include VME indicators. In 2009, VME indicators were included, and defined as species of coral identified as antipatharians, gorgonians, cerianthid anemone fields, *Lophelia*, and sea pen fields or other VME elements; however, VME elements were not defined in that measure (Recommendation 13/2009). Sponges were included in square brackets, indicating that not all Parties were in agreement with their inclusion as VME indicators, but by 2010 sponges had been accepted as indicator organisms (Recommendation 11/2010).

The list of VME indicator species and taxa was modified and expanded in 2014 (Recommendation 19/2014), and representative taxa were assigned to VME habitat types and physical elements (Table 2).

Thresholds

Threshold levels for encounters with a possible VME were first established by NEAFC in 2009, and have been regularly revised since (Table 3). The current thresholds, as advised by ICES, are:

a) for a trawl tow, and fishing gear other than longlines: the presence of more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; and
b) for a longline set: the presence of VME indicators on 10 hooks per 1 000-hook segment or per 1 200-m section of longline, whichever is the shorter.

TABLE 2
VME indicator species (taxa) and elements adopted by NEAFC in 2014

VME Habitat type	Representative Taxa
1. Cold-water coral reef	
a. *Lophelia pertusa* reef	*Lophelia pertusa*
b. *Solenosmilia variabilis* reef	*Solenosmilia variabilis*
2. Coral garden	
a. Hard-bottom garden	
i. Hard-bottom gorgonian and black coral gardens	Anthothelidae, Chrysogorgiidae, Isididae, Keratoisidinae, Plexauridae, Acanthogorgiidae, Coralliidae, Paragorgiidae, Primnoidae, Schizopathidae
ii. Colonial scleractinians on rocky outcrops	*Lophelia pertusa, Solenosmilia variabilis*
iii. Non-reefal scleractinian aggregations	*Enallopsammia rostrata, Madrepora oculata*
b. Soft-bottom coral gardens	
i. Soft-bottom gorgonian and black coral gardens	Chrysogorgiidae
ii. Cup-coral fields	Caryophylliidae, Flabellidae
iii. Cauliflower coral fields	Nephtheidae
3. Deep-sea sponge aggregations	
a. Other sponge aggregations	Geodiidae, Ancorinidae, Pachastrellidae
b. Hard-bottom sponge gardens	Axinellidae, Mycalidae, Polymastiidae, Tetillidae
c. Glass sponge communities	Rossellidae, Pheronematidae
4. Sea pen fields	Anthoptilidae, Pennatulidae, Funiculinidae, Halipteridae, Kophobelemnidae, Protoptilidae, Umbellulidae, Vigulariidae
5. Tube-dwelling anemone patches	Cerianthidae
6. Mud- and sand-emergent fauna	Bourgetcrinidae, Antedontidae, Hyocrinidae, Xenophyophora, Syringamminidae
7. Bryzoan patches	

VME indicator elements

Physical elements	Explanation
Isolated seamounts	Non-MAR seamounts
Steep slopes and peaks on mid-ocean ridges	Steep ridges and peaks support coral gardens and other VME species in high density
Knolls	A topographic feature that rises less than 1 000 m from the sea floor
Canyon-like features	A steep-sided "catchment" feature not necessarily associated with a shelf, island or bank margin
Steep flanks >6.4°	From Murillo, 2011

TABLE 3
VME indicator species encounter threshold levels in the NEAFC Regulatory Area

Year	Unit	VME indicator	Measure
2008	Catch	Evidence of VMEs	
2009	Catch per set[1]	Corals: 100 kg live; Sponges: [1 000 kg live][2]	Rec. 13/2009
2010-2012	Catch per set	Corals: 60 kg live; Sponges: 800 kg live	Rec. 11/2010
2013	Catch per set	Corals: 30 kg live; Sponges: 400 kg live	Rec. 12/2013
2014-	Trawl tow, other gears	Corals: 30 kg live; Sponges: 400 kg live	Rec. 19/2014
	Longline set[3]	10 present per 1 000 hooks or 1 200 m line	Rec. 19/2014

[1] "set" defined as trawl tow, longline set, or gillnet set.
[2] Not accepted by all Contracting Parties.
[3] The presence of VME indicators on 10 hooks per 1 000-hook segment or per 1 200-m section of longline, whichever is the shorter.

Impact assessments

The general approach of NEAFC since 2008 has been to identify areas where VMEs are known or likely to occur, and to close these areas to bottom fishing activities to protect the VMEs from significant adverse impacts. Initially, before the VME and bottom

fishing measures were fully developed, NEAFC planned to assess all bottom fishing activities and specified a procedure for doing this, whereby Contracting Parties were required to submit their bottom fishing plans for the next year along with anticipated impacts on VMEs (Recommendation 16/2008). These would then be assessed by ICES and PECMAS, and the Commission would decide whether to allow, prohibit, or restrict such fishing. A more detailed interim protocol for exploratory fishing in new bottom fishing areas was adopted the following year (Recommendation 13/2009), and further developed in 2011, which required that cumulative impacts on VMEs also be considered, as well as a risk assessment to determine whether impacts could be regarded as significantly adverse (Recommendation 15/2011). The same basic procedure applies currently, although more detail is required in the report, which must be completed in part by a scientific observer.

Observers

NEAFC requires that vessels undertaking exploratory fisheries carry an observer on board, who collects data in accordance with the VME Data Collection Protocol (Box 2). This protocol, in force in interim form during 2008–2013, was re-adopted with minor amendments in 2014:

BOX 2
VME Data Collection Protocol

Observers on fishing vessels in the Regulatory Area who are deployed pursuant to Article 6.6 of this Recommendation shall:

(a) Monitor any set for evidence of presence of VMEs and identify coral, sponges and other organisms to the lowest level;
(b) Record on data sheets the following information for identification of VMEs: vessel name, gear type, date, position (latitude/longitude), depth, species code, trip-number, set-number, and name of the observer on data sheets, if possible;
(c) Collect, if required, representative samples from the entire catch (biological samples shall be collected and frozen when requested by the scientific authority in a Contracting Party); and
(d) Provide samples to the scientific authority of a Contracting Party at the end of the fishing trip.

Scientific research

Within closed areas, Contracting Parties intending to conduct scientific investigations (which excludes exploratory fishing), are required to make a notification of their intended research programmes, taking account of Article 206 of the UN Convention on the Law of the Sea, which requires that States "having reasonable grounds for believing that planned activities may cause harmful changes to the marine environment, shall assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments to all members of the competent international organization".

Review procedures

Every five years, the Commission reviews the effectiveness of the regulations on the protection of VMEs from significant adverse impacts, taking into account any new scientific advice. VME closures are usually, but not always, for a fixed period of between 1 and 5 years, and the measures controlling these closures are reviewed prior to the end date. Closures are normally extended, often with a modification of the boundaries. The review date for most of the current closures is 31 December 2017.

Other regulations that also protect benthic areas

Gear restrictions

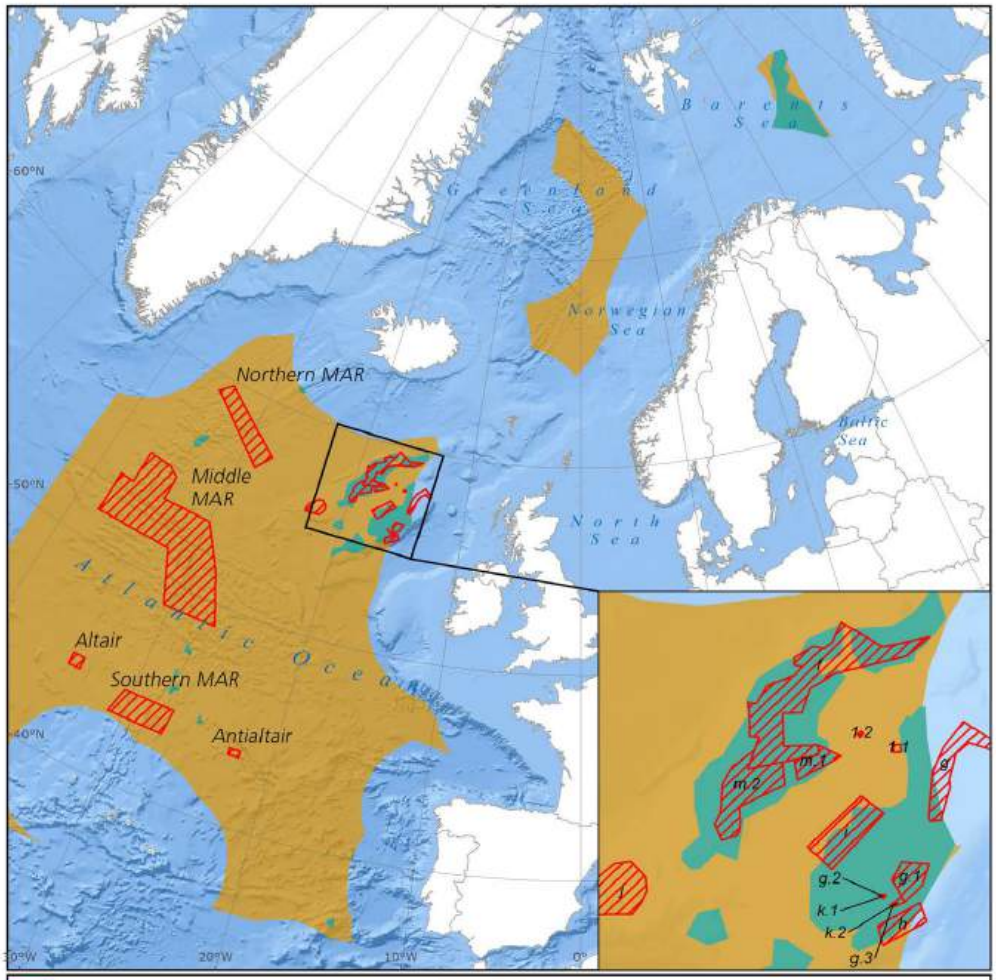
NEAFC has prohibited the deployment of gillnets, entangling nets, and trammel nets in any position where charted depth is greater than 200 m (Recommendation 3/2006). Furthermore, there is an obligation for vessels fishing with fixed gear to have on board equipment to retrieve lost gear, and to attempt to retrieve lost gear as soon as possible (NEAFC, 2015). If the gear cannot be retrieved, the vessel must report the incident, including type of gear and position, to its flag State, and subsequently to all Contracting Parties. Contracting Parties must on a regular basis undertake to retrieve lost gear.

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

The current area measures adopted by NEAFC to protect VMEs address delineated existing bottom fishing areas, encounters and exploratory fishing inside and outside existing bottom fishing areas, and closures (Figure 6). The development of NEAFC's measures to protect VMEs and other benthic areas from 2005 to present is shown as a map in Figure 7 and in Table 4.

FIGURE 6

Spatial management measures adopted by NEAFC in 2015 for the protection of VMEs. Encounter protocols apply throughout the NEAFC Regulatory Area



Hatton Bank 1	f	South-West Rockall Area 3	g.3
North west Rockall	g	South-West Rockall Bank Area 1	k.1
Logachev Mounds	h	South-West Rockall Bank Area 2	k.2

West Rockall Mounds	i	Hatton-Rockall Basin Area 1	l.1
Edora's bank	j	Hatton-Rockall Basin Area 2	l.2
South-West Rockall (Empress of Britain Bank) Area 1	g.1	Hatton Bank 2 Area 1	m.1
South-West Rockall Area 2	g.2	Hatton Bank 2 Area 2	m.2

FIGURE 7
The evolution of measures adopted by NEAFC to protect VMEs and other benthic habitats. See Figure 6 for key to closed areas

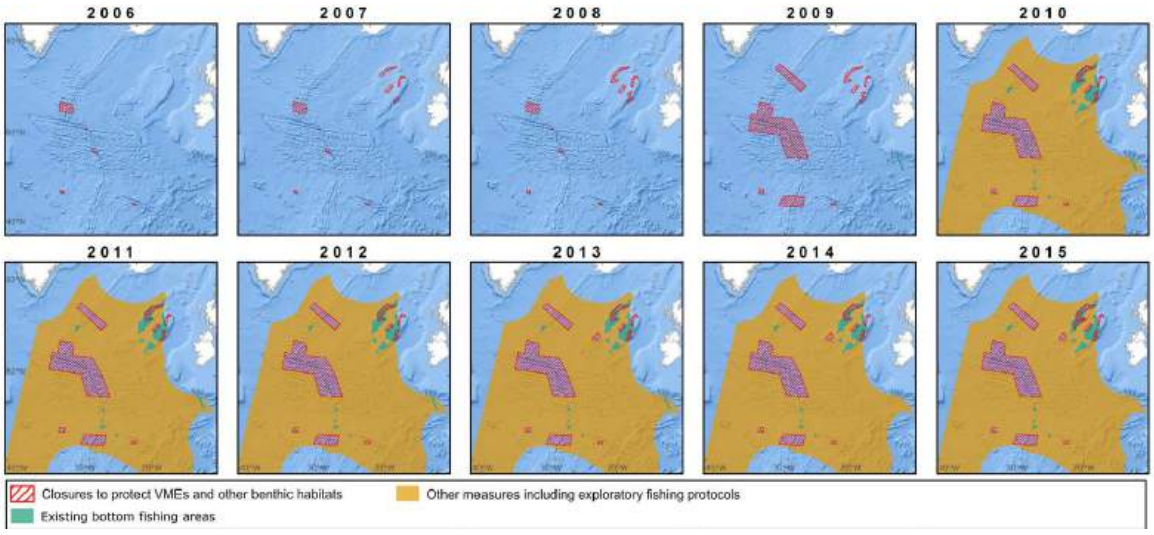


TABLE 4
The chronological development of closed areas to protect VMEs. C denotes a closed area, C1, C2, etc., denotes boundary changes; R is a review; EBB is Empress of Britain Bank

Year	2005	2006	2007	2008	2009[1]	2009[2]	2010	2011	2012	2013	2014	2015–2017
Recommendation	05/2005		09/2007	07/2008 09/2008	14/2009	pv/2009	8/2010	14/2011	08/2012	08/2013 09/2013	19/2014	19/2014
Altair Seamount	C	C	C(R)	C(R)	C(R)	C1	C1	C1	C1	C1	C1(R)	C1
Antialtair Seamount	C	C	C(R)	C(R)	C(R)	C1	C1	C1	C1	C1	C1(R)	C1
Hecate Seamount	C	C	C(R)	C(R)	C(R)[3]							
Faraday Seamount	C	C	C(R)	C(R)	C(R)[3]							
Reykjanes Ridge	C	C	C(R)	C(R)	C(R)[3]							
Hatton Bank			C	C1	C1	C1(R)	C2(R)	C2(R)	C3(R)	C4	C4(R)	C4
Northwest Rockall			C	C1	C1	C1(R)	C1(R)	C1(R)	C1(R)	C1	C1(R)	C1
Logachev Mounds			C	C	C	C(R)	C(R)	C(R)	C(R)	C	C(R)	C
West Rockall Mounds			C	C	C	C(R)	C(R)	C(R)	C(R)	C	C(R)	C
Edora's bank										C	C(R)	C
Southwest Rockall (EBB) Area 1[4]				C	C	C(R)	C(R)	C(R)	C(R)	C	C(R) C	C
Northern MAR Area						C	C	C	C	C	C(R)	C
Middle MAR Area (Charlie-Gibbs Fracture Zone and sub-Polar Frontal Region)						C	C	C	C	C	C(R)	C
Southern MAR Area						C	C	C	C	C	C(R)	C
Southwest Rockall (EBB) Area 2											C(R)	C
Southwest Rockall (EBB) Area 3											C(R)	C
Southwest Rockall Bank Area 1											C	C
Southwest Rockall Bank Area 2											C	C

TABLE 4 (CONTINUED)

Year	2005	2006	2007	2008	2009[1]	2009[2]	2010	2011	2012	2013	2014	2015–2017
Hatton-Rockall Basin Area 1											C	C
Hatton-Rockall Basin Area 2											C	C
Hatton Bank 2 Area 1											C	C
Hatton Bank 2 Area 2											C	C

[1] 1 January 2009-31 March 2009.
[2] 16 July 2009-31 December 2009.
[3] Became part of the new "Middle MAR Area (Charlie-Gibbs Fracture Zone and sub-Polar Frontal Region)" area in 2009.
[4] Became Southwest Rockall (EBB) Area 1 in 2014 with no change of boundary.

SURVEYS

Members of ICES conduct scientific cruises and undertake numerous regular repeat surveys in the northeast Atlantic, some of which provide information for assessing deep-water resources and VMEs in the NEAFC Regulatory Area. These investigations supplement existing published scientific information and databases available for assessments conducted by ICES expert groups such as WGDEC and WGDEEP. Further details of scientific investigations and surveys are available in the ICES expert group reports.

OTHER INFORMATION

Reported encounters

No encounters (i.e. bycatch of VME indicators exceeding threshold levels) have been reported. Several Contracting Parties have, however, reported to ICES data on sub-threshold bycatch of VME indicators, and these records are incorporated in the ICES VME database.

Exploratory fishing

No exploratory fishing using bottom fishing gears has been conducted by Contracting Parties in the Regulatory Area since the exploratory fishing protocol entered into force in 2009. Three "Notices of Intent" for an exploratory fishery for crabs in the Barents Sea was submitted by the EU in 2015. In all three cases, PECMAS concluded that the proposed activity was not likely to result in significant adverse impacts on VMEs. However, the Commission rejected all the proposals on the grounds that the target species was a sedentary species on the continental shelf of a coastal State. It was therefore such jurisdictional issues, and not issues relating to VME protection that caused these proposals for exploratory fishing to be rejected.

Identification guides

There is currently no VME identification guide for the northeast Atlantic that is used in the Convention Area or referred to in the NEAFC Scheme of Enforcement or in the conservation and management measures. ICES assessed the usefulness for NEAFC of the NAFO VME species guides for corals and sponges in the northwest Atlantic, and determined that about half of the species in the guides also occur in the northeast Atlantic (WGDEC, 2012, Item 8.3). PECMAS has recommended that a guide specific to the northeast Atlantic be developed.

Data sharing protocols

Data-sharing in NEAFC operates at a number of levels.

Contracting Parties to NEAFC must provide the following information to NEAFC:

- Daily catch weights (kg, to nearest 100 kg) of at least regulated species (Scheme, Article 12 1b; except EU)

- EU only: weekly catch weights (kg, to nearest 100 kg) of at least regulated species (NEAFC, 2015, Scheme, Article 12 1b; footnote 1)
- Monthly catches of species listed in Annexes I and IV of Recommendation 2/2011
- Catches of VME indicator species above the threshold level (Recommendation 19/2014, Article 8 1biii)
- Exploratory fisheries: an observer report on the VME Data Collection Protocol, and all data derived from exploratory bottom fishing (also to be sent to ICES) (Recommendation 19/2014).

The most important link, beyond the duties of the Contracting Parties, is between NEAFC and ICES. This is achieved through the MoU that states "NEAFC and ICES will work together to arrange for any relevant consolidated data for scientific analysis to be provided to ICES, while ensuring the NEAFC's confidentiality obligations." The main information provided to ICES by NEAFC is what is reported directly to the NEAFC Secretariat pursuant to the NEAFC regulations that permit vessels to fish in the Regulatory Area; this includes catch statistics, observer reports, and VMS information. In general, and in accordance with the MoU, only aggregated information is provided to ICES, as opposed to vesselspecific set-by-set information. NEAFC now provides VMS and catch information, in a form that does not identify vessels and/or flag states, to ICES twice yearly. ICES also receives information directly from its Member States, and from EuroStat, that can also be used to provide the best scientific advice to NEAFC.

As mentioned earlier, NEAFC also has an MoU with OSPAR, which likewise ensures the free flow of mutually useful information (including data) between the two organizations. This mutual cooperation ensures that the common objectives of the two organizations are realised. The WGStats is responsible for the collection of statistics relating to the fisheries and for monitoring the exchange of information with other organizations.

NEAFC has no protocol for sharing its information with a wider audience. Annual catch information, aggregated by country and area, is available on the NEAFC Web site, as are conservation measures and all its current and historical meeting reports, which include meetings of all committees and working groups. Documents submitted to meetings are not available on the public pages of the NEAFC Web site, but are available to all participants to NEAFC meetings. ICES has data use and sharing policies, and a large amount of open-access information is available in various databases.

Other activities that might impact vulnerable marine ecosystems

The level of human activity in the Regulatory Area is generally low. Laying and operation of cables for electronic communication and research activities, including exploration of marine genetic resources and minerals, are activities currently ongoing that may potentially impact VMEs. In 2012, OSPAR adopted Guidelines for Best Environmental Practice in cable laying and operation; it had previously adopted a Code of Conduct for scientific research, and in 2015 is investigating whether there is a need for new measures related to the search for and exploitation of marine genetic resources.

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Northwest Atlantic Ocean

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REGIONAL GEOGRAPHY AND BATHYMETRY

The northwest Atlantic region is dominated by the extensive North American continental shelf that extends eastwards off Nova Scotia, Newfoundland, and Labrador (Figure 8). The Grand Banks, a rich fishing ground, is only about 100 m deep, and lies mostly within the Canadian EEZ with just the "nose" to the east and "tail" to the southeast in international waters. The continental slopes at the edges of the Grand Banks are steep, and punctuated in many places with deep canyons, which extend down to the abyssal plains to depths of 3 000–5 000 m or more. To the east of the Grand Banks, separated by the deep Flemish Pass, lies the Flemish Cap, which is surrounded by steep slopes and canyons, particularly on its southern and eastern flanks. It lies entirely in international waters. Therefore, the slopes around the Grand Banks and Flemish Cap include many of the physical elements that can constitute VMEs (NAFO SC, 2014).

To the southwest of the Grand Banks, off the coast of Nova Scotia, is another highly productive fishing ground, Georges Bank, which lies mostly within the United States of America's EEZ. To the north of the Flemish Cap lies Orphan Knoll, and rising from the abyssal plain to the south and east of the Grand Banks and Flemish Cap are several seamounts and seamount chains that form the Corner Rise, New England, Newfoundland, and Fogo seamounts.

Orphan Knoll is a single peak, flat-topped and relatively shallow, especially on the western side. Nevertheless, it is still deep, with 3 587 km^2 in the 1 500–2 000 m depth range. A number of smaller mounds are found on the knoll at depths of 1 800-2 300 m.

The Corner Rise seamounts are the shallowest of the four chains, with 1 274 km^2 less than 2 000 m deep, and peaks reaching a depth of 828 m. The shallowest of these is at the western edge of NAFO's Corner Rise closure area, with the next shallowest at 1 500 m depth on the eastern edge of the closed area. There are also two shallow seamounts 900 m and 1 000 m deep just to the south of the NAFO area, in the Western Central Atlantic Fishery Commission (WECAFC) area of competence.

The New England seamounts are the next shallowest, with 699 km^2 above 2 000 m. The four seamounts on the northwestern edge rise to 1 750–2 000 m below the surface, with the two central seamounts at 1 500 m and 1 750 m. The peaks to the southeast are all deeper, at 2 500–4 000 m. The New England seamount chain extends into the United States of America's EEZ.

The Newfoundland seamounts are the deepest of these seamount chains. Of the six seamount peaks in this area, none are shallower than 2 400 m, and most are deeper than 3 500 m. The Fogo seamounts, also called the Fogo seamount chain, are a group of seamounts located about 500 km off Newfoundland and southwest of the Grand Banks. They consist of basaltic submarine volcanoes, and most are deeper than 2 000 m.

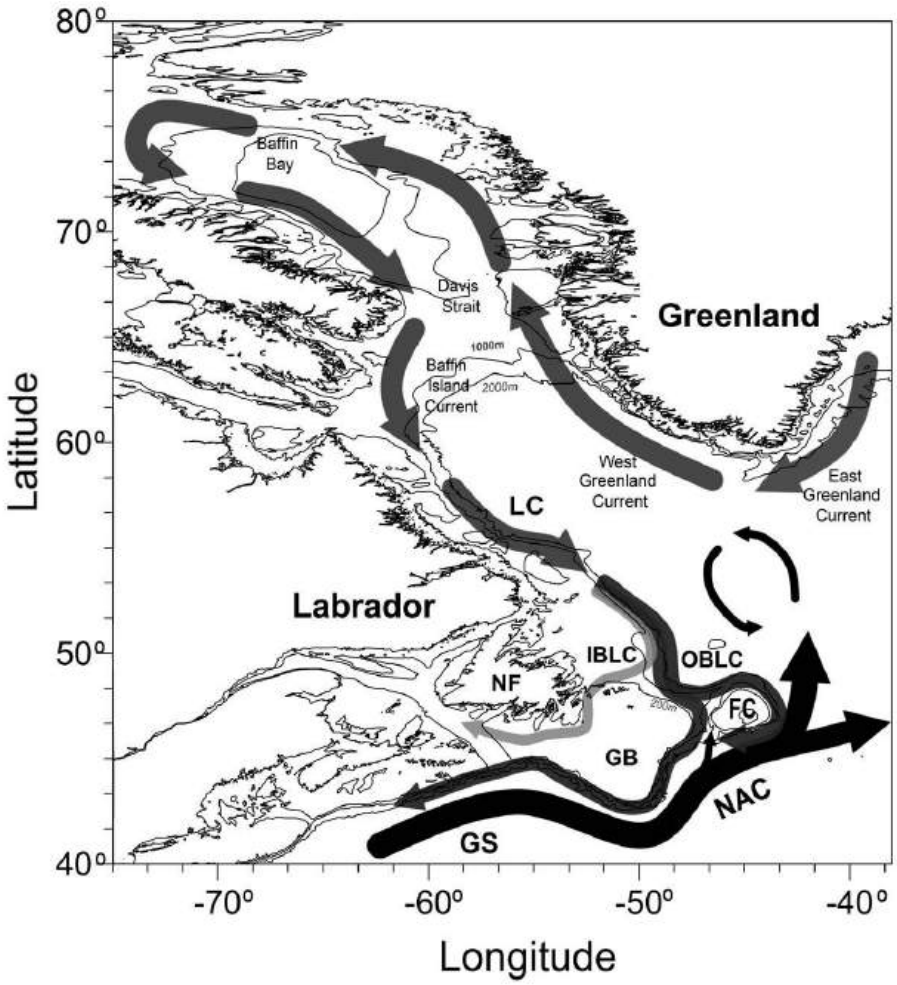
Hydrologically, the Grand Banks are an area of mixing, where the warm waters of the Gulf Stream, flowing from southwest to northeast, meet the Labrador Current, flowing southward down the western side of the Davis Strait (Figure 9). This mixing contributes to the high productivity of the area. The hydrography of the area is well studied, and annual trends are presented to the annual meeting of the Scientific Council.

FIGURE 8

Northwest Atlantic Ocean with the FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nm arcs

FIGURE 9

Map showing the major ocean currents in the NAFO Convention Area. LC=Labrador Current, GS=Gulf Stream, NAC=North Atlantic Current, FC=Flemish Cap, GB=Grand Bank, NF=Newfoundland, IBLC=Inner Branch of the Labrador Current, OBLC=Outer Branch of the Labrador Current. The size of the lines are indicative of the relative strength of the currents. The anticyclonic gyre over the Flemish Cap formed by the OBLC is shown. Figure taken from Figure 3.1.1 NAFO SCS Doc. 12/26 (p. 46)



NORTHWEST ATLANTIC FISHERIES ORGANIZATION

Background

The International Commission for the Northwest Atlantic Fisheries (ICNAF), established by a Convention in 1949, was the first regional fisheries body in the northwest Atlantic Ocean (Kulka, 2012). The adoption of 200 nm EEZs in the 1970s meant that most of the ICNAF area came under the jurisdiction of individual states, and ICNAF could no longer fulfil its functions. It was dissolved in 1978, and in 1979 NAFO was formed by a new Convention (NAFO, 2004). The convention area remained the same, but NAFO now had management responsibilities only in the NAFO regulatory area (NRA), defined as that part of the convention area outside the national 200 nm EEZs. The EEZs are part of the convention area, and NAFO provides advice on EEZ fisheries to the coastal states upon request. Stocks that lie wholly within EEZs are managed by the respective coastal State(s), and straddling stocks are managed cooperatively with the pertinent coastal State(s). The Convention, which was amended in 1980, 1987, and 1996 by changes to various geographical boundaries, "... applies to all fishery resources of the Convention Area ..." (Article I.4) with some exceptions,

and establishes that the objective of NAFO is "...to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area." (Article II.1). The Convention recognises the need to investigate "... environmental and ecological factors affecting these fisheries..." (Article VI.1a, b), and NAFO maintains a Standing Committee on the Fisheries Environment (STACFEN).

With the adoption of UNCLOS in 1982 and the UNFSA in 1995, elaborated in the 1995 FAO Code of Conduct for Responsible Fisheries and various UN Resolutions on impacts from fisheries, NAFO was in need of a more appropriate Convention that would allow the organisation to address fisheries within an ecosystem context. In 2005, NAFO commenced the process of amending its Convention to reflect the application of an ecosystem approach to fisheries. The amended Convention (NAFO, 2007) was adopted by NAFO in 2007, and by July 2016 had been ratified by seven of twelve Contracting Parties. Two more ratifications are required for the amended Convention to enter into force. In 2008, NAFO adopted a resolution that permits the organization to apply an ecosystem approach to fisheries prior to the ratification of the amended Convention (NAFO, 2008).

The amended Convention establishes, in Article II, that "the objective of this Convention is to ensure the long-term conservation and sustainable use of the fishery resources in the Convention Area and, in so doing, to safeguard the marine ecosystems in which these resources are found.", and in Article III (General Principles) that "in giving effect to the objective of this Convention, Contracting Parties individually or collectively, as appropriate, shall: ... (d) take due account of the impact of fishing activities on other species and marine ecosystems and in doing so, adopt measures to minimize harmful impact on living resources and marine ecosystems; (e) take due account of the need to preserve marine biological diversity; ...". This provides the necessary framework for NAFO to act within the requirements of modern fisheries management.

Mandate

The Northwest Atlantic Fisheries Organisation (NAFO), founded in 1979, is the regional fisheries management organization (RFMO) responsible for the management and conservation of the fisheries resources of the northwest Atlantic Ocean. Currently, NAFO has 12 members (Canada, Cuba, Denmark, France, Iceland, Japan, Norway, Republic of Korea, Russian Federation, Ukraine, the United States of America, and the European Union, which represents several fishing nations).

The NAFO Convention Area includes Baffin Bay and the Davis Strait, and stretches south to the latitude of Cape Hatteras at 35°N and east to the 42°W meridian, slightly to the east of the southern tip of Greenland in the mid-Atlantic. The NRA is that part of the Convention area that lies beyond the ABNJ (Figure 10). For purposes of fisheries statistics, it is also defined as FAO Statistical Area 21.

Regulatory capacity

Management of the fisheries in Newfoundland started in the 1880s, with hatcheries to supplement commercial stocks (mainly cod). In 1919, minimum mesh sizes for cod traps were introduced (Baker *et al*., 1992; Halliday and Pinhorn, 1996); closed areas were used to minimize gear conflicts, and in the 1920s and 1930s a limit was placed on the number of trawlers. ICNAF was established in 1949 with the purpose of the "investigation, protection and conservation of the fisheries of the northwest Atlantic Ocean, in order to make possible the maintenance of a maximum sustained catch from those fisheries" (ICNAF, 1951), thus introducing the concept of sustainable use of fishery resources into the northwest Atlantic. ICNAF's primary duties were the collection of fisheries statistics, their subsequent use in assessing the status of

FIGURE 10
Northwest Atlantic Ocean showing NAFO convention and regulatory areas

fish stocks, and the development of management regulations for sustainable fisheries. ICNAF started with effort control and technical measures, and later introduced measures to manage stock size and protect certain life history stages. In the 1970s, ICNAF introduced TAC limits and quotas for some target fish stocks. However, in keeping with ICNAF's mandate, all measures were directed at the target fish species.

When NAFO replaced ICNAF in 1979, its regulatory capacity was confined to waters beyond the 200 nm national EEZs. It covered both stocks within this regulatory area and some straddling stocks, but fish stocks and species wholly within the EEZs of coastal States are not regulated by NAFO. NAFO's main task is still the development of measures to ensure sustainable fisheries; however, since about 2000, it has given increased importance to the interactions between fisheries and the ecosystems occupied by the target fish stocks.

NAFO has adopted resolutions designed to guide the work of the organisation and its Contracting Parties in implementing the precautionary approach (1999), reducing sea turtle mortality (2006), interpreting and implementing the future Convention (2008), and urging other international organisations to protect VMEs from activities other than fishing (2012).

NAFO's fishery regulation measures are published annually in a compendium of the NAFO Conservation and Enforcement Measures (NCEM). This document contains all currently applicable regulations, including quotas, closed areas, limits on gear types and mesh sizes, inspection and reporting requirements, and data confidentiality issues.

Structure

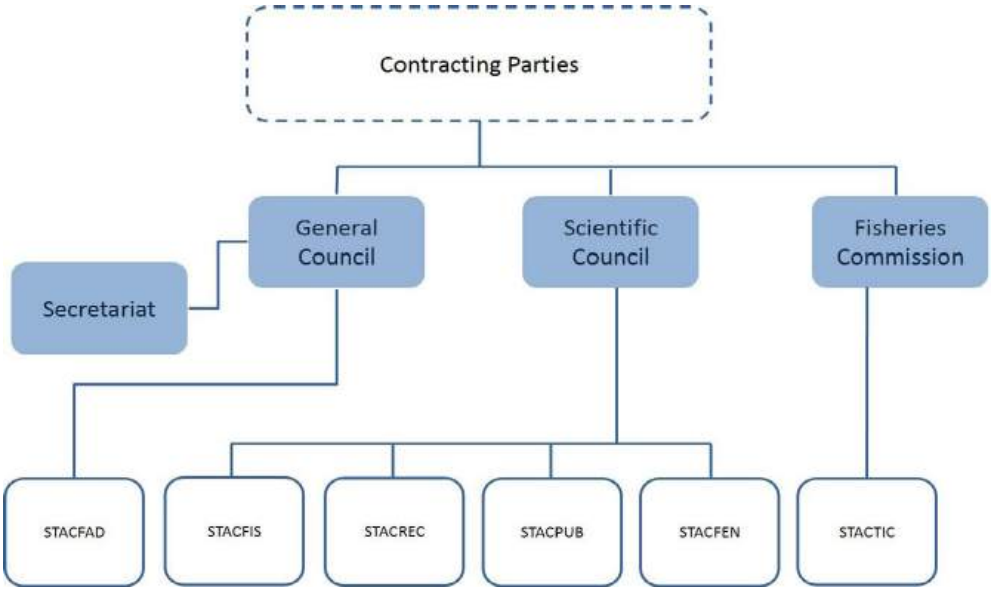
The organizational structure of NAFO (Figure 11) is laid down in the Convention, and currently consists of a General Council, a Scientific Council, and a Fisheries Commission, each made up of representatives of Contracting Parties. Once the amended Convention enters into force, the General Council and Fisheries Commission will combine to form a single new body called the Commission. Any of these bodies can form committees and subcommittees to carry out specific duties and functions; there are currently six Standing Committees and a number of working groups. Generally speaking, the General Council deals with decisions relating to the administration of the organisation; the Scientific Council provides scientific advice and furthers scientific knowledge relating to the fish stocks, fisheries, and associated ecosystems; and the Fisheries Commission develops and adopts regulatory measures for controlling the fisheries. There is a Secretariat, based in Nova Scotia, Canada, to support the work of the organisation.

In September 2007, the Scientific Council created a Working Group on an Ecosystem Approach to Fisheries Management (WGEAFM), and recruited suitable participants from amongst the Contracting Parties to attend the first meeting held in May 2008. This working group meets annually and provides scientific information and assessments on VMEs to Scientific Council. In 2013, this working group changed its name to the Working Group on Ecosystem Science and Assessment (WGESA) to avoid confusion with a new joint working group of the Scientific Council and Fisheries Commision which has a similar acronym.

In September 2007, a joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC) was formed. The WGDEC meets annually during the February–March period.

In 2008, the Fisheries Commission established the Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems (WGFMS-VME) to assist it in its work on VMEs; this group also meets annually. Subsequently a joint Fisheries Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management (FC-SC WGEAFFM) was established, also consisting of both fisheries managers and scientists, and with terms of reference that include proposals for

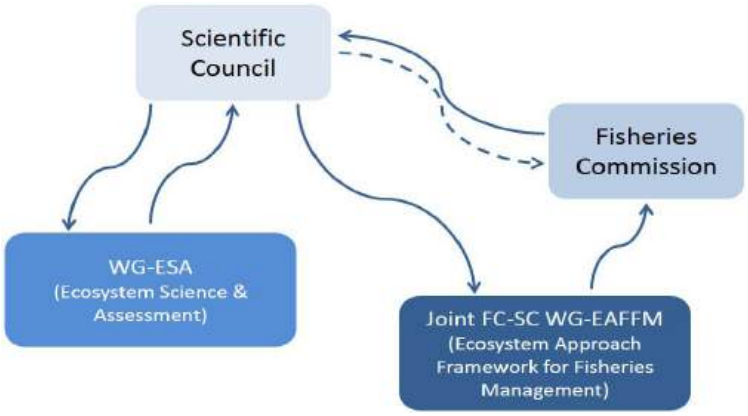
FIGURE 11
Organizational structure of NAFO under the current Convention



STACFAD: Standing Committee on Finance and Administration; STACFIS: Standing Committee on Fisheries Science; STACREC: Standing Committee on Research Coordination; STACPUB: Standing Committee on Publications; STACFEN: Standing Committee on Fisheries Environment; STACTIC: Standing Committee on International Control.

the reduction of significant adverse impacts on VMEs (Figure 12). This group held its first meeting in July 2014. The group is still chaired by representatives of both Fisheries Commission and Scientific Council. On top of the broadening of the remit of the group to include consideration of the wider ecosystem, the main procedural change is that the views of Scientific Council are now formally represented by the Scientific Council Chair during round table discussions on management recommendations.

FIGURE 12
Flow of information related to VMEs within the current NAFO organizational structure



Decision process

NAFO operates under a formal system of communication between the Fisheries Commission and the Scientific Council that governs the flow of information between these two bodies. Under normal circumstances, the Fisheries Commission, at its annual

meeting, usually in September, develops and adopts "Requests for Scientific Advice on Management", and includes these as an appendix to the report of its meeting. The requests may be recurrent, as happens for most of the targeted fish stocks requiring annual or multi-annual assessments, as a result of following the direction of an agreed timetable resulting from the the high-level objectives of NAFO's "Roadmap to an Ecosystem Approach to Fisheries Management", as happens for most of the VME work, or on an ad hoc basis. The Scientific Council will normally start the necessary intersessional work to address these requests soon after the annual meeting, often organized through working groups, and produces a report for review at the Scientific Council meeting in June of the following year. The Scientific Council formulates its advice at that meeting, and includes in its report a section addressing each Fisheries Commission "Request for Scientific Advice", with the background to the advice and the advice itself, usually in the form of a "Recommendation".

For matters relating to VME protection measures, the WGEAFFM, chaired jointly by representatives of the Scientific Council and Fisheries Commission, provides a forum for representatives of both bodies to work in a less formal setting, considering the scientific advice and discussing nuanced issues, and revert back to a delegation structure for the formulation of recommendations to the Fisheries Commission.

The Contracting Parties review these recommendations prior to the annual meeting of the Fisheries Commission in September, and either individually, bilaterally, or multilaterally, develop proposals for the Fisheries Commission to act on, based on the Scientific Council's recommendations or on any other information that the Fisheries Commission may have. The recommendations and proposals are discussed by the Fisheries Commission at its annual meeting, and, if appropriate, amendments to the NCEM are adopted.

Scientific Council meets concurrently with the Fisheries Commission at the NAFO Annual meeting in September. It is normal for the Fisheries Commission, during its annual meeting, to ask for further immediate guidance from the Scientific Council to help its deliberations. Typically, the Scientific Council can only address issues of clarification, and more substantial questions are included in the Fisheries Commission's "Requests for Scientific Advice" for more complete answers the following year.

It has also been common for the Fisheries Commission and Scientific Council to hold special intersessional meetings on more urgent matters, especially when dealing with VMEs that have required substantial work against tight deadlines.

Relationships with other bodies

NAFO works collaboratively with NEAFC, its counterpart in the northeast Atlantic Ocean. Recently these RFMOs formed a joint advisory group on data management and agreed to a joint Deployment Plan to coordinate control and inspection activities. NAFO also collaborates with the FAO, alongside other RFMOs, in diverse areas such as data management and reporting (Fisheries Global Information System, FIGIS), the coordination of fisheries statistics (Coordinating Working Party on Fishery Statistics, CWP), the development of a VME DataBase, and the curation of biobliographic information on marine sciences (Aquatic Sciences and Fisheries Abstracts, ASFA).

NAFO has a long standing relationship with the International Council for the Exploration of the Seas (ICES) and in addition to the joint working group on VMEs has other joint working groups for stock assessments. Further, NAFO has collaborated in a number of symposia over the years with both ICES and its Pacific counterpart, the North Pacific Marine Science Organization (PICES).

In 2014, NAFO's Scientific Council supported the attendance of a participant at the 2014 CBD workshop, which proposed ecologically and biologically significant areas in ABNJ in the northwest Atlantic region. In 2014, a regional seas body, the Sargasso Sea

Commission, was established by the governments of the Azores, Bermuda, Monaco, United Kingdom and United States of America. This Commission aims to "encourage and facilitate voluntary collaboration toward the conservation of the Sargasso Sea." The Sargasso Sea Commission is now an observer to NAFO, and requests for advice in respect of fisheries in the part of the Sargasso Sea overlapping with the NAFO Convention Area were addressed by NAFO's Scientific Council in 2013.

OVERVIEWS

Bottom fisheries

The Grand Bank and Georges Bank in the northwest Atlantic Ocean have been favoured fishing grounds for approximately 500 years. NAFO holds catch statistics dating back to 1804 (NAFO, 2015; Reilly, 2014).

The fisheries of Grand Bank and Flemish Cap started with longlines and later included trap nets. Trawling became widespread in the 1920s and 1930s and has continued to the present day. Today, bottom fishing in the northwest Atlantic is almost exclusively with bottom trawls with varying cod-end mesh sizes, depending upon the target species: prawns and shrimp (minimum mesh size 40 mm), shortfin squid (60 mm), other groundfish (130 mm) and skate (280 mm in the codend and 220 mm in all other parts of the trawl) (NCEM 2015, Article 13). A snow crab (*Chionoecetes opilio*) pot fishery operates on the upper slopes around the edges of the Grand Bank in NAFO Divisions 2J and 3KLNO and extending into international waters. There is also a Canadian hydraulic dredge fishery for surf clam (*Spisula solida*) operating on the southwestern slopes of the Grand Bank. These species are regarded as sedentary, and therefore their assessment and management is the responsibility of Canada.

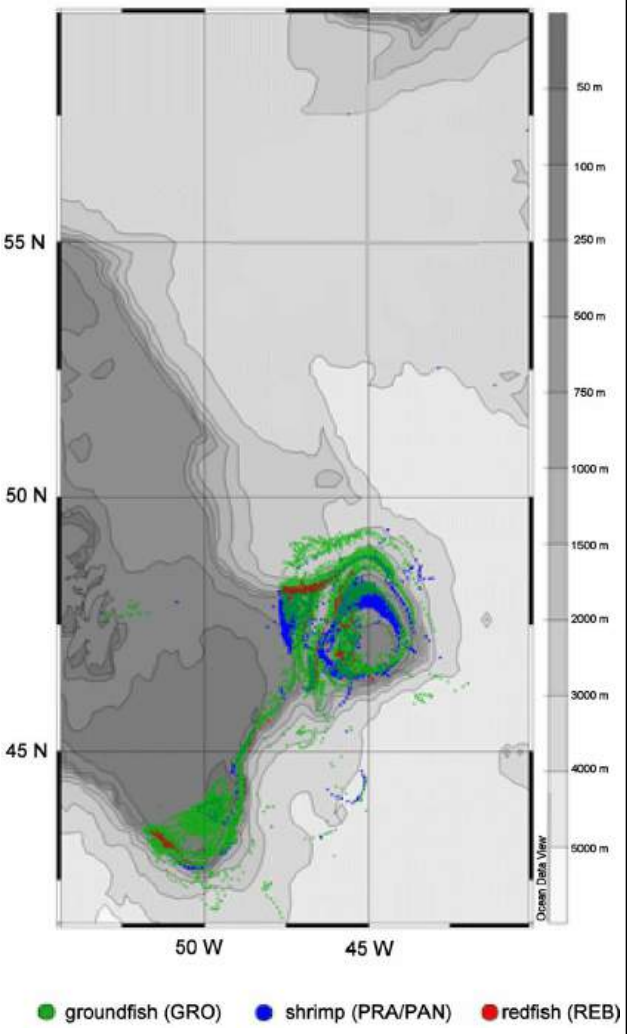
Currently, NAFO assesses eight groundfish species, as well as shrimp and squid, comprising 19 stocks covering mainly the upper slopes on the perimeter of the Grand Bank and Flemish Cap. Demersal fish and shrimp catches are almost all taken with demersal otter trawls. Of the 377 vessels recorded in the NAFO Fleet Registry since 2003, only ten are known to use long-lines, thiry are mid-water trawlers and the remainder use a variety of demersal otter trawl gears (single-rig, multi-rig, pair trawl, etc.). The number of vessels and effort (days) for bottom trawls in the NRA during 2005–2012 are given in Table 5 (NAFO, 2014). Effort has remained fairly constatnt for the groundfish fisheries, however, the effort for the shrip fishery has declined owing to declining shrimp stocks.

The distribution of fishing effort is focused on the upper slopes around the edges of the Grand Bank and Flemish Cap, and within this there is a clear concentration of effort corresponding to the major bottom fishing grounds for groundfish, redfish and shrimp

TABLE 5
Number of vessels, and effort, in days fishing, for groundfish and prawns in the NAFO Regulatory Area, 2005–2012

	Groundfish		Prawns	
Year	No. of vessels	Days in NRA	No. of vessels	Days in NRA
2005	50	6 948	27	3 558
2006	45	5 908	21	1 776
2007	45	4 158	14	1 948
2008	38	3 302	13	1 551
2009	41	4 122	20	889
2010	42	4 170	16	584
2011	47	4 922	8	360
2012	44	5 050	5	250
2013	54	4 510	7	190

FIGURE 13
VMS mid-positions for vessels bottom fishing for groundfish, shrimp, and redfish in 2006



Source: Campanis, 2007 (modified).

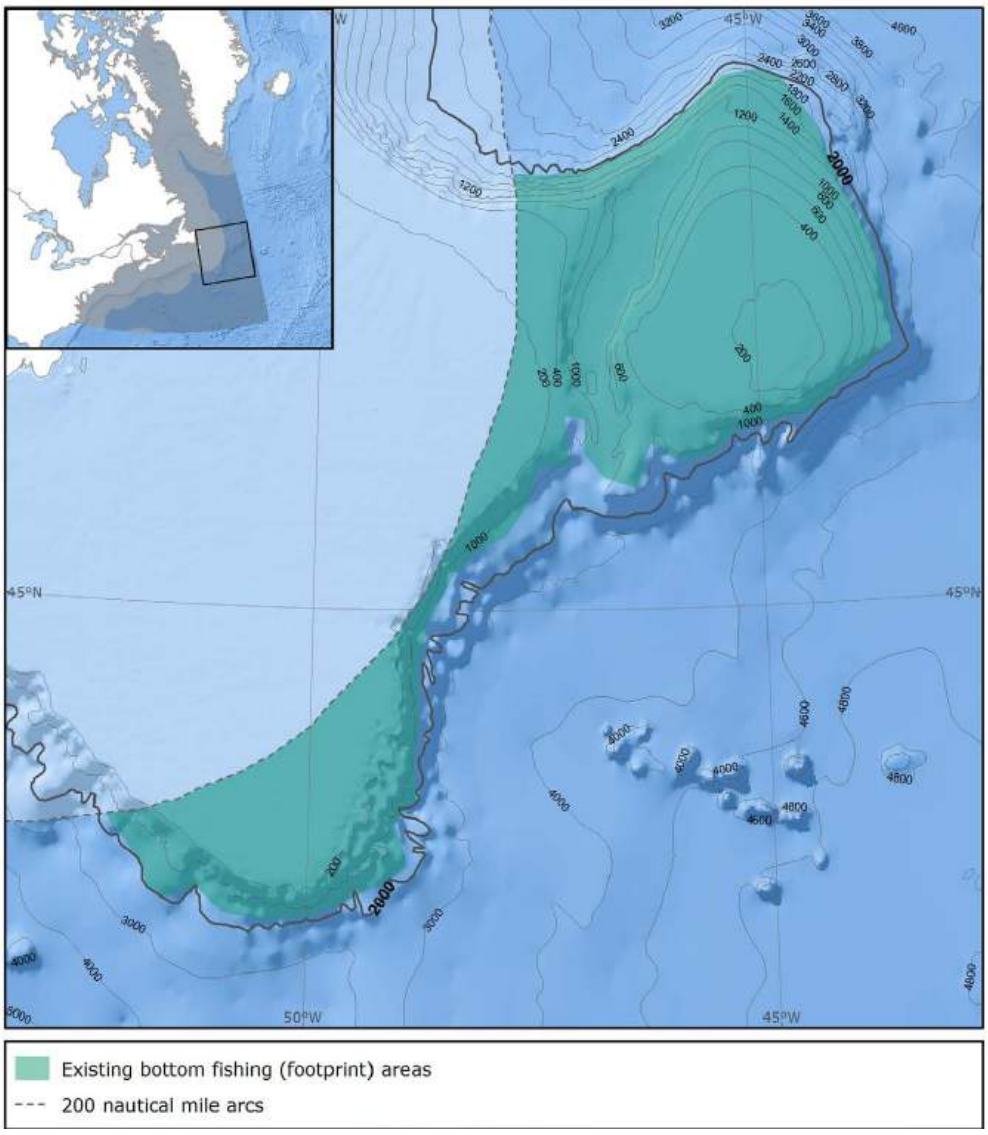
(Figure 13; Campanis, 2007; Campanis *et al.*, 2008). The total area subjected to bottom fishing by all gears combined from 1987–2007 were plotted from data submitted by Contracting Parties and used to delineate a perimeter around the existing fishing areas by fishery. This was determined from an analysis of logbook and VME data for bottom trawling and the process took over two years. The information was provided for all gears combined in various formats, some easier to map than others. Additionally, information on effort was included only in some submissions, and the VMS data used to support the submissions had only been collected since 2003. In the final analysis by the Secretariat, it was generally possible to filter the supplied information to "areas that had been fished twice" but the spatial resolution to do this was somewhat arbitrarily selected, and this affected the extent of the delineated areas (NAFO Secretariat, 2009). The final composite map, for all gears combined, was adopted in 2010 and has not been revised to date (Figure 14; NAFO, 2010, Item 12.1c; NCEM, 2015). A comparison of Figures 13 and 14 shows that there is a wide range of fishing effort within the bottom fishing footprint with most of the area being only lightly fished.

The seamounts in the northwest Atlantic are almost exclusively in the international waters of the NRA, and have been subject to very limited fishing with both bottom and mid-water trawls, although some of these seamounts are probably too deep for commercial bottom trawl fishing. The effort recorded on the Newfoundland and New England seamounts was 5 and 11 days between 2003 and 2007, with long trawl durations, indicating that these were likely mid-water trawls. A fishery for alfonsino (*Beryx splendens*) has developed on the Corner Rise seamounts. The fishery opened in 1976, with catches of 10 200 tonnes, however these declined to 800 tonnes by 1977. Thereafter, catches have been sporadic rising to a few thousand tonnes in some years (Thompson and Campanis, 2007; Vinnochenco, 1997; FAO FishStat, 2015). Catches in this fishery are not regulated by NAFO, and as the gear used is a mid-water trawl, the fishery is not subject to the exploratory protocol. There have been proposals made by NAFO to assess and manage this alfonsino fishery, however no consensus has been reached (NAFO SC, 2014).

Vulnerable marine ecosystems

NAFO began developing protocols for protecting VMEs from possible significant adverse impacts resulting from the use of bottom contact fishing gears as part of its implementation of an ecosystem approach to fisheries management following the adoption of the UNGA Resolution 61/105 in 2006. In January 2007, NAFO closed

FIGURE 14
Current existing bottom fishing area (green) in the NAFO Regulatory Area



four seamount areas to bottom trawling as a precautionary measure. Early fishing, and benthic surveys undertaken in the 1970s by Russia provided much of the historical seamount information used for those decisions. The process was supported by the amended NAFO Convention which broadened the scope of the organization from focussing solely on fisheries, to considering the wider interaction of fisheries and ecosystems.

In 2007, Scientific Council established a Study Group on the Ecosystem Approach. This group first met in the spring of 2008. This group became the Scientific Council WGEAFM, which met annually to provide guidance to Scientific Council on specific ecosystem-related issues and requests from the Fisheries Commission. The group operates within a set of high-level themes and terms of reference, and NAFO's "Roadmap for Developing an Ecosystem Approach to Fisheries", which are being systematically addressed by the group into the future. Their work builds on the findings of the ICES/NAFO deepwater ecology (WGDEC) group and took into consideration the definitions for vulnerable species and habitats.

In 2008, the ad hoc Fisheries Commission WG FMS-VME was established to consult with Scientific Council, and provide recommendations to Fisheries Commission. In 2013, this group was superseded by the joint Fisheries Commission-Scientific Council WGEAFFM that will report to both Fisheries Commission and Scientific Council. As a first step, closures to bottom fishing were implemented on seamounts and in an area along the continental slope of the southern Grand Bank, straddling the Canadian EEZ to bottom trawling to protect coral (3O Coral Closure). Furthermore, an exploratory protocol for fishing in new fishing areas, and a requirement to report encounters with VME indicator species above an adopted threshold level to the Secretariat were introduced, although many of the concepts involved were poorly identified. In 2013, this working group changed its name to the WGESA.

The outcome of extensive work done by WGEAFM and WGESA were changes to the NAFO Conservation and Enforcement Measures to prohibit bottom fishing in a number of areas where VME indicator species were known to occur in high densities in order to protect the biodiversity of these places. Initially, four seamount areas were closed in 2007 as a precautionary measure, and Parties were asked to submit their benthic survey data. Extensive data sets from Canadian Government fisheries surveys, the European Union's survey of the Flemish Cap, and the EU-Spain 3NO survey, supplemented in the 1970s by Russia and subsequently by the Spanish-led multinational NAFO Potential Vulnerable Marine Ecosystems-Impacts of Deep-sea Fisheries (NEREIDA) project cruises in 2008–2010. These cruises were used to determine initial distributions of corals and sponges in the NRA and multibeam bathymetric data. Early fishing and benthic surveys conducted through NEREIDA led to the identification of VME elements in the NRA. Over 500 invertebrate taxa collected in the surveys were screened against the FAO Deep-sea Fisheries Guidelines (FAO, 2009) to produce a list of seven VME indicator groups (large and small gorgonian corals, sea pens, deep-sea sponges, stalked tunicates, bryozoans and crinoids), each containing a suite of related species that are listed in the NCEMs. Survey data were subjected to analyses to identify significant concentrations of VME indicators, and species distribution models, incorporating environmental data were prepared. Identification guides for corals and sponges were created to improve the reporting of VME indicators on surveys and on commercial vessels. These are being updated to include all of the VME indicator groups.

In recent years, encounter thresholds for sponges and corals were scientifically determined using the known locations of the VME and their depth, and the biodiversity function of the extensive sponge grounds on Flemish Cap was verified. More recently, ecological interactions between cod, redfish and shrimps and comprehensive lists of VME indicator species and VME elements have all been discussed by the group. NAFO currently has defined 18 VME areas on seamounts, slopes and canyons that contain the most significant concentrations of corals and sponges in the NRA, and these are closed to fishing with bottom contact gears. The list of VME species and elements has also been updated (NCEM, 2015).

In June 2014, the Scientific Council undertook a comprehensive review of the closures to protect benthic habitats (NAFO SC, 2014). The VME indicator species and VME elements are listed and described for each closure, along with maps showing tracks of fishing vessels near the closed areas. The Scientific Council report also advised that two areas on the eastern slopes of the Flemish Cap be considered as VMEs based on the occurence of sea pens. This advice was reviewed first by the Fisheries Commission-Scientific Council WGEAFFM in July 2014, and then by the Fisheries Commission in September 2014. The Fisheries Commission extended the existing closures until 2020, with some modifications to boundaries to reflect improved information on the distribution of VME indicator species, and defined a new closed area near Beothuk Knoll.

REGULATIONS AND MEASURES

Bottom fishing areas

The Fisheries Commission, at its special session in April-May 2008, adopted a new Chapter (Chapter 1bis) for the 2008 NCEM which defined "existing bottom fishing areas" as those areas where VMS data and/or other available geo-reference data indicate that bottom fishing activities have been conducted in at least two years during the 1987–2007 period (Figure 14). "New bottom fishing areas" were defined as all other areas within the NRA which are not defined as existing bottom fishing areas. The bottom fishing area definitions cited above were amended in the 2012 NCEM to coincide with the adopted footprint such that existing bottom fishing areas were within the footprint and new bottom fishing areas outside of it.

Exploratory fishing protocols

In 2008, NAFO adopted a protocol for exploratory fishing in new bottom fishing areas described above, which were implemented in 2009. Exploratory fishing, or"exploratory bottom fishing activities", is defined as bottom fishing activities conducted in (a) new bottom fishing areas, or (b) in existing bottom fishing areas, but with significant changes to the conduct or in the technology used (NCEM 2015, Article 15.4). Before any exploratory fishing could be conducted, a plan and an assessment of any anticipated impacts must be submitted advance to NAFO for review. If the plan was approved, the exploratory fishing would be permitted for two years, during which it would be closely monitored, with all vessels involved in exploratory fisheries required to carry a scientific observer. A further review would then be conducted, and a decision taken as to the future of the exploratory fishery. This protocol was rolled over from 2009–2011, but with more details in the annexes on the information required in the plan and for recording information, including an Exploratory Fishery Data Collection form added in 2010. There have been slight modifications and clarifications leading to revisions in the 2012–2015 NCEMs. The management of exploratory fisheries in 2015, based on advice and recommendations from the Scientific Council and FC-SC WGEAFFM, will include:

a) allowing, prohibiting or restricting bottom fishing activities;
b) requiring specific mitigation measures for bottom fishing activities;
c) allowing, prohibiting or restricting bottom fishing with certain gear types, or changes in gear design and/or deployment; and
d) any other relevant requirements or restrictions to prevent significant adverse impacts to vulnerable marine ecosystems (NCEM, 2015, Article 20).

Vulnerable marine ecosystems

NAFO has been proactive in identifying areas that may or do contain benthic organisms, consistent with the criteria set out in the FAO Deep-Sea Fisheries Guidelines for VMEs (FAO, 2009). The first action occurred in 2005, when the Fisheries Commission sent a request to the Scientific Council to study certain seamounts in more detail; these were subsequently closed in 2007. During 2008–2014, there have been regular reviews of areas that do or may contain VMEs, and new areas have been closed to protect VMEs, and reviewed almost annually. To date, no closed areas have been opened.

The Scientific Council has approved a novel approach for operationalising the term "significant concentration" of VME indicators within the NRA, as referenced in the FAO Deep-sea Fisheries Guidelines. In NAFO's interpretation of the guidelines, vulnerability is related to the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and the likelihood that it would recover and in what time frame. When identifying VMEs, the guidelines indicate that species groups, communities, habitats, and features often display characteristics consistent with possible VMEs, but state that the presence of an

element itself is not sufficient to identify a VME. This has two related and important implications: firstly, the full spatial distribution of a species that meet the VME criteria does not constitute a VME; secondly, VMEs must possess a level of organization larger than the scale of a singular or individual presence.

This approach allowed for objective identification of VMEs based on biological criteria (aggregative properties), consistent with the identification of structure-forming habitats. NEREIDA research on sponge grounds has confirmed that these habitats are areas of increased biodiversity. At its meeting in June 2013, the Scientific Council stated "that management through the closing of areas with significant concentrations of VME indicator species is the most effective measure for protecting VMEs in the NRA and that the need to implement encounter protocols gradually becomes redundant as the locations of the benthic VMEs becomes increasingly well-defined. This avoids issues associated with the implementation of complex move-on rules." (NAFO SC, 2013, VII.1.c.v).

NAFO has endorsed the use of quantitative modelling to determine VMEs. The primary tool used to quantitatively determine VMEs is kernel density analysis (Kenchington *et al.*, 2014). This analysis identifies "hotspots" in the biomass distribution derived from research vessel trawl survey data, by looking at natural breaks in the spatial distribution associated with changes in local density. These natural breaks allow defining of significant area polygons. The Scientific Council has stated that this method delineates areas of VMEs according to the definition, however, also recognized that the method has limited spatial resolution regarding the delineation of borders for the VME areas, and that if this method is used as a basis for making management decisions, depth contours, type of substrate, current and temperature fields, etc. should be taken into account. The general locations given by the kernel method is NAFO's current best approach to determining the VME. Black corals are not considered a VME indicator species in NAFO, due to the requirement to possess a level of organization above the individual. Species which meet the uniqueness/rarity criterion in the FAO Deep-sea Fisheries Guidelines have not yet been identified. NAFO conducted a full review of closures in 2014, and harmonized the measures relating to them.

Encounter protocols

The encounter provisions set out the rules for the actions to be taken by vessels and vessel masters upon encountering catches of VME indicator species above the threshold levels. NAFO first established an encounter protocol in 2007 for fishing permitted within the four areas closed to bottom fishing. Any encounters with hard corals would trigger a notification to the Executive Secretary and an immediate closure pending review by the Fisheries Commission at its next annual meeting. This was rolled over until 2011 when threshold levels for encounters were defined. In 2008, the first encounter protocol relating to areas open to fishing was adopted, which required vessels to cease bottom fishing activities and report the encounter to the Executive Secretary, so that "appropriate measures can be adopted". This measure was refined in 2009, when "existing" and "new" bottom fishing areas were implemented, with stricter rules in the new fishing areas. In both types of area, the catch of VME indicator species, i.e. corals and sponges, must be recorded. In existing fishing areas, catches above the threshold must be reported, and the vessel is required to move at least 2 nm away. These encounters are reported to the Fisheries Commission and Scientific Council for any appropriate actions required. In new fishing areas, the process is the same, except that the encounter results in a temporary closure of 2 nm radius. This encounter protocol has, with some modifications in wording, been rolled over each year to 2015. There were some changes to the way in which the temporary closures outside the footprint are notified, and this is now the responsibility of the Contracting Parties.

The Scientific Council has provided the Fisheries Commission with scientifically-based encounter thresholds and "move-on" rules. Essentially, in the NAFO regulatory area these relate to predicted commercial catches in the VMEs and to movement out of the VMEs, using information on their known spatial distribution, including depth. These values and criteria are scientifically defensible but become very complicated when dealing with multiple VME types and fisheries which are prosecuted over relatively small areas. For this reason NAFO has favoured closed areas within its fishing footprint and surrounding waters along the continental slope of the Flemish Cap and Grand Bank.

Vulnerable marine ecosystem indicators

The list of organisms used by NAFO to indicate the presence of VMEs has evolved since it was first proposed in response to more detailed requests from Fisheries Commission to Scientific Council for scientific advice. Initial focus was on coral and sponges but later requests included all VME indictors and prompted an expansion of the list to include other species that met the definitions provided by the FAO (FAO, 2009).

The NCEMs adopted in 2007 and 2008 were the first to indicate that corals were an important component of VMEs, as information on corals identified in the closed areas must be reported to the Secretariat. In 2009, the Fisheries Commission adopted its provisions for interim encounters, with "indicator species of coral identified as antipatharians, gorgonians, cerianthid anemone fields, lophelia, and sea pen fields or other VME elements" (Article 5bis), with the note that an encounter with these indicators was not sufficient to identify a VME. This was rolled over to 2010 and 2011. In 2012, sponges that constitute sponge grounds or aggregations were added to the list (NCEM, 2012, Article 15.6). In 2013, the definitions of these terms were both clarified and expanded, to include both "VME indicator species" for biota (67 species listed in Annex I.E.VI) and "VME elements" for physical features (five elements listed in Annex I.E.VII). Also, antipatharians were removed from the list, since the NEREIDA surveys indicate that they are sparsely but widely distributed, and crinoids, erect bryozoans and sea squirts were added. This has been carried through to the 2015 measures.

Thresholds

It is necessary to define a threshold, or minimum catch, in order to implement the required actions by commercial fishing vessels when encountering evidence of potential VMEs. In the beginning, these thresholds were chosen somewhat arbitrarily by the Fisheries Commission, but were refined in 2013 after the Scientific Council addressed the issue. The threshold values for 2009–2015, expressed as catch of live VME indicator taxa per set (e.g. trawl tow, longline set, or gillnet set) (Table 6).

TABLE 6
Thresholds adopted by NAFO for catches of VME indicator species

Year (NCEM)	Corals	Sponges	Seapens
2009	100 kg	1 000 kg	-
2010–2011	60 kg	800 kg	-
2012	60 kg	400 kg (new fishing area) 600 kg (existing fishing area)	-
2013–2015	60 kg	300 kg (all areas)	7 kg

Impact assessments

Impact assessments (assessments to determine whether deep-sea fisheries are having significant adverse impacts on VMEs) are called for under UNGA Resolution 61/105 (Paragraph 83a), and are expanded upon in the FAO Deep-Sea Fisheries Guidelines

(Paragraphs 47, 49, 51, 52, and 83). Since 2008, NAFO has had the following requirements for a preliminary assessment: "Any Contracting Party proposing to participate in exploratory bottom fishing activities shall submit, in support of their proposal, a preliminary assessment of the known and anticipated impacts of the bottom fishing activity which will be exercised by the vessels flying its flag on VMEs" (NCEM, 2008, Article 19.1). Such assessments are reviewed by the Scientific Council, which seeks further assessments if deemed necessary. These assessments will be ongoing in exploratory fisheries through the "Exploratory Bottom Fishing Trip reports" (NCEM, 2015, Article 21).

Assessments are also required in the case of encounters with VME indicator species in all fishing areas. These assessments also review any temporary closures that have resulted from such an encounter in new fishing areas.

Observers

Since 2007, when NAFO adopted its first seamount closures, the regulations regarding observers have remained effectively unchanged. Vessels fishing commercially in the NRA are required to carry a compliance observer at all times, except for vessels with a functional VMS capable of sending electronic observer and catch reports, which may apply to carry an observer for only 25 percent of the time spent in the NRA. In practice, as fishing trips in the NAFO regulatory area are typically long and vessels may only make a single trip per year, this derogation has not been used. Any vessel undertaking exploratory fishing is required to carry an additional scientific observer, or, as worded in the 2015 NCEM (Article 22.2b), an observer with sufficient scientific expertise to identify corals, sponges, and other organisms to the lowest possible taxonomic level, and deliver the results to the vessel master.

Scientific research

The administrations of NAFO Contracting Parties whose vessels engage in scientific research in the NAFO regulatory area are required to notify the Secretariat of their research plan in advance of any operations. NAFO has a standing committee of Scientific Council which oversees research survey design and coordination (STACREC). Standardized survey series extend back to the 1960s and their consistency is critical in the assessment in certain stocks where catch data is considered unreliable. At present, vessels engaged in scientific research are exempt from NAFO's conservation and management measures, namely mesh size, size restrictions, closed areas and closed seasons. Large catches of VME indicator species (up to 10 tonnes of sponges in a single haul) have been recorded by research vessels fishing within closed areas. This inconsistency has been recognized by NAFO, and since 2013 Fisheries Commission has made a number of requests for Scientific Council to explore ways in which VME closed areas can be incorporated into fishery survey design without compromising the integrity of the data obtained.

Review procedures

Benthic deep-sea areas that may require protection from certain bottom fisheries are formally identified by the Fisheries Commission when measures are applied to them. NAFO classifies its protected bottom areas as Seamount Closures, 3O Coral Area Closure, and High Sponge and Coral Concentration Area Closures. The review procedures for these areas are typically included in the NCEMs themselves, and usually take the form of "The measures referred to in Article [xx] shall be reviewed in 20[xx] by the Fisheries Commission, taking account of the advice from the Scientific Council ...". This is to ensure that any current measures are consistent with the current requirements, which of course change over time. Measures were reviewed in 2014, however no date was agreed for the next review. The duration of the closure is usually

between one and five years. NAFO has no permanent closures to protect bottom habitats; the closure periods adopted in 2014 have all been synchronized, and the areas are closed to bottom fishing activities from 2015 to 2020.

The review decision by the Fisheries Commission depends on new information provided and the advice given by the Scientific Council on the risk of significant adverse impacts. Such impacts are dependent upon fishing gears and methods of deployment, and these can change over time. Up to 2014, the Fisheries Commission has either rolled over the measures, extended existing area boundaries, or closed new areas to bottom fishing.

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

NAFO adopted its first closures in 2007 with four seamount areas. It then adopted a trans-boundary closure in 2008 with the support of Canada to protect corals. NAFO has adopted various additional colosues to protect benthic habitats, especially around the slopes of the Grand Bank and Flemish Cap. As of 2015, there are 18 areas that are closed to bottom fishing to protect known or likely VMEs (Table 7, Figure 15). NAFO classifies its protected bottom areas as Seamount Closures, 3O Coral Area Closure, and High Sponge and Coral Concentration Area Closures. There are also other measures that help to protect known and likely VMEs including the identification of existing and

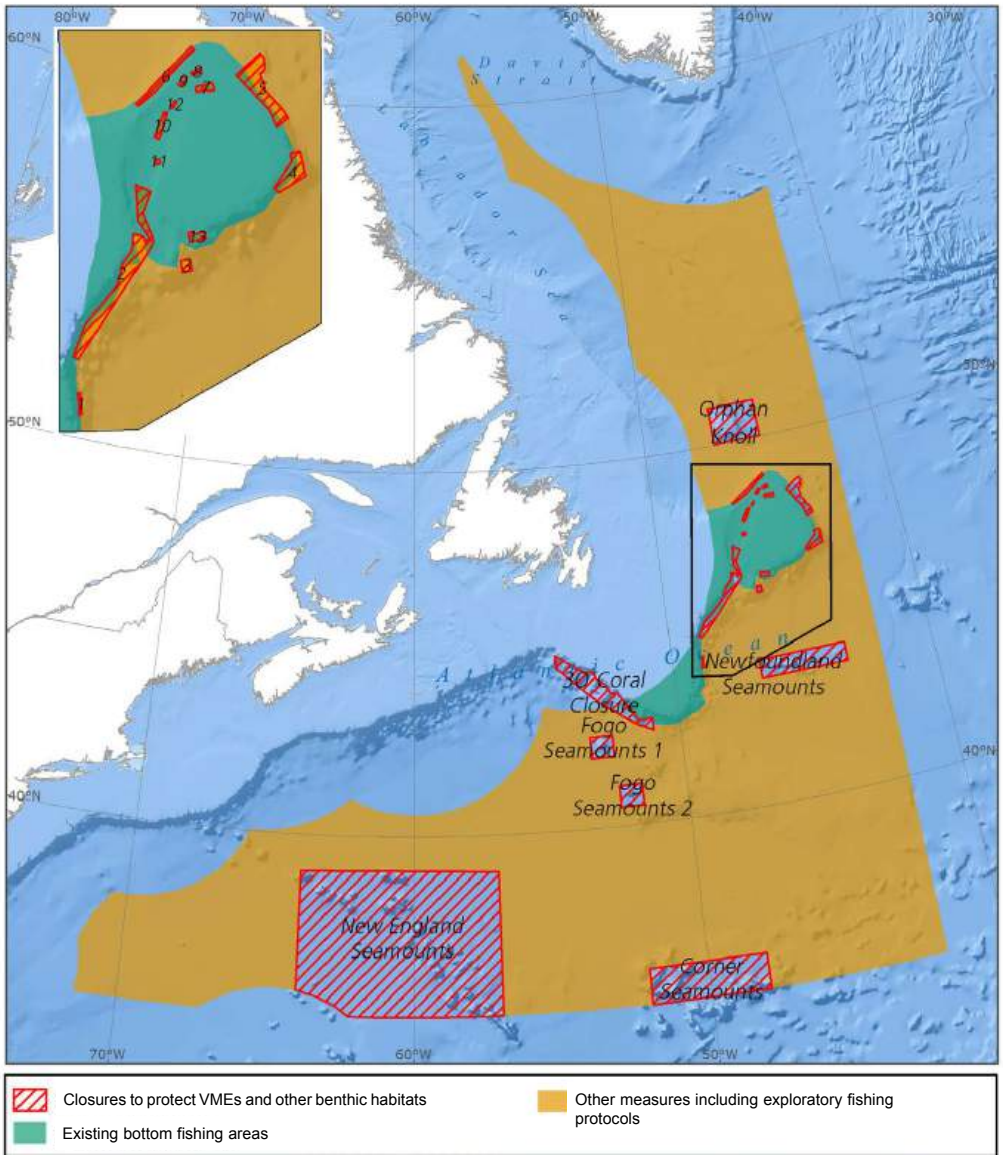
TABLE 7
Bottom fishing areas closed by adopted NAFO measures for 2006-2020

Area name	VME inside closure and concerns[1]	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015–2020
3O Coral Closure	Seapens, Gorgonians, Cerianthids		(A)	C	C	C	C	C(R)	C	C(R)	C
Beothuk Knoll 3	Sponges, large Gorgonians				(A)	C	C(R)	C	C	C(R)	C
Beothuk Knoll 13	Knoll									(A)	C
Corner Seamounts	Seamount	(A)	C	C	C	C(R)	C	C	C	C(R)	C
Eastern Flemish Cap 4	Sponge, large Gorgonians, Cerianthids				(A)	C	C(R)	C	C	C(R,B)	C1
Flemish Pass/Eastern Canyon 2	Sponge & large Gorgonians with sea pens in the northern part				(A)	C	C(R)	C	C(B)	C1(R)	C1
Fogo Seamounts 1	Seamount				C(A)	C(R)	C	C	C	C(R)	C
Fogo Seamounts 2	Seamount				C(A)	C(R)	C	C	C	C(R)	C
New England Seamounts	Seamount	(A)	C	C	C	C(R)	C	C	C	C(R,B)	C1
Newfoundland Seamounts	Seamount	(A)	C	C	C	C(R)	C	C	C	C(R)	C
Northeast Flemish Cap 5	Sponge				(A)	C	C(R,B)	C1	C1	C1(R)	C1
Northern Flemish Cap 7	Sea pen system				(A)	C	C(R)	C	C(B)	C1(R)	C1
Northern Flemish Cap 8	Sea pen system				(A)	C	C(R)	C	C(B)	C1(R)	C1
Northern Flemish Cap 9	Sea pen system				(A)	C	C(R)	C	C	C(R)	C
Northwest Flemish Cap 10	Sea pen system				(A)	C	C(R)	C	C(B)	C1(R)	C1
Northwest Flemish Cap 11	Sea pen system				(A)	C	C(R)	C	C	C(R)	C
Northwest Flemish Cap 12	Sea pen system								(A)	C(R)	C
Orphan Knoll	Knoll	(A)	C	C	C	C(R)	C	C	C	C(R)	C
Sackville Spur 6	Sponge				(A)	C	C(R)	C	C	C(R)	C
Tail of the Bank 1	Sponge				(A)	C	C(R)	C	C	C(R)	C

C = Area closed to bottom fishing, C1 represents a boundary change.
(A) = Measure adopted for first closure
(B) = Boundary change adopted
(R) = Area/measure reviewed
(1) = NAFO SC Report, June 2014: p. 51

FIGURE 15

Current areas closed by NAFO to bottom fishing to avoid significant adverse impacts on VMEs and other benthic habitats. Encounter protocols apply throughout the NAFO Regulatory Area (see Table 7 for key to closed areas around the Flemish Cap)



new fishing areas and measures associated with encounter protocols and exploratory fishing, that have been developed and adopted since 2006 (Figure 16).

SURVEYS

Annual surveys are undertaken by the Department of Fisheries and Oceans of Canada (Labrador and Newfoundland region) and the European Union (Portugal and Spain) to collect information on the status of the target species. Since 2000, these surveys have recorded bycatches of invertebrates and other species (Table 8), and have formed the basis for the Scientific Council's scientific advice. The surveys follow depth-stratified random sampling designs, and provide information for the whole of the NRA.

FIGURE 16
The evolution of spatial measures adopted by NAFO to protect VMEs and other benthic habitats. See Figure 15 for key

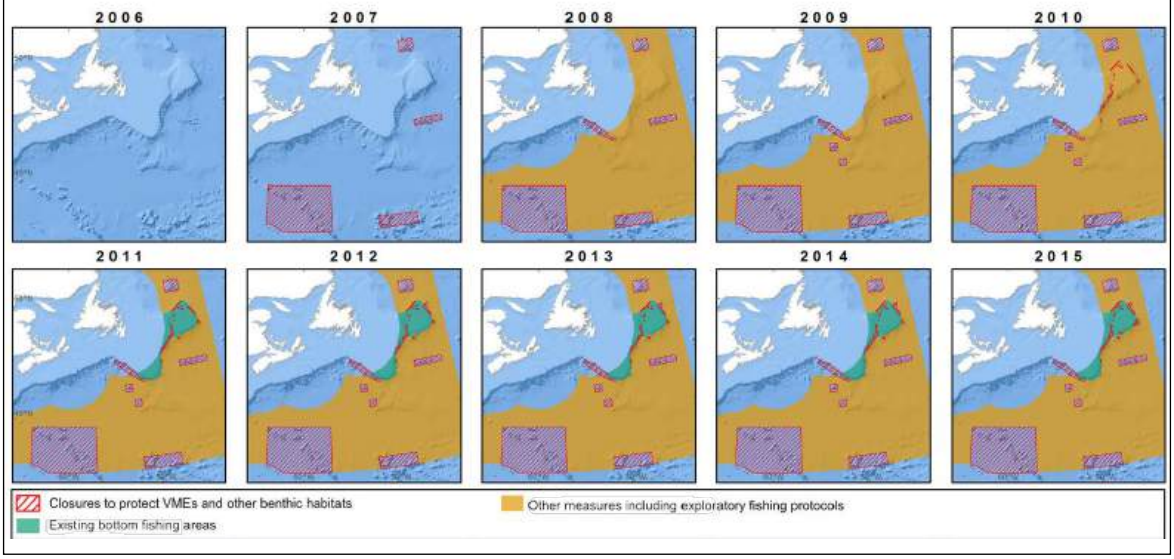


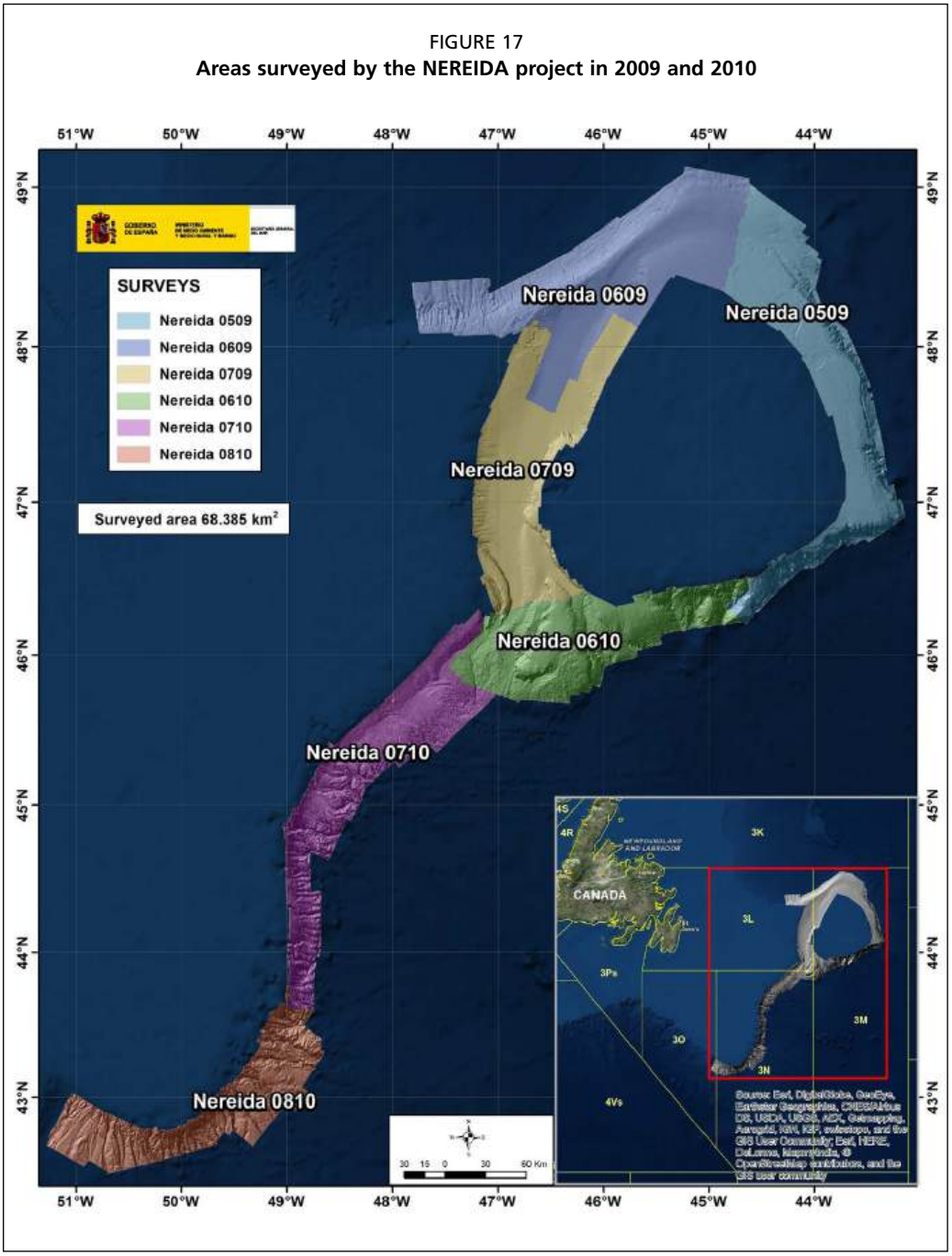
TABLE 8
Example research surveys in the NAFO Regulatory Area that collect data on VMEs

Survey name	Lead organization	NAFO divisions	Data type	Comment	Report (if available)
Spanish 3NO Survey	Instituto Español de Oceanografía, Vigo, Spain	3NO	Trawl bycatch	Annual survey	Yellowtail flounder, redfish (*Sebastes* spp.), and witch flounder indices http://archive.nafo.int/open/sc/2014/scr14-006.pdf Greenland halibut, American plaice, and Atlantic cod http://archive.nafo.int/open/sc/2014/scr14-005.pdf
EU Flemish Cap Survey	Instituto Español de Oceanografía, Vigo, Spain; Instituto de Investigaciones Marinas; Instituto Português do Mar e da Atmosfera	3M	Trawl bycatch	Annual survey	Groundfish assemblages on Flemish Cap http://archive.nafo.int/open/sc/2014/scr14-009.pdf
Spanish 3L Survey	Instituto Español de Oceanografía, Vigo, Spain	3L	Trawl bycatch	Annual survey	Results of the Spanish survey in NRA, Division 3L, 2003–2013 - http://archive.nafo.int/open/sc/2014/scr14-012.pdf
DFO NL Multispecies Surveys	Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada	3LNO	Trawl bycatch	Semi-Annual survey	2014 assessment of northern shrimp - http://archive.nafo.int/open/sc/2014/scr14-048.pdf Assessment of thorny skate - http://archive.nafo.int/open/sc/2014/scr14-023.pdf
Benthic Surveys	Bedford Institute of Oceanography, Fisheries and Oceans Canada	NRA	Underwater imagery, grab samples, project-specific sampling tools	Regular surveys with a targeted research focus	
NEREIDA	Spain, Canada, United Kingdom, Russian Federation	NRA	Multibeam bathymetry, box corer samples, benthic dredge samples	2009-2010 multidisciplinary surveys targeting VME areas in the NRA	www.nafo.int/science/nereida.html

The most recent extensive benthic survey of the NRA is the NEREIDA project, which in six separate cruises mapped the slopes around the Grand Bank and Flemish Cap, using a variety of sampling gears including multibeam sonar, underwater camera systems, and cores (NEREIDA, 2015). This nondestructive sampling is the most extensive conducted in the NRA, and covered areas that are typically not visited by commercial fishing vessels or research vessels undertaking stock assessment surveys. The surveys, which took place in 2009 and 2010, covered the area between the 700-2 000 m isobaths in the high seas around the Flemish Cap and Grand Bank (Figure 17). The results are being analysed, and are reported in the NAFO Scientific Reports and peer-reviewed publications.

The NAFO Secretariat maintains an inventory of biological surveys undertaken and planned in the Northwest Atlantic (NAFO, 2015) and these are reported annually in the Scientific Council Summary (SCS) document series.

FIGURE 17
Areas surveyed by the NEREIDA project in 2009 and 2010



OTHER INFORMATION

Reported encounters

Despite having encounter threshold provisions since 2009, no encounters above the threshold in place have been reported. Given the known locations of the VMEs in the fishing footprint, and the location of the fishing activity, this is not unexpected and Scientific Council have demonstrated this.

Exploratory fisheries

There have been no formal applications to start an exploratory fishery using bottom-contact fishing gears. An experimental survey using both mid-water and bottom trawl was conducted in 2012 on the Kükenthal Peak within the Corner Rise seamount complex (NAFO SCR 15/18; NAFO SC 2015, p. 79-80). This was not further developed into an application for an exploratory fishery under the NAFO exploratory fishing protocol.

Coral and sponge identification guides

NAFO first identified and listed the common deepwater corals and sponges in the 2008 WGEAFM report (NAFO WGEAFM, 2008), and then developed coral and sponge identification guides in 2009 and 2010, respectively (Best *et al.*, 2010; Kenchington *et al.*, 2015). These were designed for use aboard commercial and research vessels by observers and scientists. They are not taxonomic keys, but will identify the species most likely to be caught that are of importance to the identification of VMEs. The keys are taken to the level where the identifications can be made by a non-expert. Many coral and sponges require microscopic examination to determine species.

Data sharing protocols

NAFO has considered but not implemented formal data sharing protocols for scientific data. Data sharing is achieved at various levels within NAFO, and not all of the protocols are relevant to VMEs.

The Convention states, in Article VI (Functions of the Scientific Council), that "The Contracting Parties shall furnish to the Scientific Council any available statistical and scientific information requested by the Council for the purpose of this Article." Historically, this has been taken to mean commercial fisheries catch information and the associated biological and hydrographic data used for fisheries stock assessments. This is reinforced in the 2006–2014 NCEMs under "Reporting of Catches and Effort", which frame the requirement to provide statistics annually to NAFO through the STATLANT (2015) reporting system. The information in the fishing logbooks or observer reports is usually used more for inspection purposes than scientific purposes, though Contracting Parties may release such information to their own scientists. VMS information was initially considered to be for compliance purposes, but since 2007 this is provided to the Scientific Council in summary form to determine fishing effort on and around vulnerable habitats and for any other NAFO purpose. At a more detailed level, sharing of biological information collected by governments or projects could be useful for the assessments of benthic areas by the Scientific Council or its working groups. In general, members of working groups share information from their own governments, usually in summary form; sharing raw data is less common, and may require formal data-sharing agreements among the parties involved. The NEREIDA project included an intellectual property and data-sharing agreement between Canada and Spain which facilitated the joint research.

Other activities that might impact vulnerable marine ecosystems

In 2014 NAFO began to consider other activities or events which might impact on VMEs. A nonexhaustive list of activities known to be taking place in, or impacting

upon, the NAFO regulatory area includes mining, introduced species, marine litter, microplastics, cable and pipeline laying, transportation, oil and gas exploration and exploitation, defense activities, solid waste dumping, climate change, ocean acidification and eutrophication.

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Eastern Central Atlantic Ocean

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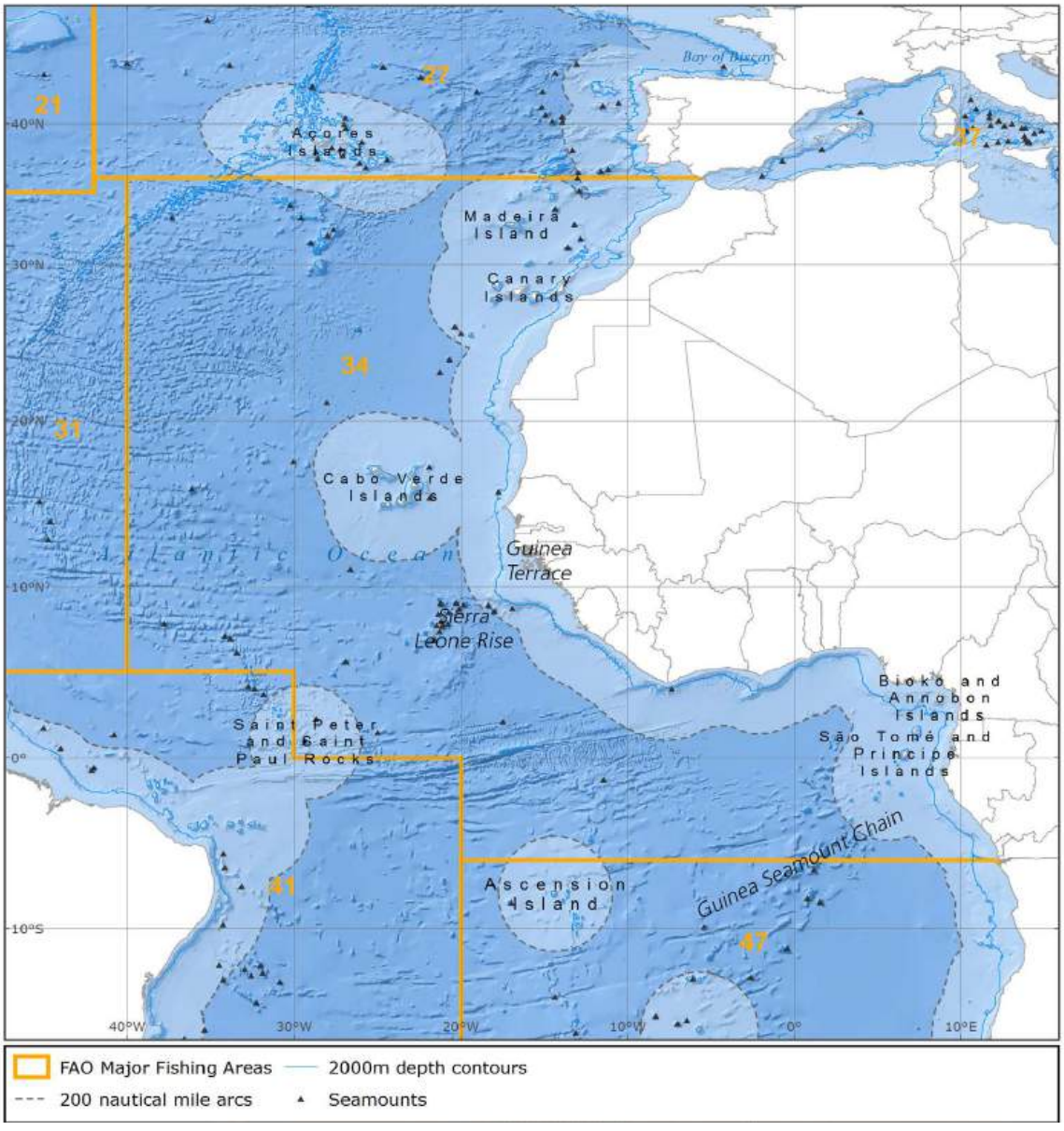
REGIONAL GEOGRAPHY AND BATHYMETRY

The eastern central Atlantic Ocean (Figure 18), defined as FAO Major Fishing Area 34, is bounded to the east by the coastline of continental Africa, 36°N in the north (Cap Spartel, Morocco), 6°S in the south (the mouth of the Congo River, on the Congo-

FIGURE 18
Eastern Central Atlantic Ocean. The map shows the FAO major fishing areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



Angola border), and as far as 40°W to the west, where it reaches the mid-Atlantic Ridge in some places. It encompasses the islands of Annobon and Bioko (Equatorial Guinea), Cabo Verde, the Canary Islands (Spain), Madeira (Portugal), the remote Saint Peter and Saint Paul Archipelago (Brazil), and parts of the Exclusive Economic Zones (EEZs) of the Azores (Portugal) and Ascension Island (United Kingdom) (Figure 18).

In general, the eastern central Atlantic is characterized by a narrow continental shelf that drops off rapidly to deep depths within the EEZs of the African countries. In most of the area, the seabed is very deep, at 5 000-7 000 m, with the main features being the fracture zones running east-west. Its northwestern and southwestern corners just touch the mid-Atlantic Ridge. There are relatively few seamounts in the eastern central Atlantic, and most of them lie within the EEZs of the Azores (Portugal), Cabo Verde, the Canary Islands (Spain), and Madeira (Portugal). There is a chain of seamounts, many of them shallower than 800 m, which extends southwest from the Guinea Terrace, off Guinea-Bissau, into and around the Sierra Leone Rise. To the very southeast of the area lies part of the Guinea Seamount Chain whose seamounts are generally deep though some have summits that are less than 800 m below the surface. There are also seamounts in other areas, such as north of the Ascension Island and along the mid-Atlantic Ridge, but these are also generally deep and many are well below fishable depths. There are several large canyons along the shelf slopes off Mauritania, Senegal and Guinea-Bissau, within EEZs.

FISHERY COMMITTEE FOR THE EASTERN CENTRAL ATLANTIC

Mandate

The Fishery Committee for the Eastern Central Atlantic (CECAF) was established as an FAO Article VI regional fisheries body (RFB) in 1967. Its statutes, particularly the description of the purpose, functions and responsibilities of the Committee, were last amended in October 2003. The purpose of the Committee is to promote the sustainable utilization of the living marine resources within its area of competence by the proper management and development of the fisheries and fishing operations. In recent years, the focus has been primarily to keep under review the state of the fishery resources and the fisheries based on them. This includes, among others, promoting research, data collection and dissemination, monitoring of key resources and fisheries, establishing a scientific basis for management decisions and the formulation of management advice, and training. The area of the Committee is congruent with FAO Major Fishing Area 34 (Figure 19), and covers both the EEZs and high seas. The committee also provides advice on fisheries resources in the northern part of the marine waters off Angola for the purposes of assessing shared stocks. Membership is open to coastal States and States (or entities) whose vessels fish in the area, or that undertake research in the area and contribute to the work of the Committee. Currently there are 34 members, of which 21 are coastal States.

Regulatory capacity

CECAF is an Article VI FAO Body and is, therefore, advisory in nature: it adopts recommendations that are non-binding to its members. The recommendations of the Committee can be integrated into the national fisheries management plans and legislative frameworks of its members. Members can request guidance for various fish species and stocks covered by CECAF from its specific working groups as well as other guidance relevant to CECAF's mandate.

Structure

The Committee, which is composed of all CECAF member States, is the central body in CECAF (Figure 20). Sessions of the Committee should normally be held every two years, although this has not been the case in recent years: prior to its last meeting in

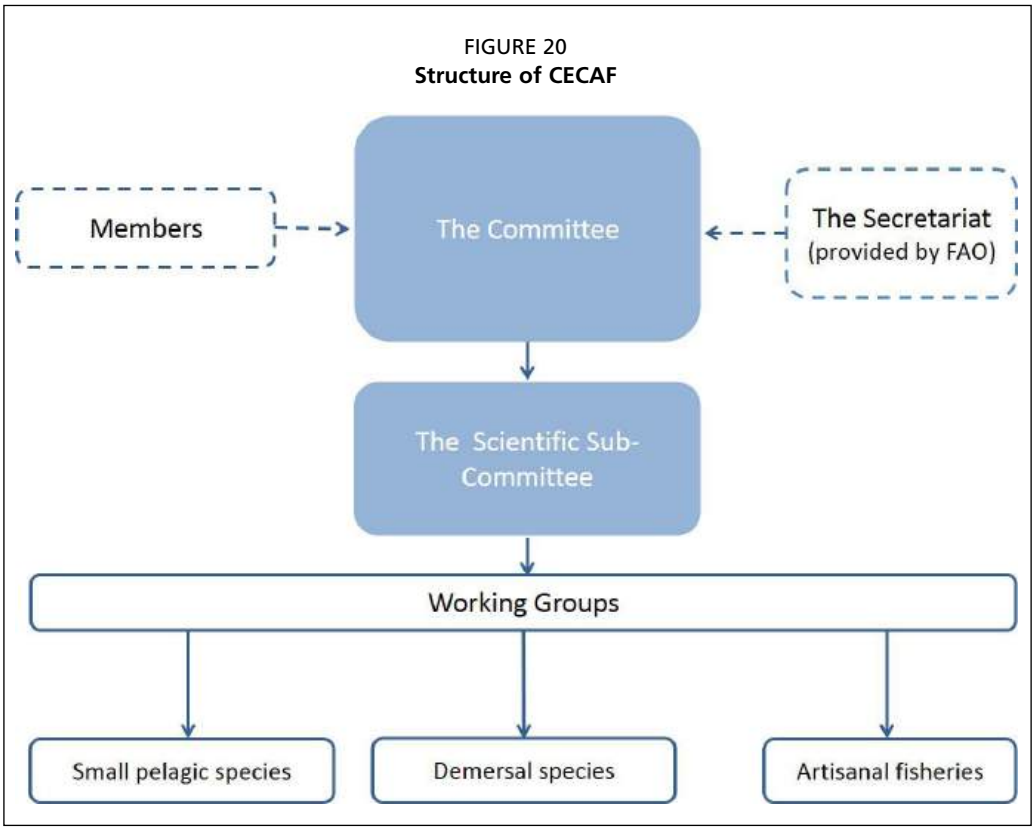
FIGURE 19
CECAF area of application in the eastern central Atlantic Ocean

2016, it had not met since 2012. According to the statutes, decisions of the Committee are taken by a majority of the votes cast, with each member having one vote. However, in practice most decisions are taken by consensus.

In 1998, the Committee established a Scientific Sub-Committee, whose main function is to provide appropriate fisheries management advice to the Committee. The Scientific Sub-Committee, which held its first meeting in 2000, should also meet every two years, in alternate years to the Committee, with the option of holding additional meetings.

In 2000 the Scientific Sub-Committee established three permanent working groups to address small pelagic species, demersal species, and artisanal fisheries. The working groups meet as required, and provided that funding is available. The general objective of the working groups on small pelagic and demersal species is to assess the state of these resources within the CECAF area and make recommendations on fisheries management and exploitation options aimed at ensuring optimal and sustainable use

FIGURE 20
Structure of CECAF



of fish resources for the benefit of coastal countries. While the Committee's mandate extends out into ABNJ, its activities have been concentrated on coastal resources and fisheries.

Decision process

The Committee acts as the forum where members discuss fisheries-related matters of importance to the region, which include recommendations endorsed by the Scientific Sub-Committee and issues such as IUU fishing, and coordination with other bodies, amongst others. Any member can request items to be included on the agenda for a meeting, and during meetings any member may make interventions. The Scientific Sub-Committee reviews the reports of the working groups and endorses, modifies, or otherwise addresses their recommendations, and includes them in its own report, which is then presented to the Committee. The Scientific Sub-Committee also discusses issues relating to data, statistics, information, and reporting, as well as research-related issues, and recommends the programme of work for the working groups

The working groups undertake their assigned programmes of work, which in the case of the pelagic and demersal working groups involves stock assessments and recommendations for management actions. These are documented in their reports and presented to the Scientific Sub-Committee for review.

Relationships with other bodies

FAO hosts the Secretariat of CECAF and provides technical support. The work of CECAF is governed by its own statutes and its members. However, certain items of business must be approved by FAO, such as the selection of members, changes in the statutes, and certain items related to the budget.

Other international maritime bodies operate within the CECAF area. Some of these, such as the International Maritime Organization (IMO), the International Seabed Authority (ISA), the IWC, and the International Commission for the Conservation of

Atlantic Tuna (ICCAT), have the authority to adopt and enforce binding management measures appropriate to their mandates.

There are also several other regional and sub-regional fisheries bodies whose areas of competence fall within or overlap the CECAF area, mainly within EEZs. These include the Sub-regional Fisheries Commission (SRFC), the Fishery Committee for the Western Central Atlantic (FCWC), the Fishery Committee for the Central Gulf of Guinea (COREP), and the Ministerial Conference on Fisheries Cooperation Among African States Bordering the Atlantic Ocean (ATLAFCO). The South East Atlantic Fisheries Organisation (SEAFO) Convention Area borders the CECAF area to the south and a small part of the SEAFO area overlaps with the CECAF area, on the high seas just north of Ascension Island between latitude 6°S and the Equator and longitudes 20°W and 10°W (for more information on SEAFO, see the Southeast Atlantic Ocean chapter).

OVERVIEWS

Bottom fisheries

Given the limited extent of deep-sea fisheries on the high seas of the CECAF area, there is normally little information related to these fisheries in the CECAF reports. There are, however, deepwater fisheries for hake, shrimp and other species within the EEZs. Catches of over 100 tonnes of alfonsino (*Beryx splendens*), a fish typical of seamounts and ridges, have been reported to FAO in recent years by the Republic of Korea, the Russian Federation, and Spain, with lower catches by Lithuania, Poland, and Portugal. It is possible that some of the catches by vessels from the European Union are from within EEZs, but the other countries likely represent high-seas catches (the Republic of Korea reported on such catches in 2012). Annual catches of 2 000-6 000 tonnes of black scabbardfish (*Aphanopus carbo*) from this area have been reported by Portugal, and the species is quite widely distributed in the CECAF area.

An experimental longline fishery for alfonsino (*B. splendens*) conducted by the Spanish Oceanographic Institute (IEO) on the high seas of the eastern central Atlantic Ocean, on four seamounts in the Sierra Leone Rise in 2001, showed catches of around 207 tonnes for the study period. Fishing depths ranged from 200 m to 987 m (Salmerón *et al*., 2015). The account provides no information on the benthic habitats fished.

Vulnerable marine ecosystems

Most of the high seas region of the CECAF area is very deep, with only its northwestern and southwestern corners over the mid-Atlantic Ridge, and some other seamount areas being within fishable depth. There has been no discussion in CECAF relating to the identification of VMEs within the eastern central Atlantic Ocean until very recently. Deep-sea fisheries and VMEs were discussed at the seventh meeting of the Scientific Sub-Committee in 2015, and at the 21st session of CECAF in April 2016 (FAO, 2016 a and b).

In 2011, SEAFO closed an area in the central Atlantic Ocean, which overlaps with a small area of CECAF's competence area, to bottom fishing to protect likely VMEs on four seamounts with recorded depths between 1 294 m and 1 749 m (Figure 21; NOAA, 2015). These seamounts appear to be relatively unknown: there have been no benthic surveys in the area, and it is believed that there has not been any fishing on these seamounts (SEAFO, 2010).

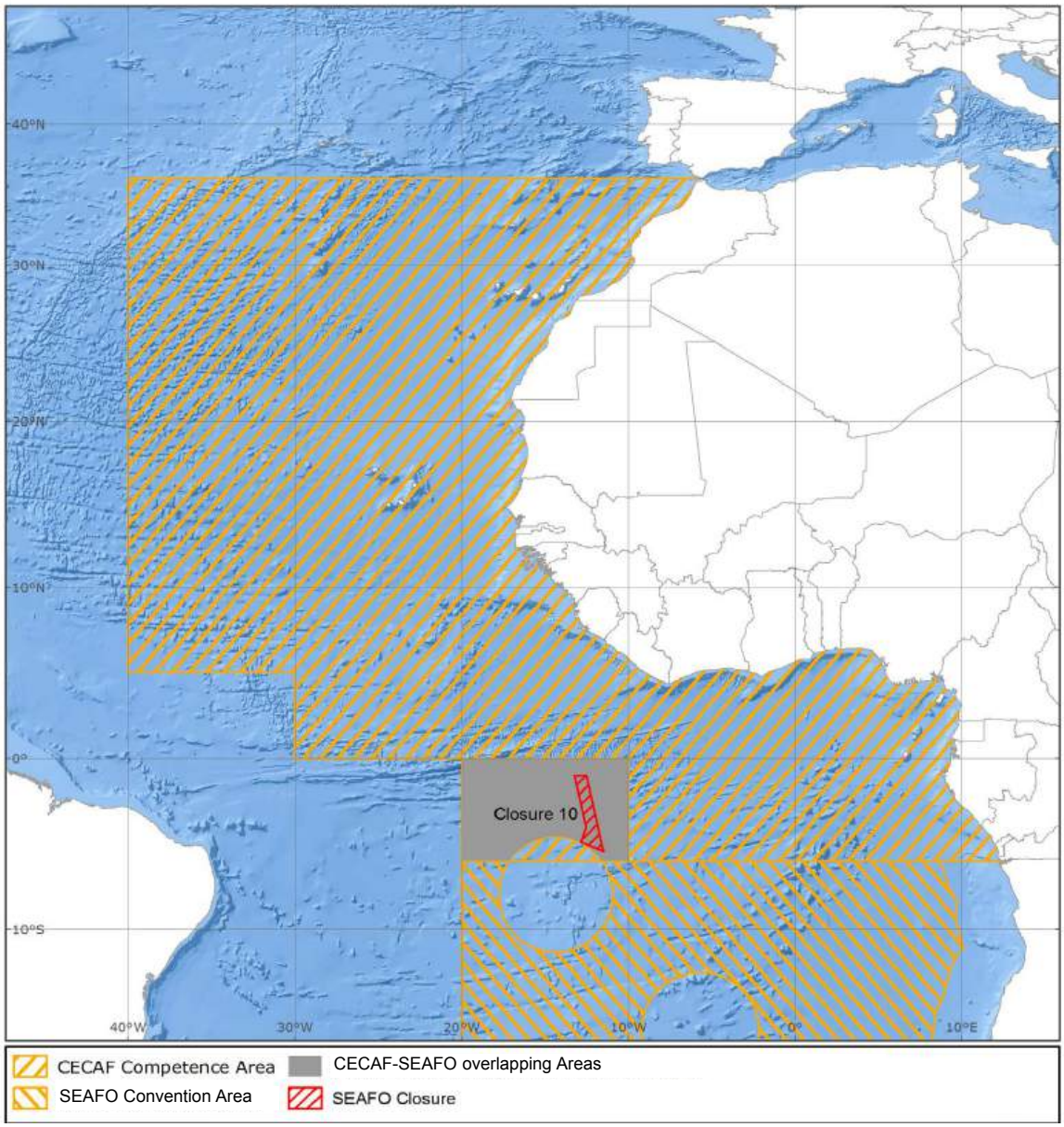
REGULATIONS AND MEASURES

Vulnerable marine ecosystems

At its 21st session in April 2016, the Committee recommended that the members of CECAF should respect the SEAFO VME closures in the overlapping area of competence (FAO, 2016b).

FIGURE 21

The overlap between the southern part of the CECAF area of application and the northern part of the SEAFO Convention Area in the eastern central Atlantic Ocean (in grey). The location of closure adopted by SEAFO in 2011 to protect likely VMEs on seamounts (in red)



Other regulations that also protect benthic areas

CECAF has no other regulations in effect that could lead to enhanced protection of benthic areas on the high seas.

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

Apart from the area closed to bottom fishing in the overlapping jurisdiction of SEAFO and CECAF (Figure 21), there are no other areas in CECAF that are closed to protect VMEs.

SURVEYS

There appear to have been few deepwater high seas surveys relevant to the identification of VMEs. Some surveys using underwater cameras were carried out on high seas seamounts in the southern Azores region (Pakhorukov, 2008) and the Sierra Leone Rise (1999), but they were mainly focused on fish species. There have been a number of surveys within EEZs, for example, in the deeper waters of Mauritania and off the southwest coast from Sierra Leone to Ghana (Martos and Jiménez, 1991).

OTHER INFORMATION

There is no other information for the high seas area to report at this stage.

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Western Central Atlantic Ocean

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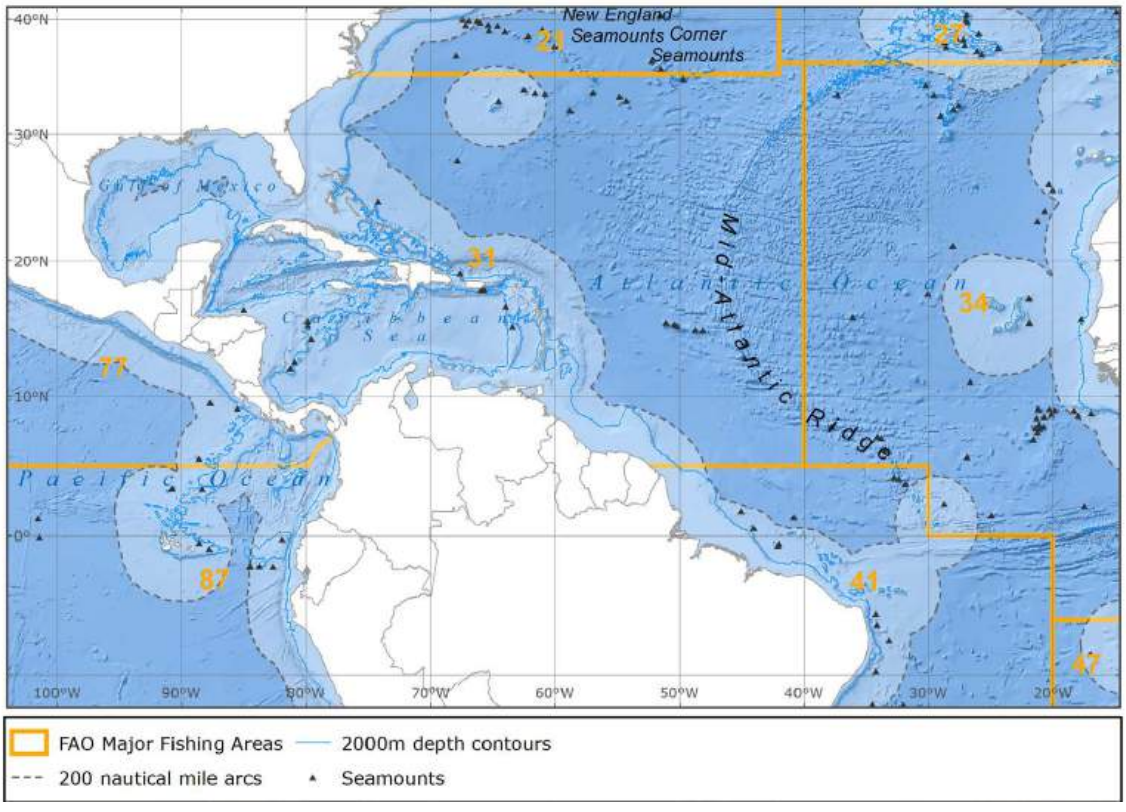
REGIONAL GEOGRAPHY AND BATHYMETRY

The western central Atlantic Ocean is covered by FAO Major Fishing Area 31, and extends north to Cape Hatteras (35°–36°N) and south to Cayenne, French Guiana (5°N). It is bounded on the western side by the coast of North and South America, and extends east to the centre of the Atlantic Ocean (40°W). The area is not further divided (Figure 22).

The region is dominated by the Caribbean Islands, all of which are situated within this area. They contribute to the complex bathymetry of the region, with strong ocean currents and extensive shallow and deep reef systems. There are waters deeper than 200 m in the Gulf of Mexico and the Caribbean Sea, both of which are considered to be under national jurisdiction. Further to the east, in high-seas areas, the seabed descends rapidly to the abyssal plains. The Mid-Atlantic Ridge runs down the eastern edge of the area. There are scattered deep seamounts and ridges towards the northern boundary and east of Bermuda. These comprise the southern extensions of the New England and Corner Rise seamounts, which lie mostly in the northwest Atlantic region. There

FIGURE 22
Map of the western central Atlantic Ocean. The map shows the FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



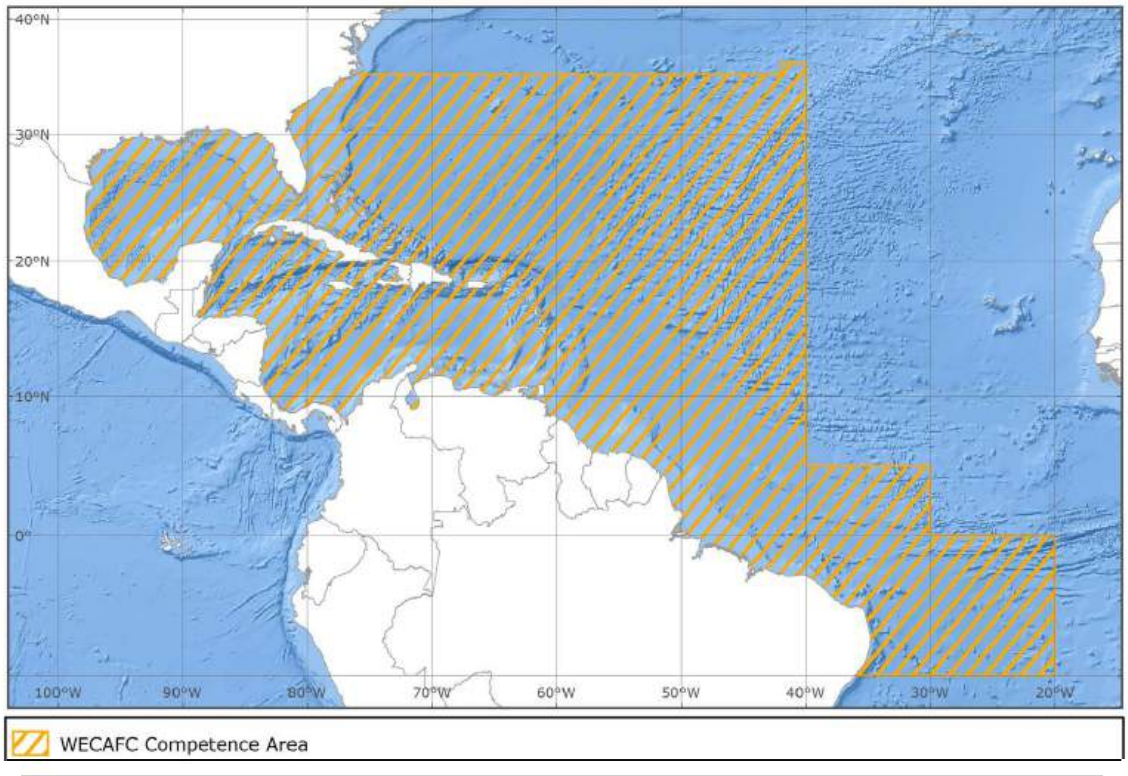
is a small chain of deep seamounts along the Mid-Atlantic Ridge and extending to the southeast corner of the region. This part of the Mid-Atlantic Ridge contains mapped hydrothermal vents.

WESTERN CENTRAL ATLANTIC FISHERY COMMISSION

Mandate

The Western Central Atlantic Fishery Commission (WECAFC) was established in 1973 as a regional fisheries body under Article VI of the constitution of FAO, which means that WECAFC receives financial and technical support from FAO. Its statutes were amended in 1978 and 2006, and its most recent Rules of Procedure were adopted at the 15th session of the Commission in 2014. The Commission has a wide range of duties, covering the promotion of the effective conservation, management, and development of the living marine resources in the Commission's area of competence. This is to be achieved within the framework of responsible fisheries management established by the FAO Code of Conduct for Responsible Fisheries, and can include education, training, technical and management advice, and extension activities. The Commission is also tasked with promoting the harmonisation of relevant national laws and cooperation among all competent institutions. The Commission's area of competence includes all marine waters in FAO Major Fishing Area 31 (western Central Atlantic) and the northern part of FAO Major Fishing Area 41 (southwest Atlantic) (Figure 23). Membership is open to coastal States and States whose vessels fish in the area. Currently there are 34 members (Antigua and Barbuda, Bahamas, Barbados, Belize, Brazil, Colombia, Cuba, Dominica, Dominican Republic, European Union, France, Grenada, Guatemala, Guinea, Guyana, Haiti, Honduras, Jamaica, Japan, Mexico, Netherlands, Nicaragua, Panama, Republic of Korea, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Spain, Suriname, Trinidad and Tobago, United Kingdom, United States of America, and Venezuela).

FIGURE 23
WECAFC Competence area in the western central Atlantic Ocean



Regulatory capacity

WECAFC acts as an advisory body to its members and its resolutions and fisheries management recommendations are non-binding. WECAFC has thus not been given a mandate to set or enforce binding measures. The Commission's resolutions and recommendations are often incorporated by members in their national fisheries management plans and legislative framework. It is then the responsibility of the members to apply them to their respective flag vessels as they deem appropriate. Members can request guidance from various WECAFC species- or fisheries-specific working groups, some of which work jointly with other regional organisations active in the region.

Structure

The principal body is the Commission, which is composed of all members and normally meets every two years.

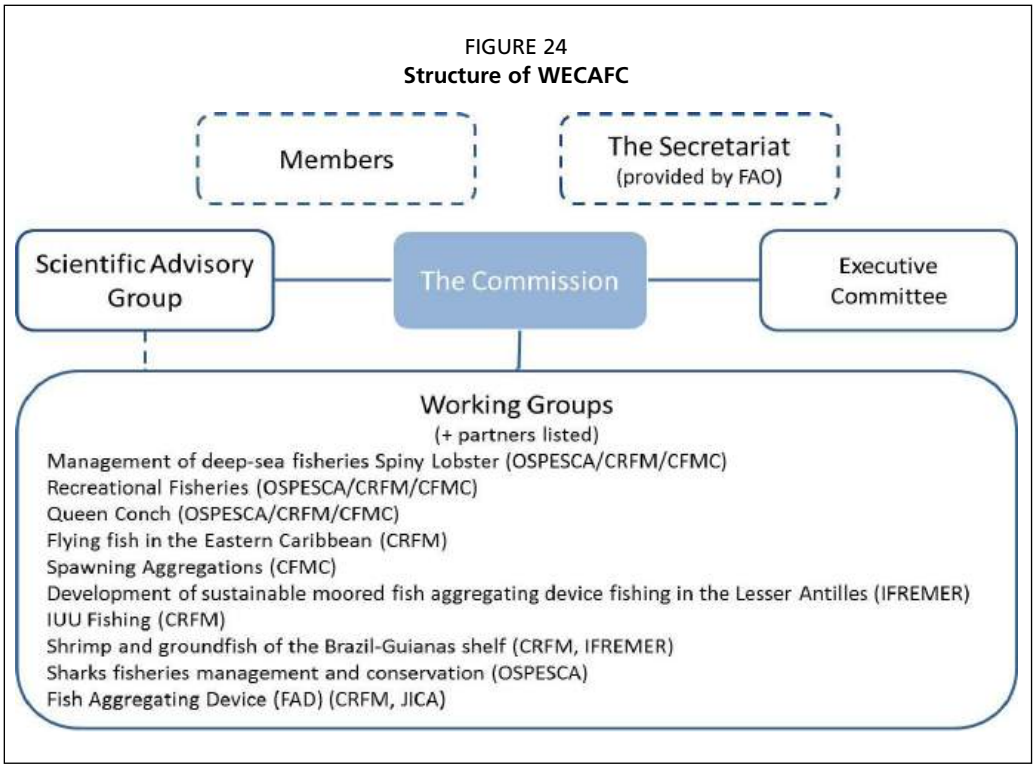
The Scientific Advisory Group (SAG) comprises at least five suitably-qualified scientists, who serve in a personal capacity and advise the Commission on stock status and trends in the fisheries, and also review the recommendations made by the working groups before they are passed to the Commission. The SAG meets before each session of the Commission.

There are currently ten working groups, often operated jointly in partnership with other regional organisations. The only working group relevant to deep-sea fisheries is the WECAFC Working Group on the Management of Deep-Sea Fisheries, which was formed in 2011 and formalized in 2012 by the Commission to inform and provide guidance on responsible fisheries management, the protection of marine biodiversity, and to facilitate the implementation of the FAO Deep-sea Fisheries Guidelines. The first meeting of this group was held in October 2014.

The WECAFC Executive Committee, consisting of the chair and vice-chair of the Commission and the chair of the SAG, also serves to act intersessionally to support the organisation and its meetings. WECAFC also has a Secretariat supported by FAO and based in Christ Church, Barbados.

An organogram of WECAFC is shown in Figure 24.

FIGURE 24
Structure of WECAFC



Decision process

The WECAFC statutes include among the duties of the Commission the requirement to provide to its members support and advice on management measures, their scientific basis, and on monitoring, control and surveillance, of both contained and straddling stocks.

The flow of information among the various bodies starts by the Commission establishing Terms of Reference (ToRs) for its working groups, which then undertake the work necessary to address their ToRs for the next meeting. If appropriate, the Working Group then makes draft recommendations to the Commission. These are normally reviewed by the SAG, and then discussed and, if agreed, adopted by the Commission. Since 2014, these recommendations have been drafted as WECAFC non-binding fisheries management measures. The actual formulation and adoption of binding management measures must be undertaken by the individual member states. However, as mentioned above, WECAFC can provide advice to members on the drafting of measures, and many follow this guidance.

The members of WECAFC can also adopt resolutions. In 2012, the Commission adopted its first resolution, on strengthening the implementation of international fisheries instruments in the Caribbean region and to establish the WECAFC Working Group on the Management of Deep-Sea Fisheries to assist with this. In 2014 five more resolutions followed.

Relationships with other bodies

Since WECAFC is an Article VI FAO body, the principal body it works with is FAO. The work of WECAFC is governed by its statutes and its members. However, certain items of business must be approved by FAO, though this normally only relates to matters that have budgetary or legal implications.

There are other international maritime bodies that operate within the WECAFC area of competence. Some of these, such as the IMO, International Seabed Authority (ISA), IWC, and ICCAT, have the authority to adopt and enforce binding management measures.

There are no formal partnership arrangements or memoranda of understanding between WECAFC and other organisations. However, WECAFC works closely with a number of organisations in its working groups, such as the Caribbean Regional Fisheries Mechanism (CRFM), the Organization of Fisheries for the Central American Isthmus (OSPESCA), the Caribbean Fisheries Management Council (CFMC) of the United States Department of Commerce, the French Research Institute for Exploitation of the Sea (IFREMER), and Japan International Cooperation Agency (JICA).

WECAFC is looking to increase its cooperation with NAFO in order to explore options to coordinate the management of the northern seamount areas to protect known or likely VMEs, and to harmonise measures on deep-sea fisheries (WECAFC, 2016).

OVERVIEWS

Bottom fisheries

Most of the deep-sea fisheries started as shallower inshore fisheries within national EEZs and have progressively expanded into waters more than 200 m deep: this has been observed off Bermuda, Colombia, Dominica and Venezuela. However, the vessels are generally not well adapted for fishing at such depths, and are usually too small to be at sea for extended periods. In contrast, very little is known about the high-seas deep-sea fisheries. The bathymetry indicates that there are few fishable areas; the most likely places are the Corner Rise seamounts on the northern border of FAO Area 31, where splendid alfonsino (*Beryx splendens*), black cardinal fish (*Epigonus telescopus*), black scabbardfish (*Aphanopus carbo*), and wreckfish (*Polyprion americanus*) are found.

There are virtually no statistics on catches of deep-water fish species in the high seas part of the WECAFC area. FAO statistics do not separate out the EEZ and high seas catches. During the 1970s catches of alfonsino, a typical seamount species, were recorded in FAO Area 31; most likely these were from the Corner Rise seamount area, and could have been caught by deep-set pelagic trawls or by bottom trawls. In 1995 and 1996, Russian Federation vessels caught 278 and 15 tonnes, respectively, of alfonsino, and in 1996, Icelandic vessels caught 7 tonnes (FAO, 2015); since then no catches of alfonsino have been recorded in FAO Area 31. The only other catch information available is from Spanish experimental pelagic trawl surveys on the Corner Rise seamounts, which produced low fish catches (Bensch *et al*., 2009).

Vulnerable marine ecosystems

There have been no benthic surveys in the high-seas areas, and the only information available for determining the location of possible VMEs is from an assessment of the bathymetry. The WECAFC Working Group on the Management of Deep-Sea Fisheries met for the first time in 2014 and reviewed the information available for assessing potential VME areas. It identified four seamount areas towards the northern boundary of the WECAFC area of competence and an area along the Mid-Atlantic Ridge where hydrothermal vents are known to occur. The Working Group recommended these five areas as candidate VMEs for consideration by the Commission in 2016. A further area was noted in the south, but more information is required (WECAFC, 2015). The Commission adopted a recommendation identifying the five proposed VME areas (WECAFC, 2016).

REGULATIONS AND MEASURES

In July 2016, WECAFC adopted Recommendation WECAFC/16/2016/4 "on the management of deep sea fisheries in the high seas" to identify five selected and delineated areas that contain or are likely to contain VMEs, and requested that States act accordingly to close these areas to bottom fishing on a temporary basis and subject to review (WECAFC, 2016).

Other regulations that also protect benthic areas

There are no other regulations in effect to protect benthic areas in the high seas of the WECAFC area of competence.

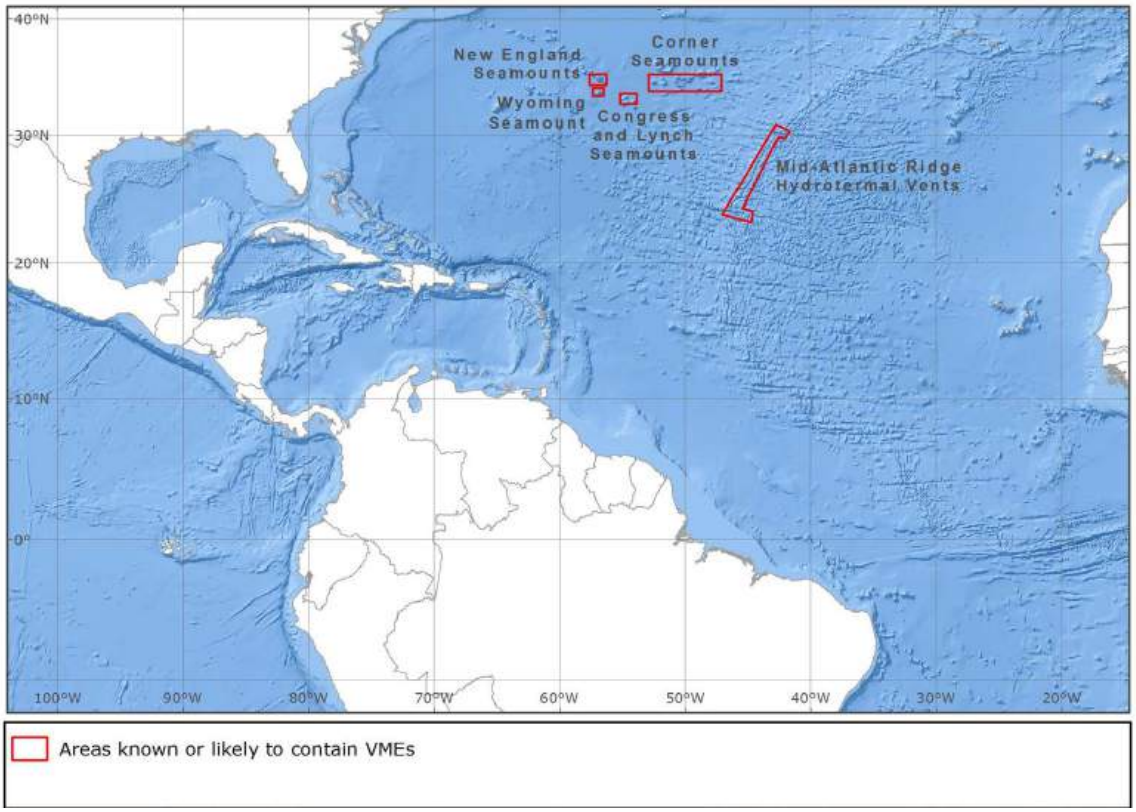
VULNERABLE MARINE ECOSYSTEMS AND OTHER REGULATED AREAS

WECAFC delineated five areas in 2016 that are known or likely to contain VMEs. Four of these were around seamounts and included the Corner Seamounts and New England Seamounts where NAFO has already closed those parts within its regulatory area. The Wyoming Seamount and Congress Seamount were also delineated. The fifth area was along the Mid-Atlantic Ridge and is known to contain active hydrothermal vents (Figure 25; WECAFC, 2016).

SURVEYS

No deep-water high-seas surveys have been recorded relevant to the identification of VMEs. WECAFC, in order to increase the knowledge base, has requested that members develop data and information collection programmes and undertake surveys on deep-sea fisheries and VMEs. This includes requests for fishing vessels to submit plans for exploratory fisheries and catch and effort statistics for established fisheries (WECAFC, 2016).

FIGURE 25
Areas adopted by WECAFC in 2016 to protect benthic habitats that are known or likely to contain VMEs



OTHER INFORMATION

Other activities that may have impacts on VMEs

At present, the risks of significant adverse impacts on any VMEs are low, given that there is little or no deep-sea fishing in the area. However, WECAFC has been informed of concessions granted by ISA for exploratory deep-sea mining on the Mid-Atlantic Ridge in the WECAFC area of competence. There could be conflicts in the future between the interests of the mining and fisheries sectors, but this is of limited concern to most WECAFC members at present.

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Southwest Atlantic Ocean

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REGIONAL GEOGRAPHY AND BATHYMETRY

For the purposes of this chapter, the southwest Atlantic Ocean is defined by the boundaries of FAO Major Fishing Area 41. It is bounded to the west by French Guiana, Brazil, Uruguay, and Argentina and, except in the north and south, extends eastwards to the 20°W meridian (Figure 26). The largest island group in the southwest Atlantic are the Falkland Islands (Islas Malvinas). Other smaller islands include Trindade and Martim Vaz, Rocas Atoll and Fernando de Noronha, all situated off the coast of Brazil at distances of 130–600 nm from the mainland. Brazil's remote Saint Peter and Saint Paul Archipelago lies just beyond the northeastern border of the southwest Atlantic.

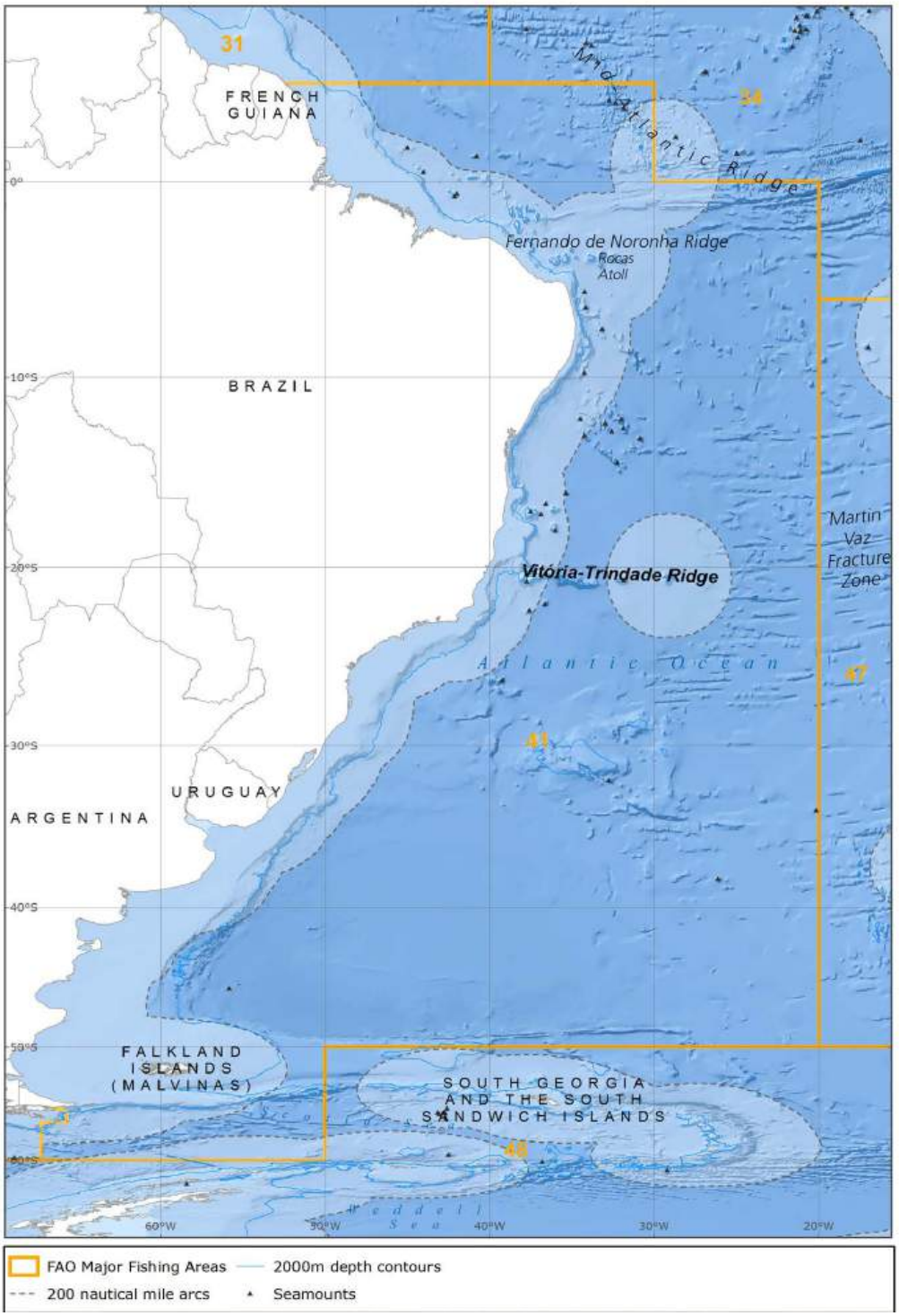
The continental shelf extending into the Atlantic off the southern half of Brazil and Argentina is from 150 to 250 nm wide. It reaches its greatest width at the southern end of Argentina, where it and the Falkland Island Plateau extend eastward around the Falkland Islands (Islas Malvinas) and toward South Georgia. The Mid-Atlantic Ridge just touches the north-western corner of the southwest Atlantic, so the whole area is on the South American tectonic plate. There are therefore no extensive trenches and ridges, although on the eastern edge there are the fracture zones extending out from the Mid-Atlantic Ridge. The water is generally very deep, between 4 500 and 7 000 m in almost all of the area. There are seamounts off central Brazil, between about 2°S and 35°S, some of which form clusters and chains extending due east into the Atlantic. They start at the North Brazilian Ridge and include the Fernando de Noronha Ridge, the Pernambucõ Seamounts, the Bahia Seamounts, and the Vitória-Trindade Seamount chain. They end in the south with the large subsurface Rio Grande Rise, which also has associated seamounts, some with summit depths of 400–800 m. There are also some deeper seamounts at the very southern edge, around and to the south of the Falkland Islands (Islas Malvinas).

REGIONAL BODY

There is no regional fisheries organization that cooperatively manages the bottom fisheries of the high seas portion of the southwest Atlantic. Therefore, it is the responsibility of States to cooperate in the management of high seas fisheries, and "enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned" States shall also cooperate to establish subregional or regional fisheries organizations to this end (LOS Convention, Article 118).

From 1990 to 2005, there was a bilateral arrangement between Argentina and the United Kingdom that enabled cooperative management of the main fisheries in the southwest Atlantic between 45°S and 60°S (Barton *et al.,* 2004). This organization, the South Atlantic Fisheries Commission, typically met twice per year and managed

FIGURE 26
Southwest Atlantic Ocean showing FAO major fishing areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



a number of fisheries that used bottom trawls or mid-water trawls that fished on or near to the seabed. The principal fisheries studied and managed by this Commission included those targeting the Argentine short-finned squid (*Illex argentinus*) and the southern blue whiting (*Micromesistius australis*).

OVERVIEW

Bottom fisheries

The bottom fisheries of the southwest Atlantic were reviewed with information obtained from national questionnaires (Bensch *et al.*, 2009). It was noted that there is a general paucity of information about the high seas fisheries in this region. FAO fisheries statistics, the main source of information, do not differentiate between high seas and national catches, but catches by vessels of non-South American countries are known to have been taken on the high seas. High seas catches of *Illex argentinus* have been use for stock assessment purposes south of 45°S (Basson *et al.*, 1996).

The fishery for hake (*Merluccius* spp.) on the northern Patagonian Shelf started in the 1920s and operated mainly out of Mar del Plata, Argentina (Agnew *et al.*, 2001). This fishery operated at depths between 90 and 180 m at distances of up to 100 nm from Mar del Plata. In subsequent years, the Argentine fleet incorporated larger vessels that could fish further to the south (Portela *et al.*, 1997; 2002). The fishery expanded, and by the early 1960s the fishery resources on the Patagonian Shelf, especially Argentine hake (*Merluccius hubbsi*), were exploited by the coastal states (Argentina, Brazil, and Uruguay). At the end of the 1960s, fleets from the former Soviet Union and from other Asian and Far Eastern countries increased their effort in the area. Fishing activities on the southern Patagonian shelf and slope and on Burdwood Bank started in 1978 (Csirke, 1987), when long-distance fishing fleets from Argentina, Japan, and Poland began targeting cephalopods, southern blue whiting, and other previously unexploited demersal resources (FAO, 1979, 1983).

A Spanish bottom-trawling fleet has been operating in the southwest Atlantic since the early 1980s. Effort reached a peak in 1991, with around 100 vessels. The number of Spanish flagged vessels declined subsequently, as some moved to joint ventures off the Falkland Islands (Islas Malvinas) and Argentina and to new fisheries being developed in other areas (Portela *et al.*, 2002). It is currently estimated that about 25 Spanish vessels are operating on the high seas of the Patagonian Shelf.

The main demersal fisheries are for Argentine hake and Argentine short-fin squid, and are typically conducted with bottom trawls and jigs on sandy bottoms on the shelf flats. These species have been targeted by several distant-water fleets in addition to those of South American countries. Annual catches have been large, and appear to have peaked approximately 700 000 tonnes in 1996 and 1.2 million tonnes in 1999, respectively. A wide range of other associated species is caught in these bottom trawls. Other important fisheries exist or existed, often dating back to the presence of large distant-water fleets from the former Soviet Union; they include the fisheries for southern blue whiting, which peaked in 1990 at 193 630 tonnes but declined to 10 622 tonnes in 2013, due to the combined effects of overfishing and poor recruitment, and for Patagonian grenadier (*Macruronus magellanicus*), which peaked in 2004 with a reported catch of 145 697 tonnes. There is also a significant bottom-set longline fishery for toothfish conducted by South American countries and distant-water fleets, with a peak catch of 15 079 tonnes in 1996 that have declined to average 6 500 tonnes for 2009–2013. There were caches of alfonsino (*Beryx* spp.), a typical seamount species, around the Rio Grande Rise area in the 1980s–2002 of up to 749 tonnes, but none catches have been reported in recent years. The current status of this fishery is unknown (FishStat, 2015).

REGULATIONS AND MEASURES

Given the lack of a subregional or regional fisheries management organization responsible for the management of VMEs in the southwest Atlantic, there are no internationally adopted conservation and management measures relating to the identification and management of VMEs in the region. However, the flag States of some of the vessels conducting bottom fishing in the area have established regulations governing the duties and responsibilities of their vessels (see below).

SURVEYS

The deeper waters of the southwest Atlantic have been little studied. At the 2012 "Ecological or Biological Significant Area" workshop which covered the northern part of FAO Area 41, the existence of seamounts was noted and modelled predictions of the distribution of deep-sea corals were presented. The only area with deep-sea corals described with precision was in the southern Brazilian Sea, where there are vast and continuous deep-sea coral reefs at depths of between 400 and 900 m, composed of five important reef-building species: *Lophelia pertusa*, *Solenosmilia variabilis*, *Enallopsmmia rostrata*, *Madrepora oculata*, and *Dendrophyllia alternate* (Pires, 2007; CBD, 2012).

The Spanish Institute of Oceanography and the General Secretariat of Fisheries of the Spanish Ministry of Agriculture, Food, and Environment, carried out a series of benthic surveys on the Patagonian shelf and adjacent slope in the southwest Atlantic under the ATLANTIS project. The study area was located on the high seas, between latitudes 42° and 48°S east of Argentina and north of the Falklands/Malvinas Conservation Zone. It covered part of the continental shelf and upper slope, and extended to a depth of 1 600 m on the middle slope.

The main objectives of the study were: i) quantitative and qualitative descriptions of the biotopes, ecosystems, or communities identified as possible VMEs; (ii) identification of potentially vulnerable organisms found in the study area; and (iii) assessment of the possible negative impacts of bottom-trawl fishing on these organisms and their habitats.

The study resulted in: i) a detailed cartographic and bathymetric mapping of the area; ii) a description of the geological substratum and the benthic features; iii) the identification and description of the VMEs; iv) the delineation of candidate sites for protected areas, based on geological, geomorphological, and biological criteria; v) a multivariate analysis of the fishery footprint in relation to VMEs; vi) an analysis of the abundance and distribution of the main commercial species; and vii) an analysis of hydrographic conditions and pollutants (Portela *et al.*, 2012).

The study swath-mapped large areas of the Argentine continental margin for the first time, obtaining full data coverage of the seafloor between the outermost continental shelf and the middle slope down to the 1 600 m depth contour. Multibeam bathymetry, coupled with high resolution seismic reflection profiles, provided details of the morphology and shallow acoustic structure of this area. The Atlantic Patagonian continental shelf north of 45°40'S is located at a depth of 170–200 m; south of this latitude the shelf edge is at 128–200 m. The shelf surface is marked by circular depressions and ridges oriented obliquely to the shelf edge. In the middle slope there are two terraces, the Nágera (20 to 60 km wide) and the Perito Moreno (15 to 60 km wide), which contain moats, hollows, potholes, sediment drifts, and sediment waves (Muñoz *et al.*, 2013). The upper slope and upper middle slope were ploughed by icebergs from the Antarctic during the Pleistocene era, and local reefs of cold-water coral further enhance the topography of the area (López-Martínez *et al.*, 2011; Muñoz *et al.*, 2012). Within the study area, seven canyons and their multiple branches bisect the upper and middle continental slopes from west to east, across the terraces and the steps. These canyons belong to the Patagonian submarine canyon system and occur at a depth of about 3.5 km. They occur near a channel known as the Almirante Brown transverse canyon, which runs parallel to the slope in a SSW–NNE direction, and they display a large variety of morphologies (Lastras *et al.*, 2011).

The benthic megafauna caught during the study cruises were dominated by the phyla Cnidaria and Porifera, which contain some structure-forming species that can be considered as indicators of the presence of VMEs, according to the criteria established by international organizations. The high abundance of Cnidaria is the more important of the two: 33.7 percent of the biomass of this phylum belongs to the class Octocorallia, which includes such groups as gorgonians, alcyonaceans, and pennatulaceans (Muñoz *et al.*, 2012).

Cold water coral reefs

In the study area, the largest biomasses of cold water corals were located at depths between 400 and 1 000 m, sometimes in low slope areas with sandy bottoms, forming both small aggregations and reefs several metres high. The most frequent species was *Bathelia candida*, distributed exclusively in southern South American waters, from Rio Grande in southern Brazil to southern Chile (Cairns, 1982; Kithara *et al*., 2009). This species is less well known than *Lophelia pertusa*, but is also very important ecologically in the development of biogenic habitat. *Solenosmilia variabilis* was also found in small quantities in the samples. In the study area, *B. candida* provided habitat for a great variety of both invertebrates and fish. Dead specimens of this species accounted for a high percentage of the community. These stony corals were colonized by many other species: the associated fauna was dominated by filter-feeders, cnidarians, sponges, molluscs, and brachiopods, but echinoderms and crustaceans were also found (Portela *et al*., 2012).

The most representative species found among Cnidarians were: (i) order Scleractinia, with *Caryophillia* spp., and *Desmophyllum dianthus* growing on the colonial Scleractinia, while *Flabellum* spp. and *Javania* spp. were found on sediment or small pebbles and molluscan debris; (ii) order Alcyonacea, which includes *Alcyonium* sp. and *Anthomastus* sp. among other taxa; (iii) order Gorgonacea, mainly represented by such species of the Primnoidae family as *Plumarella* sp., *Covexella* spp., *Primnoella* spp., *Thouarella* spp., *Dasystenella* sp., and *Fannyella* spp., among others. *Paragorgia* sp. was another abundant sea fan growing on Scleractinians, always of small or medium size depending on the substratum surface size and stability. Five new species of Scleractinia were described: *Caryophyllia kellerae, C. coronula, Solenosmilia australis, Flabellum cinctutum*, and *Javania cristata* (Cairns and Polonio, 2013).

Order Anthoatecatha, represented by many species of the family Stylasteridae such as *Adelopora pseudothyron*, *Errina antarctica*, *Errina inferolabiata*, *Errinopsis* spp., *Errinopora cestoporina*, *Cheiloporidion pulvinatum*, *Crypthelia* spp., *Sporadopora dichotoma*, *Sporadopora* sp., *Lepidopora* spp., *Conopora pauciseptata* and *Stylaster densicaulis*. (Portela *et al*., 2012).

Coral gardens

Coral gardens in this area are a dense aggregation of colonies or individual corals belonging to different taxonomic groups, and also include a large number of invertebrate species. Different species of cnidarians (Primnoidae are dominant among Alcyonacea and Gorgonacea), bryozoans, ophiuroids (Gorgonocephalidae, *Astrotoma* sp., *Ophiura lymani*), Asteroidea (*Henricia* sp. and family Solasteridae), Octopodidae, ascidians and fish such as the grenadier (*Macrourus carinatus*) were observed. The habitat included relatively large numbers of sponge species (with orders Hadromerida and Poecilosclerida especially well represented), although they were not a dominant component of the community (Muñoz *et al*., 2012).

Sponge beds

Sponge beds or sponge aggregations in deep waters consisted mainly of two classes of porifera, Hexactinellida and Demospongiae. Since sponges have a preference for deep habitats similar to those of cold water corals, it is common to find both groups coexisting in the same locations. In the study area, the presence of deep-water hexactinellid sponges belonging to the genus *Rossella* provided a three-dimensional structure of the seabed on which other species live, hunt, or find refuge against predators and water currents.

Carnivorous sponges generally colonize hydrothermal vents and abyssal zones, but in the study area they were found living at depths of less than 1 500 m. Several species, some of them new to science, belonging to the genera *Asbestopluma*, *Chondrocladia*,

*Eucheliplum*a, and *Cercicladia* (a new genus, Ríos *et al*., 2011) were identified in the samples.

Deep-sea rocky environments

A high biodiversity was found in these deep-sea rocky habitats, evidenced by underwater images taken by a remotely-operated underwater vehicle and submarine digital cameras, some of which may be important for ensuring the survival, functionality, or recovery of fish communities. These environments contain a large number of species belonging to different zoological phyla, including those traditionally considered vulnerable, such as Porifera, Cnidaria, and other invertebrate taxa (asteroids, bryozoans, crinoids, ophiuroids, tunicates, etc.).

OTHER INFORMATION

Domestic measures

The European Union established Council Regulation EC 734/2008 for protecting VMEs in the high seas from adverse impacts of bottom fishing gears in areas where no regional management organization has been established. The regulation requires flag States to undertake an impact assessment and make permits for bottom fishing subject to certain restrictions, including area closures and "move-on" rules for unforeseen encounters with VMEs.

Pursuant to this regulation, and as part of the ATLANTIS project, scientific surveys were carried out in the high seas areas of the southwest Atlantic with a view to developing the management strategies necessary to limit the impact of bottom trawling on VMEs (Portela *et al.*, 2012). Nine large areas were identified in which VMEs were present, and were designated as candidate areas for closure to bottom fishing. On the basis of this scientific advice, the Spanish Government closed a high seas area of about 41 300 km^2 in the southwest Atlantic to bottom fishing by Spanish vessels from 1 July 2011.

No other domestic measures applying to other Flagged vessels undertaking deep-sea fishing were identified.

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Southeast Atlantic Ocean

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REGIONAL GEOGRAPHY AND BATHYMETRY

The southeast Atlantic Ocean is covered by FAO Major Fishing Area 47. Most of its waters are extremely deep, with only few exceptions with prominent topographic features rising above 2 000 m deep:

1) the Walvis Ridge, which extends from around 18°S off the Namibian coast in a southwesterly direction towards the mid-Atlantic Ridge;
2) the mid-Atlantic Ridge, which runs through the entire SEAFO area from north to south at around 15°W; and
3) the Agulhas Ridge, which extends from around 35°S south of Cape Town in a southwesterly direction.

There are also numerous seamounts, guyots, banks, and plateaus, notably Valdivia Bank, and the Vema, Discovery and Meteor seamounts. In general, the available bathymetric data do not allow an accurate estimation of seabed surface, but it is believed that a relatively small portion (< 2 percent) of the region is less than 2 000 m deep (Figure 27). There remains considerable uncertainty with regard to the real depths of many seamounts. Valdivia Bank, and Vema and Ewing Seamounts, are among the few that have been mapped by modern technology, such as single or multibeam echosounders.

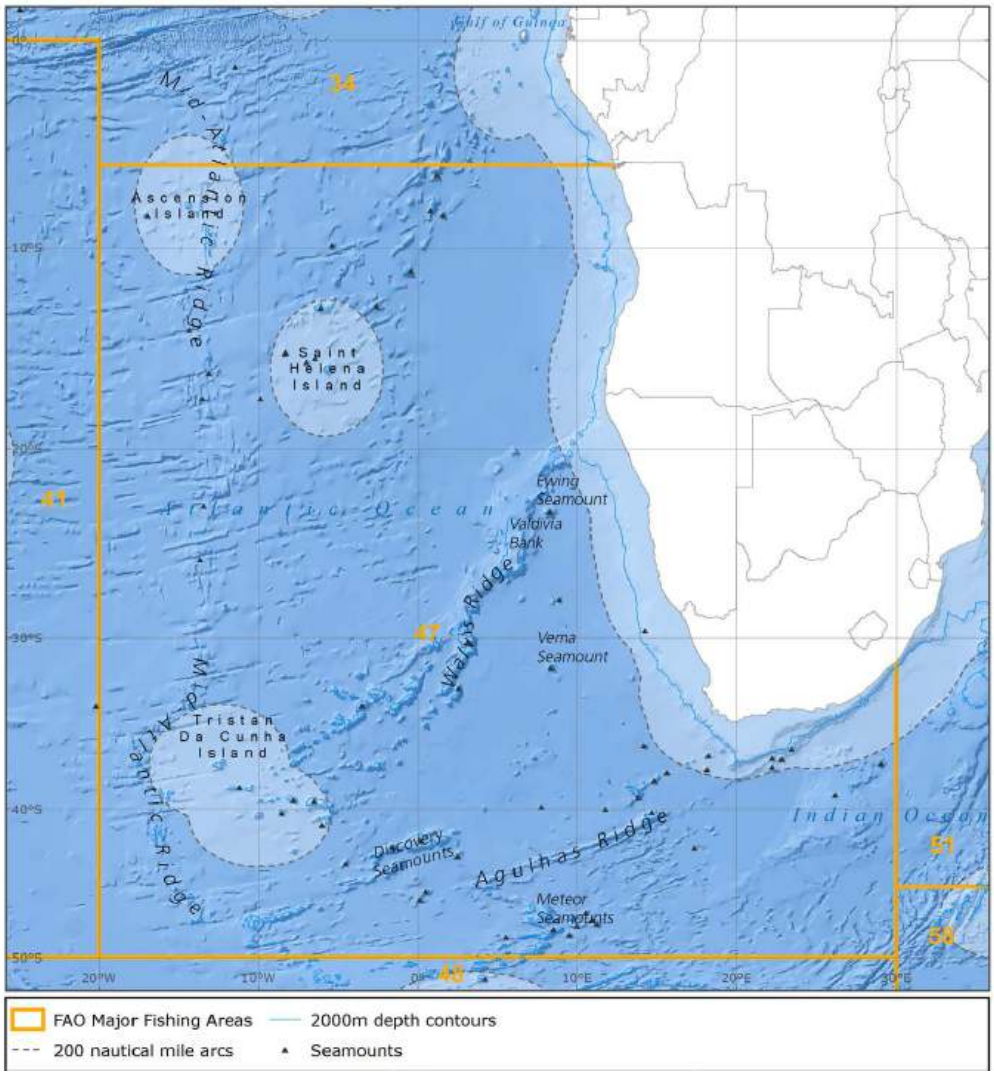
SOUTH EAST ATLANTIC FISHERIES ORGANISATION

Mandate

The regional body that manages fishery resources in the high seas of the Southeast Atlantic is the South East Atlantic Fisheries Organisation (SEAFO) which was established on the initiative of Namibia in 1995. After several years of negotiations, the SEAFO Convention was signed in 2001, and entered into force in 2003. This was the first Convention to be drafted and to enter into force following the adoption of the 1995 United Nations Fish Stocks Agreement. This and the generally broader requirement to consider an ecosystem approach that commenced in the 1990s influenced the style of the SEAFO Convention, which can be considered the first of the modern fisheries conventions.

The SEAFO Convention, formally the "*Convention on the Conservation and Management of Fishery Resources in the South East Atlantic Ocean*", addresses the management of fishery resources. These resources include fish, molluscs, crustaceans, and other sedentary species within the Convention Area, but excludes highly-

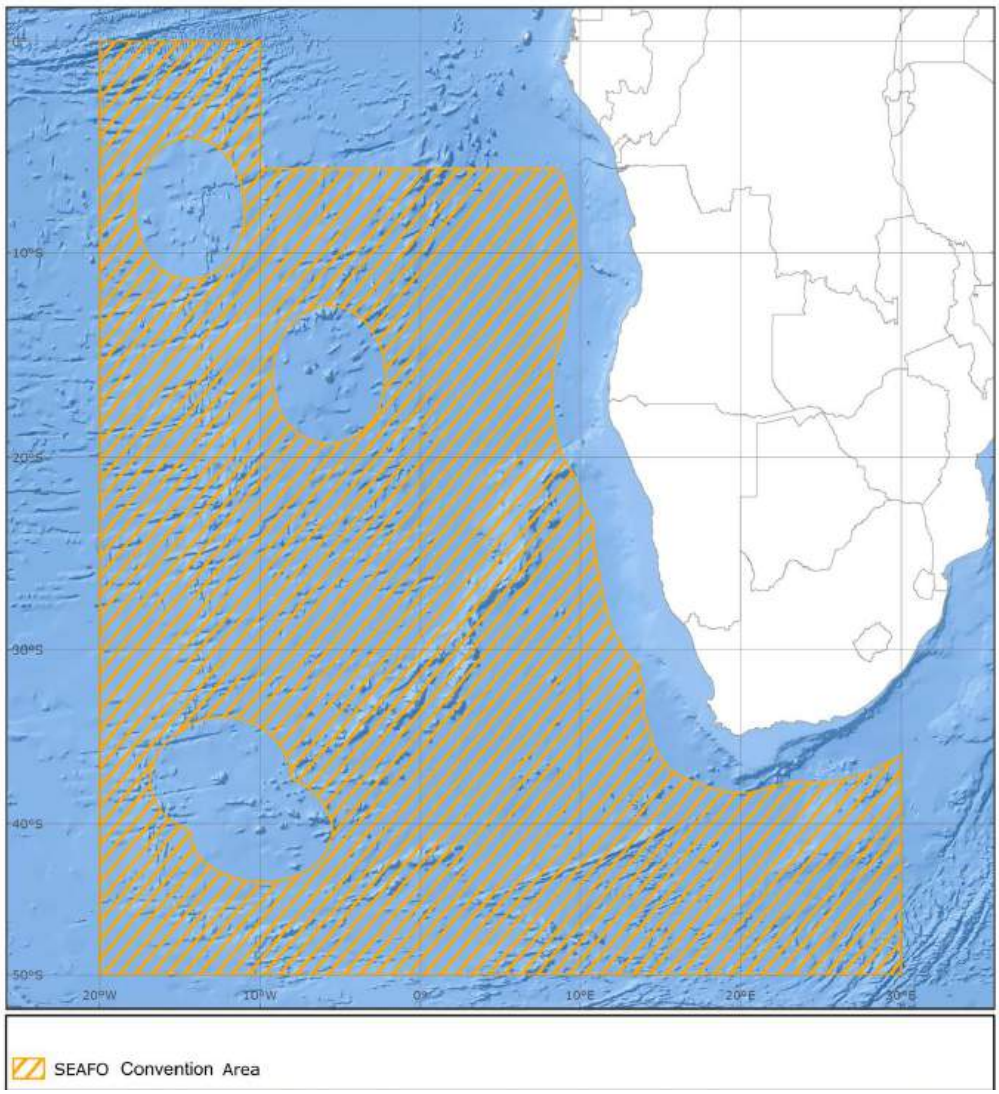
FIGURE 27
Southeast Atlantic Ocean showing FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



migratory species (typically tuna and tuna-like fishes) and some sedentary species, as listed in the 1982 LOS Convention. The geographical coverage of the Convention is restricted to the high seas (i.e. outside national EEZs).

The SEAFO Convention Area (Figure 28) lies within FAO Major Fishing Area 47 and a small part of the eastern central Atlantic Ocean in FAO Major Fishing Area 34, but excludes the 200 nm EEZs of all national jurisdictions (Angola, Namibia, South Africa, and the United Kingdom). Thus, the SEAFO Convention (2001) applies within the Convention Area, which is defined as "*all waters beyond areas of national jurisdiction in the area bounded by a line joining the following points along parallels of latitude and meridians of longitude: beginning at the outer limit of waters under national jurisdiction at a point 6°S, thence due west along the 6°S parallel to the meridian 10°W, thence due north along the 10°W meridian to the equator, thence due west along the equator to the meridian 20°W, thence due south along the 20°W meridian to a parallel 50°S, thence due east along the 50°S parallel to the meridian 30°E, thence due north along the 30°E meridian to the coast of the African continent.*"

FIGURE 28
The SEAFO Convention Area in the Southeast Atlantic Ocean



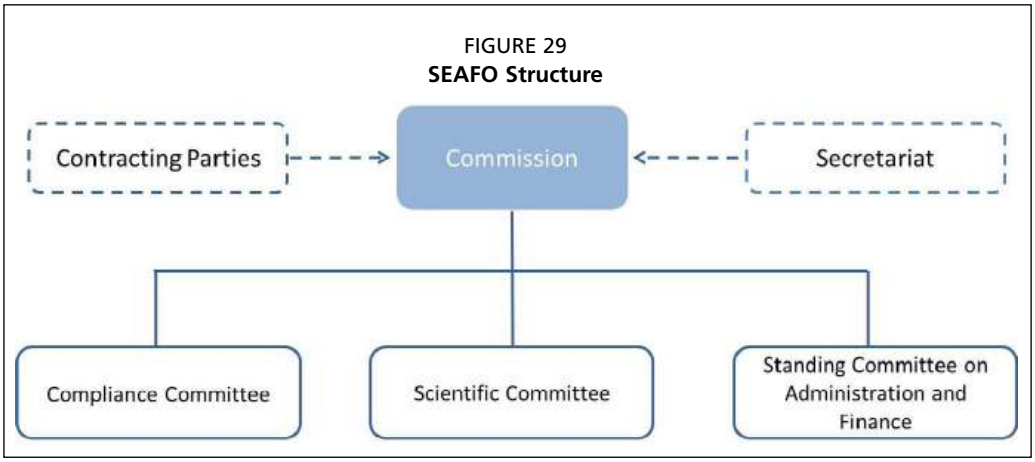
Regulatory capacity

The general principles of the Convention (SEAFO Convention, 2001, Article 3) are to ensure the long term conservation and sustainable use of the fishery resources in the Southeast Atlantic, in accordance with the ecosystem approach to fisheries management. The Convention takes into account the impacts that fishing may have on non-target species and ecosystems, and identifies the need to minimize harmful impacts on living marine resources and protect biodiversity. It further stipulates the need to adopt measures based upon the best available scientific information, and the application of the precautionary approach. There are clear definitions of "fishery resources" and "living marine resources", with the latter defined as "all living components of marine ecosystems, including seabirds".

Structure

The organizational structure of SEAFO is defined in the Convention, and consists of a Commission with three main subsidiary bodies (Figure 29): the Compliance Committee, the Standing Committee on Administration and Finance, and the Scientific

FIGURE 29
SEAFO Structure



Committee. The Contracting Parties (Angola, European Union, Japan, Republic of Korea, Namibia, Norway, and South Africa) are represented on the Commission and its subsidiary bodies, all of which meet annually.

A Secretariat coordinates and supports the work of the Commission and its subsidiary bodies. It is based in Namibia, initially in Walvis Bay, but moved to Swakopmund in 2011.

Decison process

The work of the Scientific Committee is directed by the Commission, and includes items of both a regular and an ad hoc nature. Communication between the Commission and the Scientific Committee is typically by way of reports of the meetings of the Scientific Committee. The Chair of the Scientific Committee presents its recommendations, which may include draft management measures, to the Commission at the annual meeting. Issues relating to VMEs are addressed by the Scientific Committee, and recommendations are presented to the Commission for consideration.

All recommendations adopted by the Commission at its annual meeting are binding, although Contracting Parties have 60 days after notification by the Executive Secretary to submit reasons for not accepting an adopted measure.

SEAFO publishes its Conservation Measures (CMs) on its website, along with the SEAFO "System of Observation, Inspection, Compliance and Enforcement" (SEAFO System, 2015), which lays out all the requirements and procedures established by SEAFO to regulate its fisheries.

The Commission also adopts Recommendations, intended to guide the Contracting Parties. At present, there are Recommendations on banning the use of gillnets and on deep-water shark catches.

Relationships with other bodies

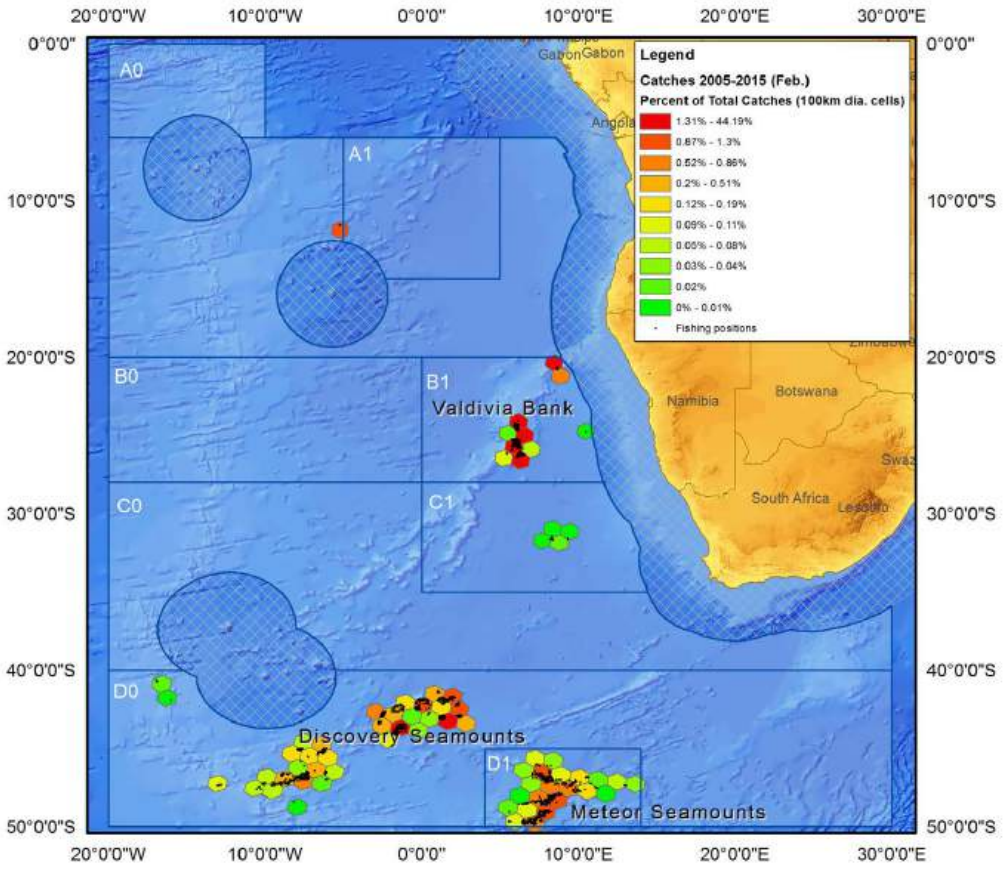
SEAFO collaborates with the FAO, alongside other RFMOs, in diverse areas such as data management and reporting (Fisheries Global Information System, FIGIS), the coordination of fisheries statistics (Coordinating Working Party on Fishery Statistics, CWP), the development of a VME DataBase, and the curation of biobliographic information on marine sciences (Aquatic Sciences and Fisheries Abstracts, ASFA). More recently, SEAFO has been working with CCAMLR on the Patagonian toothfish fishery that may represent a straddling stock.

OVERVIEWS

Bottom fisheries

The Southeast Atlantic Ocean has been subject to commercial fishing since at least the 1950s, but these fisheries have been almost entirely confined to the continental shelf

FIGURE 30
Kernel density plot of fishing effort (number sets, trawl, etc.) between 2005 and 2014



Source: SEAFO Secretariat www.seafo.org/Science

areas close to the African mainland. All fishing in the SEAFO Convention Area occurs on or around seamounts. Nowadays vessels concentrate fishing operations mainly in three distinct areas: the Valdivia Bank seamounts complex in division B1, the Discovery seamounts in division D0, and the Meteor seamounts in division D1 (Figure 30).

The main commercial target species caught in recent years in the SEAFO Convention Area are deep-sea red crab (mainly *Chaceon erytheiae*), alfonsinos (mainly *Beryx splendens*), Patagonian toothfish (*Dissostichus eleginoides*), and pelagic armorhead (= southern boarfish, *Pseudopentaceros richardsoni*). The Scientific Committee develops or updates Stock Status Reports for all commercially-exploited species on an annual basis.

Alfonsino and southern boarfish are mainly caught using bottom and mid-water trawls in division B1 at depths ranging from 200 to 700 m. These fisheries typically occur at the top and along the slopes of Valdivia Bank, depending on the spatial distribution of the species and their circadian rhythm.

Deep-sea red crab are caught with Japanese beehive pots, set in lines of about 400 pots (typically about 7.7 km in length), anchored at both ends. The fishery is focused mainly on the Valdivia Bank area (division B1), at depths of 280-1 150 m.

Patagonian toothfish are caught with longlines and trotlines. The main fishery occurs on the Discovery seamounts and around the Meteor complex seamounts in Subarea D. A smaller, more sporadic fishery occurs on the western seamounts in Subarea D, at depths of 900-1 500 m.

A commercial fishery for orange roughy (*Hoplostethus atlanticus*) was conducted between 1995 and 2005, mainly on Valdivia Bank, on Ewing seamount, and on the northeastern part of the Walvis Ridge outside the Namibian EEZ (division B1), using bottom trawls.

A fishery targeting the Tristan da Cunha rock lobster (*Jasus tristani*) took place until 2006 on the Vema seamount.

Fish bycatch is dominated by the blackbelly rosefish (*Helicolenus mouchezi*) in the Valdivia Bank trawl fishery, and macrourid species (*Macrourus* spp.) in the Patagonian toothfish fishery.

Catches of SEAFO managed species within the Convention Area are highly variable. Total annual catches for all species have exceeded 1 000 tonnes only in 2004 and 2010. The average (minimum, maximum) annual catches during 2003–2013 are, for pelagic armorhead 79 (0, 688) tonnes, for red crab 223 (5, 809) tonnes, for alfonsino 128 (0, 914) tonnes, and for Patagonian toothfish 158 (26, 393) tonnes. Annual catches of orange roughy were 5–75 tonnes during 1995–2005 (mostly from division B1), after which the fishery ceased in the Convention Area and there has been no reported catch. Annual catches of all species have decreased consistently since 2010, and in 2014 were estimated to be comprised of 135 tonnes of red crab and 26 tonnes of Patagonian toothfish.

Vulnerable marine ecosystems

The benthic fauna of the southeast Atlantic Ocean, and especially the waters of the SEAFO Convention Area, had not been well studied prior to 2000, and even since then there have only been localized studies. Bathymetric data are available, but are considered to be of limited utility owing to their low resolution and accuracy. Furthermore, associated biological and taxa information was also limited but has been recently reviewed (Jacobs and Bett, 2010). Consequently, the Scientific Committee was only able to identify geological features likely to support VMEs, but their actual characteristics remain largely uncertain. However, in spite of the general paucity of detailed information available, SEAFO has made progress in response to UNGA Resolution 61/105 in protecting seamounts and vulnerable marine habitats from significant adverse impacts caused by fishing.

The Scientific Committee created a set of closures constituting a biogeographically representative selection of subareas likely to have VMEs. Due to limited bathymetric and biological information for the area, the Scientific Committee applied the precautionary approach, and consequently focused its advice on seamounts and seamount complexes with summit depths less than 2 000 m.

In 2006, the Scientific Committee examined the available information relating to the ecosystem approach to fisheries and, following the precautionary approach, developed a list of 13 seamounts, or groups of seamounts, that probably contain VMEs, together with their known fishing exploitation history. On the basis of this advice, the Commission adopted measures to prohibit bottom fishing in 10 of the 13 seamount areas during 2007–2010 (Figure 31a).

These VME closures were reviewed by the Scientific Committee in 2010, and the Commission agreed to reopen one existing seamount complex to fishing (Discovery seamounts in division D0), change the boundaries of six others which combined some into larger areas, and close five new areas along the Mid-Atlantic Ridge. A VME area was established in 2016 in Valdivia Bank, based on evidence obtained from scientific research cruises, in which only pots and longlines are permitted. Currently, SEAFO has a total of 12 VME areas closed to bottom fishing by all or selected gears, with a combined area of approximately 505 000 km^2 (3.2 percent of its Convention Area) to bottom fishing.

REGULATIONS AND MEASURES

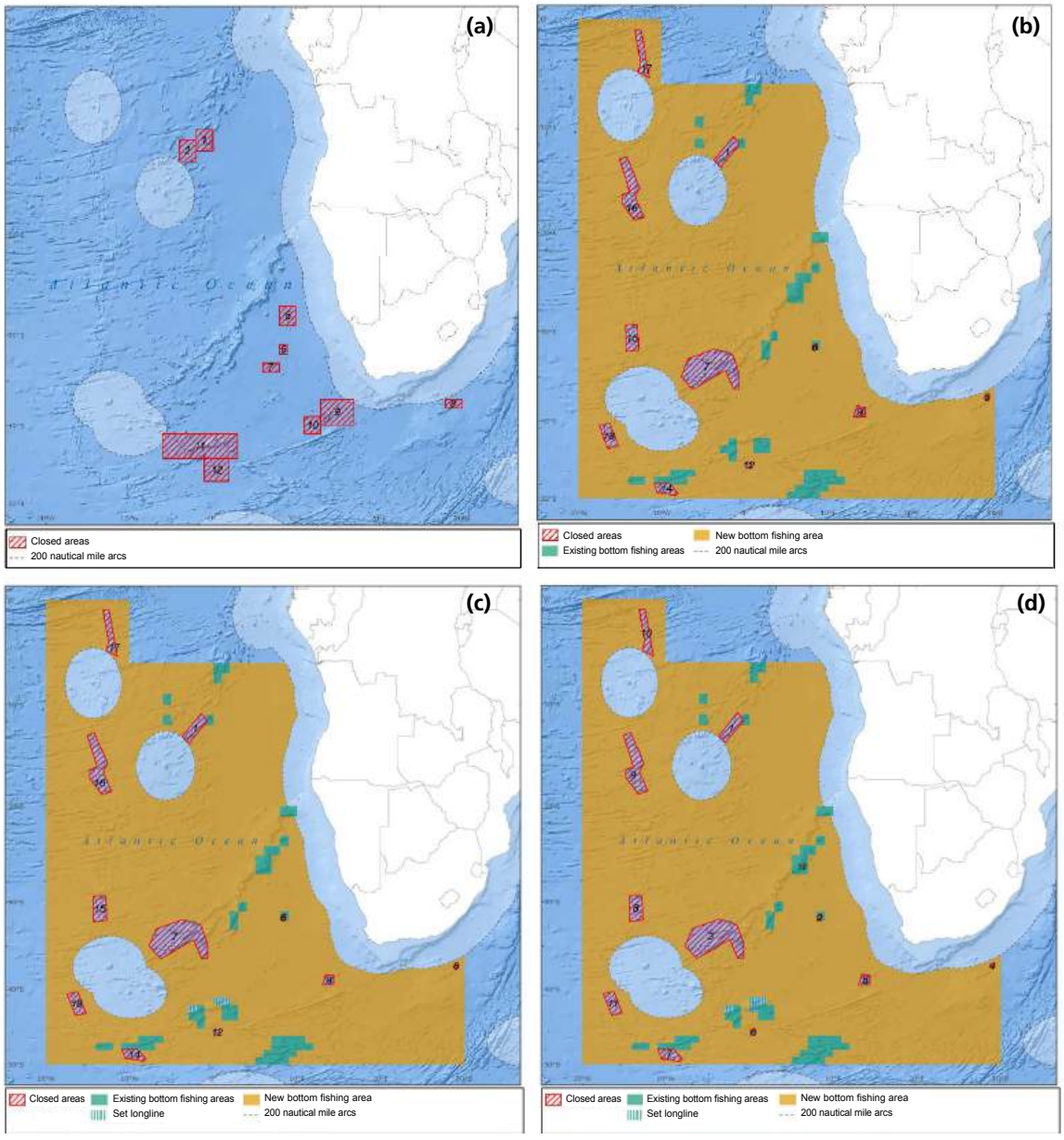
Bottom fishing areas

SEAFO held its first meeting in 2004, and introduced a VMS for fishing vessels in 2005, with the intention of monitoring fishing operations in its Convention Area more closely. Other schemes, such as vessel documentation, catch and effort reporting, and observer programmes, were introduced in 2006.

SEAFO defined "existing bottom fishing areas" in 2008 as "areas where VMS data and/or other available geo-reference data indicating bottom fishing activities have been conducted within a reference period of 1987 to 2007." (CM 12/08), and requested

FIGURE 31

Areas open to fishing and areas closed to protect potential VME areas from bottom fishing gears (a) VME areas 2007–2010; (b) revised VME areas 2011–2013, and existing fishing areas and other measures to protect VMEs were also introduced in 2011; (c) two existing bottom fishing areas (set longlines only) established in 2014; and (d) one new VME, renumbering of existing VMEs, and an extension of the existing bottom fishing area (set longlines only) in 2016 (see Table 11 for names of closed areas)



Contracting Parties to provide information on historical bottom fishing. Using data from bottom longlines, pots and trawls, the Scientific Committee developed a "fishing footprint" map of the existing bottom fishing area at a spatial resolution of 1° x 1°. The Commission adopted the map in 2011. "New bottom fishing areas" can be added via an exploratory fishing protocol, which allows fisheries to start outside of the existing bottom fishing area, subject to stringent control and review measures. Since 2014, four new 1° x 1° bottom fishing areas for commercial set longlines only have been added (Figure 31c and 31d; CM 30/15).

Vessels can undertake "bottom fishing activities" in the SEAFO Convention Area, where the fishing gear is likely to contact the seafloor during the normal course of fishing operations. However, bottom fishing inside and outside of the defined existing bottom fishing areas is subject to the condition that it does not result in significant adverse impacts on VMEs, and additional restrictions apply when this is known to be occurring. Additionally, the use of new fishing methods and/or strategies is subject to an exploratory fishing protocol, even when it occurs within an existing bottom fishing area (CM 29/14, Article 2d).

Exploratory fishing protocols

Exploratory fishing protocols were first introduced by SEAFO in 2008 (CM 12/08), and have been subject to minor modifications since, including in the most recent measures, which entered into force in early 2015 (CM 29/14). These protocols stipulate that a harvest plan, mitigation plan, catch monitoring plan, and data collection plan are all required prior to the commencement of the exploratory fishing, and are subject to assessment by the Scientific Committee and approval by the Commission. The most recent measures provide more detail on the submission of the plans and how they are assessed.

Vulnerable marine ecosystems

SEAFO was proactive in adopting measures in 2006 to close areas that are known to, or may, contain VMEs. There was very limited information available on the distribution of VMEs, and the closures were classified as precautionary. SEAFO did not adopt a definition of what constitutes a VME at that time. The FAO Deep-sea Fisheries Guidelines were available by the time of the first major review of closed areas by SEAFO, and this provided a guide to the criteria for identifying VMEs, although these were not incorporated in the measure revising the closures (CM 18/10).

In 2014, the SEAFO adopted new measures for bottom fishing and VMEs, and more formally noted that the term VMEs has the same meaning as Paragraphs 42–43 and Annex 1 of the FAO Deep-sea Fisheries Guidelines (CM 29/14). Article 3 of that measure clearly identifies SEAFO's responsibilities, and states:

> *"The Commission shall, taking account of the advice provided by the Scientific Committee, as well as data and information arising from reports pursuant to Article 8 adopts conservation and management measures to prevent significant adverse impacts on VMEs. Such measures may include:*
>
> *(a) allowing, prohibiting or restricting bottom fishing activities;*
> *(b) requiring specific mitigation measures for bottom fishing activities;*
> *(c) allowing, prohibiting or restricting bottom fishing activities with certain gear types, or changes in gear design and/or deployment; and/or*
> *(d) any other relevant requirements or restrictions to prevent significant adverse impacts on VMEs."*

Encounter protocols

An "encounter" is defined as "any encounter with a VME indicator species above threshold levels" (CM 29/14, Article 2). Protocols relating to encounters have been in force in SEAFO since 2008, with some modifications in the wording and procedures. Currently, fishing vessels must quantify the bycatch of VME indicators. If the bycatch is above threshold levels, the vessel is required to cease fishing and move away at least 2 nm from the end point of the trawl tow in the direction least likely to result in further encounters. If the encounter is with other bottom fishing gears, then the "move-on" rule is 1 nm from the most likely position of the encounter. The incident must be reported to the flag State, and then to the Executive Secretary. The Executive Secretary shall immediately inform all Contracting Parties, and archive the information received pursuant to paragraph 1, and shall, if the encounter happened outside existing fishing areas, at the same time implement a temporary closure. The temporary closure shall correspond to the buffer area defined pursuant to Paragraph 1(b) of this article. The area where the encounter occurred, if outside an existing bottom fishing area, is temporarily closed until the incident has been examined by the Scientific Committee (CM 29/14, Article 8).

Vulnerable marine ecosystem indicators

The VME indicator taxa, as defined in CM 12/08 (2008), are "species of coral identified as antipatharians, gorgonians, cerianthid anemone fields, *Lophelia*, and sea pen fields or other VME considered elements." In 2013, the Scientific Committee agreed upon a slightly more extensive provisional list of benthic invertebrates as VME indicator taxa for the SEAFO Convention Area (Table 9; SC Report, 2013).

TABLE 9
Provisional extended list of VME indicator species adopted by SEAFO

Group / Species code	Phylum / Order / Family	Common name
PFR	Porifera	Sponges
GGW	Gorgonacea (Order)	Gorgonian corals
AZN	Anthoathecatae (Family)	Hydrocorals
CSS	Scleractinia (Order)	Stony corals
AQZ	Anthipatharia (Order)	Black corals
ZOT	Zoantharia (Order)	Zoanthids
AJZ	Alcyonacea (Order)	Soft corals
NTW	Pennatulacea (Order)	Sea pens
BZN	Bryozoa	Erect bryozoans
CWD	Crinoidea (Class)	Sea lilies
OWP	Ophiuroidea (Class)	Basket stars
SZS	Serpulidae (Family)	Annelida
SSX	Ascidiacea (Class)	Sea squirts

Source: SC Report, 2013.

Thresholds

In 2006, the Commission adopted a measure that implemented a temporary closure based upon any catch of hard corals (CM 06/06, Paragraph 6). In 2008, the Commission adopted threshold values for live corals and sponges based on those adopted by the CM 26/13 for the northwest Atlantic Ocean, noting that these were precautionary. On the advice of the Scientific Committe, in 2009, the Commission revised the threshold levels downwards. In 2011, no consensus was reached on threshold values for trawls, so the Scientific Committee proposed two different sets of values and, as a compromise, the Commission adopted separate threshold values for trawls, longlines,

and pots. The thresholds for trawls were different inside and outside existing bottom fishing areas, but those for longlines and pots were the same for all areas (Table 10).

TABLE 10
Evolution of thresholds for VME encounters in the SEAFO Convention area

Year (measure)	Threshold
2008 (CM 06/06)	any catch of hard corals (inside closed areas)
2009 (CM 12/08)	100 kg live coral, 1 000 kg live sponges (existing and new fishing areas)
2010-2011 (CM 17/09)	60 kg live coral, 800 kg live sponges (existing and new fishing areas)
2011 (15 Dec) - present (CM 29/14, 22/11, 24/12, 26/13)	Trawl tow: 600 kg sponge, 60 kg coral (inside existing fishing area); 400 kg sponge, 60 kg coral (outside existing fishing area). Longline set: 10 units of 1 kg or 1 litre in one 1 200 m section or 1 000 hooks, whichever the shorter (in both existing and new fishing areas). Pot set: 10 units of 1 kg or 1 litre in one 1 200 m section (in both existing and new fishing areas).

Impact assessments

With respect to VMEs, SEAFO has followed the path of attempting to identify and close areas that contain, or may contain, VMEs, on the assumption that VMEs are generally absent outside these areas. There is, therefore, no need to conduct potential impact assessments within areas identified as existing bottom fishing areas. However, SEAFO recognises that this is not always the case, and uses the encounter threshold to trigger the immediate protection (through the "move-on" rule) of newly–identified potential VMEs, followed by a scientific assessment of these newly–identified areas and additional measures, if required.

Conducting fisheries research and basic marine science activities within areas closed for the protection of VMEs is subject to prior notification to the Parties and review by the Scientific Committee.

Conducting exploratory fishing in new bottom fishing areas is subject to a protocol that includes the assessment of any potential impacts on stocks and VMEs and an associated mitigation plan. Encounters with VME indicators above threshold levels trigger a "move–on" rule and immediate closure. There is a strict data collection protocol, with guidance and information requirements stipulated in the measures, and an assessment by the Scientific Committee and review by the Commission. The measures also encourage bathymetric surveys prior to fishing and the use of gear-monitoring technology, including cameras if practicable.

The above assessment requirement was first adopted by SEAFO in 2008 (CM 12/08), and has been subject to revision up to and including the most recent measure (CM 29/14).

Observers

The requirements for the deployment of observers on commercial fishing vessels are specified in the SEAFO Conservation Measures and in the SEAFO System (SEAFO System, 2014).

Regulations governing observers were first implemented in 2009 (CM 12/08) and remained unchanged through 2014. Observers are required on all commercial fishing vessel operating in the SEAFO Convention Area; their duties include recording catches of corals and sponges to the lowest taxonomic level possible. These scientific observers are required to:

1. Monitor any set for evidence of presence of VMEs, and identify coral, sponges and other organisms to the lowest level possible
2. Record the following information for identification of VMEs: vessel name, gear type, date, position (latitude/longitude), depth, species code, trip-number, set-number, and name of the observer on datasheets

3. Collect representative biological samples from the entire VME catch (biological samples shall be collected and frozen when requested by the scientific authority in a Party). For some coral species that are under the CITES list this will not be possible and for these species photographs should be taken
4. Provide samples to the scientific authority of a Contracting Party at the end of the fishing trip.

To assist observers, in 2014 the SEAFO provided separate Scientific Observer Forms (available on the SEAFO Web site) for vessels deploying trawls, longlines, and pots.

Scientific research

In 2014, the SEAFO adopted guidelines for scientific research being conducted in its Convention Area (SEAFO, 2014), which follows from the differentiation made between exploratory fishing and scientific research in CM 29/14. Research vessels are not restricted by SEAFO regulations pertaining to the harvesting of fish. The research plan must be submitted to the Executive Secretary in advance of the trip. Vessels are not permitted to conduct commercial fishing, but must keep a stowage plan on board. The research information collected should be forwarded to the Executive Secretariat at the end of the trip (SEAFO System 2014, Chapter VIII).

Review procedures

SEAFO first adopted specific bottom fishing measures aimed at protecting VMEs in 2006 (CM 06/06), and has reviewed them seven times within eight years, reflecting a progression of measures as knowledge of bottom fisheries, and of known or likely VMEs, has increased. Beyond this, the actual measures also establish procedures for reviewing decisions adopted at previous meetings. This is consistent with the management process used by other regional fisheries bodies, and allows for amendments to adapt to changes in the fish stocks, ecosystems, or fishing methods.

Review procedures continue to be included in the measures, and now also apply to existing bottom fishing areas (CM 29/14). However, with the approval of SEAFO, research activities are permitted within the closed areas, and further information may still lead to changes in adopted measures, including the closures. In 2014, SEAFO adopted guidelines for scientific research being conducted in the SEAFO Convention Area.

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

The areas closed by SEAFO to protect potential VMEs are listed in the Table 11, together with subsequent changes. The first set of closures, adopted in 2006 for the 2007–2010 period, included ten areas (Figure 31a). These were reviewed in 2010 by the Scientific Committee, which recommended adjusting the boundaries of some existing closed areas, opening one to fishing, and defining some new ones (Figure 31b). The SEAFO currently has 12 closed areas to protect VMEs (Figure 31d).

TABLE 11
VMEs in the SEAFO Convention area from 2006 to 2016

Seamount name - number (CM 06/06)	Seamount name - number (CM 18/10, CM 29/14)	Seamount name - number (CM 30/15)	Area	Previous exploitation	2007-2009	2010	2011-2015	2016
Dampier-1			A1	Already slightly exploited	C	C(R)		
	Kreps-16	Kreps-9	A				C	C
	Unnamed-17	Unnamed-10	A				C	C
Malahit Guyot-2	Malahit Guyot-1	Malahit Guyot-1	A1	Already slightly exploited	C	C(R,B)	C1	C1

TABLE 11 (CONTINUED)

Seamount name - number (CM 06/06)	Seamount name - number (CM 18/10, CM 29/14)	Seamount name - number (CM 30/15)	Area	Previous exploitation	2007-2009	2010	2011-2015	2016
Molloy-5			B1	Already exploited	C	C(R)		
		Valdinia Bank South-12	B1	Already exploited				C
Schmidt-Ott & Erica-9	Schmidt-Ott-9	Schmidt-Ott-5	C	Considered unexploited	C	C(R,B)	C1	C1
Africana-8	Africana-8	Africana-4	C	Considered unexploited	C	C(R,B)	C1	C1
Panzarini-10			C	Considered unexploited	C	C(R)		
	Unnamed-15	Unnamed-8	C				C	C
Vema-6	Vema-6	Vema-2	C1	Already exploited	C	C(R,B)	C1	C1
Wust-7[1]	Wüst-7	Wüst-3	C	Considered unexploited	C	C(R,B)	C1	C1
Discovery, Junoy, Shannon-11			D	Considered unexploited	C	C(R)		
Schwabenland & Herdman-12	Herdman-12	Herdman-6	D	Considered unexploited	C	C(R,B)	C1	C1
	Unnamed-14	Unnamed-7	D				C	C
	Unnamed-18	Unnamed-11	D				C	C

C = Area closed to bottom fishing; C1 represents a boundary change.
(A) = Measure adopted for first closure
(B) = Boundary change adopted
(R) = Area/measure reviewed

[1] = Erroneously placed in the eastern instead of the correct position in the western (CM 06/06). This was corrected in CM 18/10.

SURVEYS

Only a limited number of surveys have been conducted in the SEAFO Convention Area (Table 12).

TABLE 12
List of surveys undertaken in the SEAFO Convention area

Program and dates	Vessel	Area	Work
2008, 2009, 2010	R/V Vizconde de Eza	Ewing seamount and Valdivia Bank at the northeastern end of the Walvis Ridge seamount chain. Depth range of surveys was 2 183 000 m	Multibeam echosounder, CTD, bottom trawls, seismic profiles, rock dredge, sedimentary dredge, seabird and cetacean observations. (López-Abellán *et al.*, 2008)
MarEco 2009 October-November	Russian vessel Brazilian vessel	Mid-Atlantic Ridge	The cruises have as main objective to map biodiversity and distribution patterns; exploratory fishing was not conducted
EAF Nansen January-February 2015	R/V Dr. Fridtjof Nansen		New information on vulnerable marine ecosystems and fishery resource

OTHER INFORMATION

Reported encounters

Collecting information on catches of VME indicators is the duty of the on-board observers. The Scientific Committee's Report for 2010 presents some summary information of catches of coral (mainly Gorgonacea) and sponges (mostly dead),

none near threshold values, by a vessel using the Spanish longline system fishing for Patagonian toothfish, with a maximum catch of 7 kg in one set (SC Report 2010, p. 9).

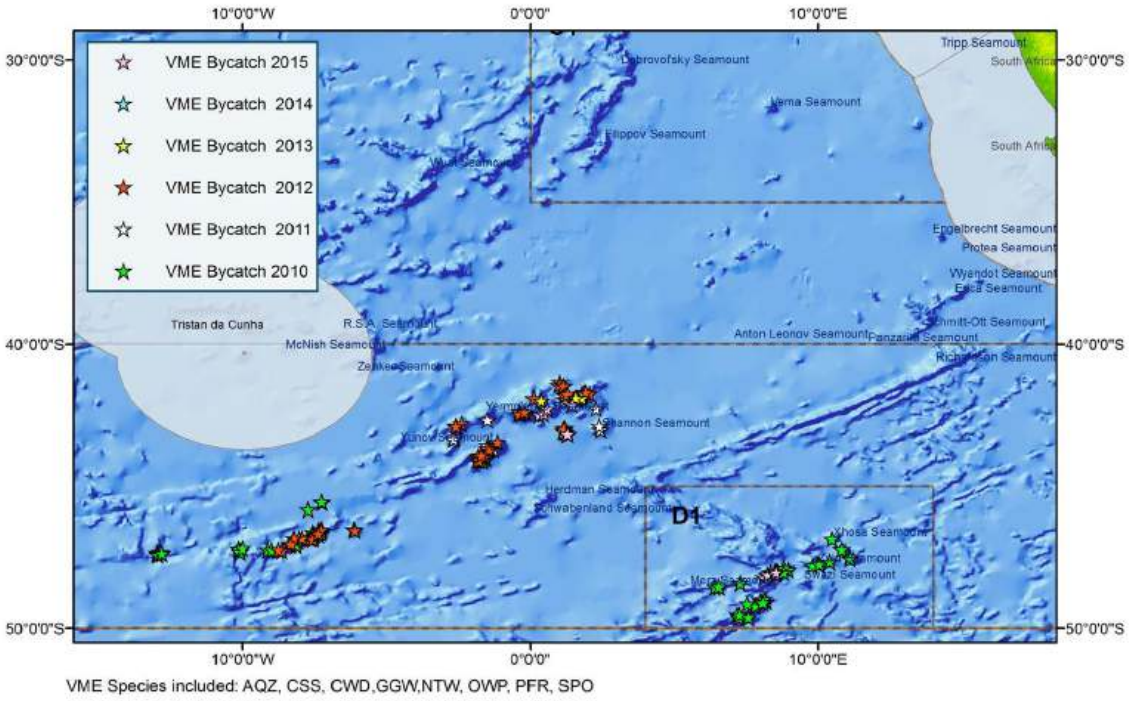
For 2011, the Scientific Committee reported no encounters above threshold. Bycatches of coral and sponges in the SEAFO Convention Area ranged from 0.005 to 4.5 kg and 0.0026.8 kg per tow/set, respectively (SC Report 2011, p. 30).

The exploratory longline fishing conducted by Japan in 2012 and 2013 did not catch any VME indicator species above threshold (SC Report 2012, p. 51).

Following a more detailed analysis of available information, the 2013 and 2014 Scientific Committee Reports (SC Report 2013; SC Report 2014) provide more information on bycatches of VME indicators. Catches of Gorgonians, black and thorny corals, Scleratinia, and sea pens during 2010–2014 are listed by country and gear type, with a map showing where these catches occurred (Figure 32). There were no catches above threshold during 2013–2014.

FIGURE 32

Bycatch of VME Species recorded by fishing activities within the convention area



Source: SC Report 2015 (Figure 7, page 70).
www.seafo.org/media/087e0925-fb69-463c-bee4-325456bc949f/SEAFOweb/pdf/SC/open/eng/SC%20Report%202015_pdf

Exploratory fishing

In 2012, 2013, and 2014, Japan applied to undertake exploratory fishing for toothfish in pre-defined areas that are currently outside the existing bottom fishing area. The request was reviewed by the Scientific Committee and approved by the Commission. At the end of the fishing season in 2012 and 2013, a report was submitted to the Scientific Committee for review (SC Report 2012, p. 16–17; SC Report 2013, p. 1314). Japan also requested that three 1°x1° rectangles be designated "existing fishing areas", based on the results of their exploratory fishing. This was approved by the Commission, but for longline gears only, and the existing fishing area was modified accordingly.

There have been no other applications to undertake exploratory fisheries.

Identification guides

In 2008, the Scientific Committee proposed that an identification guide be developed to help with mapping the distributions of various VME indicator species. This was approved by the Commission, and a "*Coral and Sponge Taxa Guide*" was developed by IEO and the Marine Science Faculty at the University of Vigo (Galicia, Spain), for use by scientific observers in the SEAFO Convention Area (Ramos *et al*., 2009).

Data sharing protocols

Contracting Parties undertaking research in the SEAFO Convention Area, especially research relevant to SEAFO's mandate, are requested to submit their data, in raw or aggregate form, to the Executive Secretary, who makes the information available to the Scientific Committee. The restrictions and use of the information are agreed between the Party and the Executive Secretary, and it is subject to the SEAFO Confidentiality Protocol (SEAFO, 2014; SEAFO System, 2014). Observers aboard commercial fishing vessels are also required to submit their information to the Executive Secretary on data forms provided on the SEAFO Web site.

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Mediterranean and Black Sea

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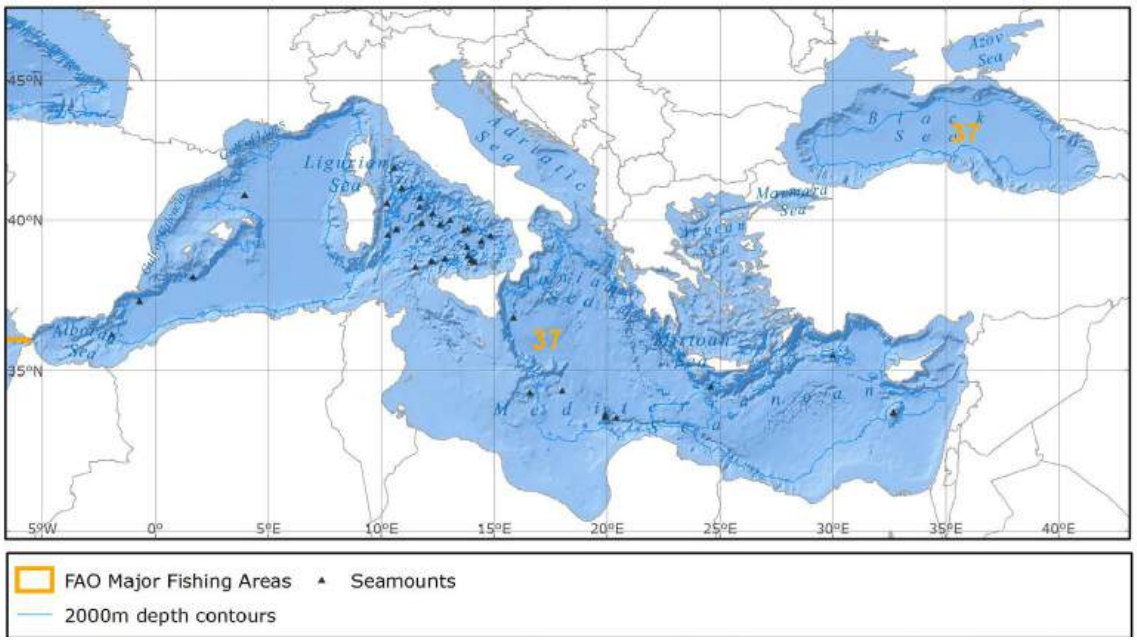
REGIONAL GEOGRAPHY AND BATHYMETRY

The Mediterranean Sea is bounded by Europe to the north, Asia to the east, and Africa to the south. It is linked to the Atlantic Ocean by the Strait of Gibraltar and to the Red Sea by the Suez Canal. It is also linked to the Sea of Marmara, the Black Sea, and the Azov Sea, all of which lie to the northeast of the Mediterranean. All the connections between these adjoining seas are narrow, which restricts the flow of seawater between them (Figure 33).

In general, the Mediterranean Sea has a narrow continental shelf, which falls off quickly into very deep waters, with an average depth of around 1 500 m and a maximum depth of 5 267 m. It is divided into the Western and Eastern Basins, which are separated by the Sicilian Channel between Sicily and Tunisia. The Western Basin is around 2 500–3 500 m deep, while the Eastern Basin is deeper, at around 4 000–5 000 m. There are a number of shallower areas, most notably around Corsica, Sardinia, the Sicilian Channel along the coast of Tunisia and Libya, and in the Aegean and Adriatic Seas. The Black Sea comprises a single deep basin with an average depth of 1 250 m and a maximum depth of 2 212 m.

There are numerous features or elements in the region that could host VMEs. These include 518 large submarine canyons (Würtz, 2012) and around 300 seamounts (CBD, 2014). The canyons occur principally along the northern coastline from Almería, Spain, eastwards along the coasts of France, Sardinia, Corsica, southwest Italy, Greece, and Crete, ending in Turkey and Cyprus. The canyons are less extensive along the southern Mediterranean coast, and occur principally off Algeria, eastern Libya, and western Egypt. They are most prominent where the continental shelf is narrow. Seamounts are scattered throughout the Mediterranean Sea, but are particularly abundant in the Alboran Sea, the Tyrrhenian Sea, the Sicilian Channel, and between Sicily and eastern Libya. The Mediterranean and the Black Sea are included in FAO Major Fishing Area 37.

FIGURE 33
Map of the Mediterranean and Black Sea showing the FAO Major Fishing Areas, larger seamounts, and 2 000 m depth contours

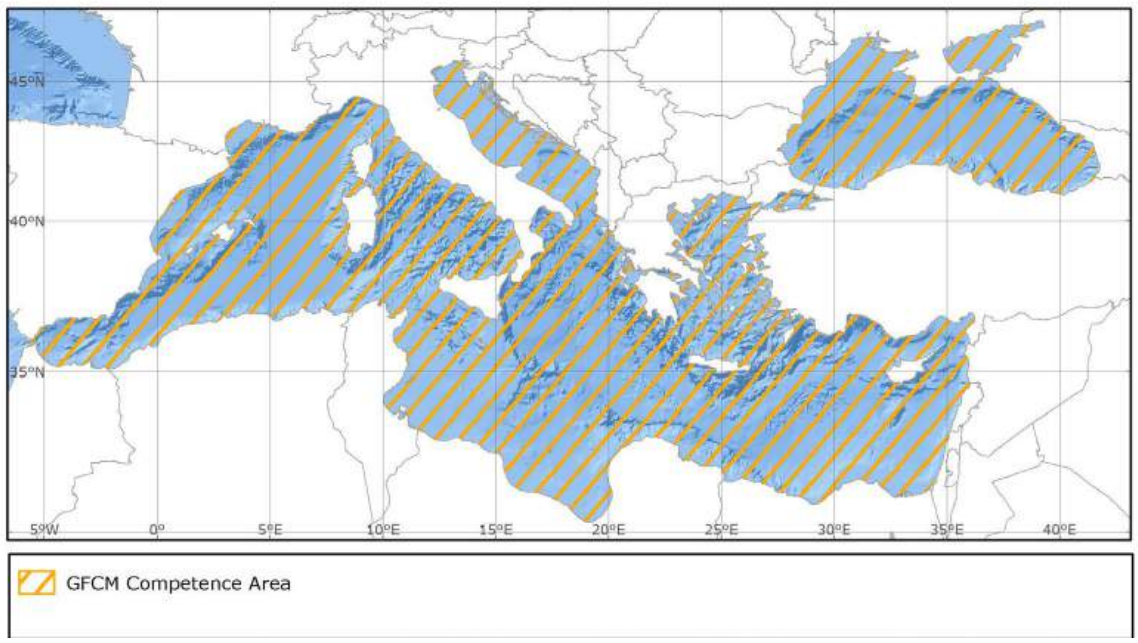


GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

Background and mandate

The General Fisheries Commission for the Mediterranean (GFCM) was established in 1949 to monitor and manage fisheries in the Mediterranean Black Seas (Figure 34) on the basis of an agreement adopted under Article XIV of the FAO Constitution, and subsequently amended four times: in 1963, 1976, 1997, and 2014 (GFCM, 2014). The

FIGURE 34
GFCM area of application in the Mediterranean and Black Seas



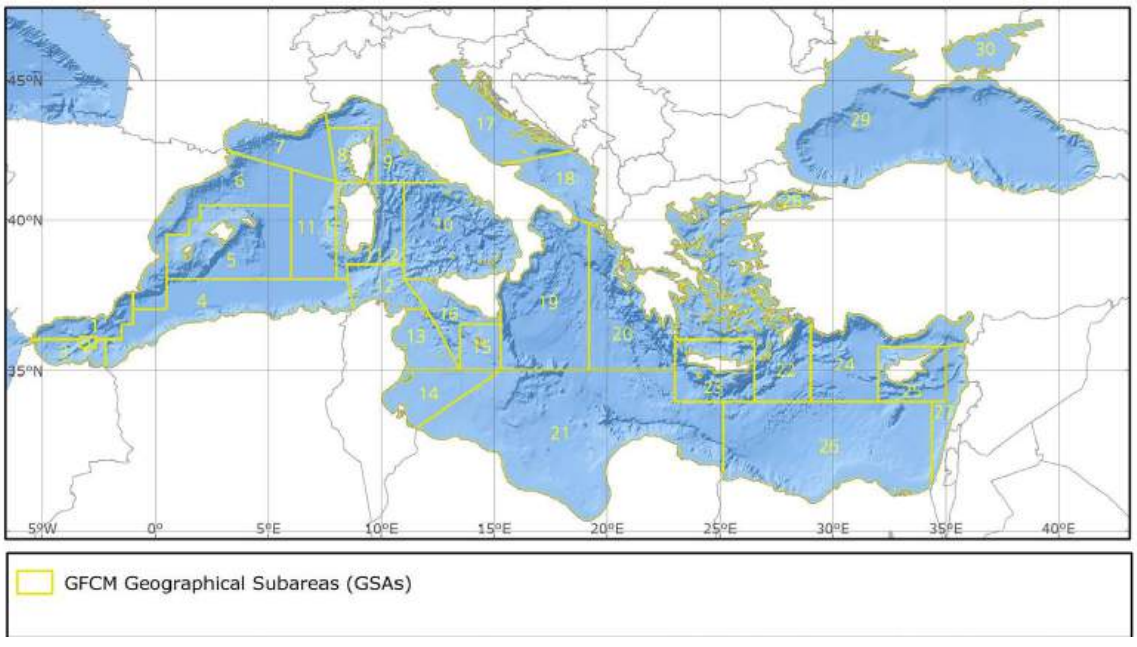
Article XIV status of the organization means that it has autonomous headquarters, Secretariat, and budget. The functions and responsibilities of the GFCM are to ensure the conservation and sustainable use of living marine resources at the biological, social, economic, and environmental levels, as well as the sustainable development of aquaculture in its area of application. The GFCM mandate uses the ecosystem approach to fisheries, and the 2014 amendment requires the Commission to consider negative impacts on marine ecosystems.

The functions of the GFCM expressly include designating Fisheries Restricted Areas (FRAs). These are area-based measures that restrict fishing practices to a designated area for the conservation and management of fisheries resources, as well as for the protection of specific marine ecosystems.

The GFCM area of application comprises the marine waters of the Mediterranean and Black Seas, and includes both national and international waters. It should be noted that national jurisdictions over marine areas are not consistently delineated in the Mediterranean Sea. Recently, some coastal countries are claiming extended jurisdictional zones beyond their territorial waters, including for fisheries purposes. However, much of the Mediterranean Sea is still regarded as international waters. Therefore, the preservation of the marine ecosystems and the living marine resources found therein is ensured through cooperation with relevant regional organizations, including the GFCM. For management purposes, the GFCM has divided FAO Major Fishing Area 37 into 30 geographical subareas (GSAs) (Figure 35).

FIGURE 35

FAO fisheries statistical subareas and GFCM geographical subareas (GSAs) in the Mediterranean and Black Seas



Regulatory capacity

The GFCM is the competent regional body in the Mediterranean and Black Seas for regulating fisheries and for recommending, adopting, and implementing, as necessary, measures to achieve sustainability of marine fisheries and aquaculture activities. The GFCM Contracting Parties and Cooperating non-Contracting Parties (CPCs) undertake to implement any recommendations made by the Commission, with the provision that, if they do not expressly object to them within 120 days, they must

incorporate them into their national legislation. The GFCM also has a number of other important functions for promoting responsible fisheries and aquaculture throughout the Mediterranean and Black Seas, including economic and social aspects.

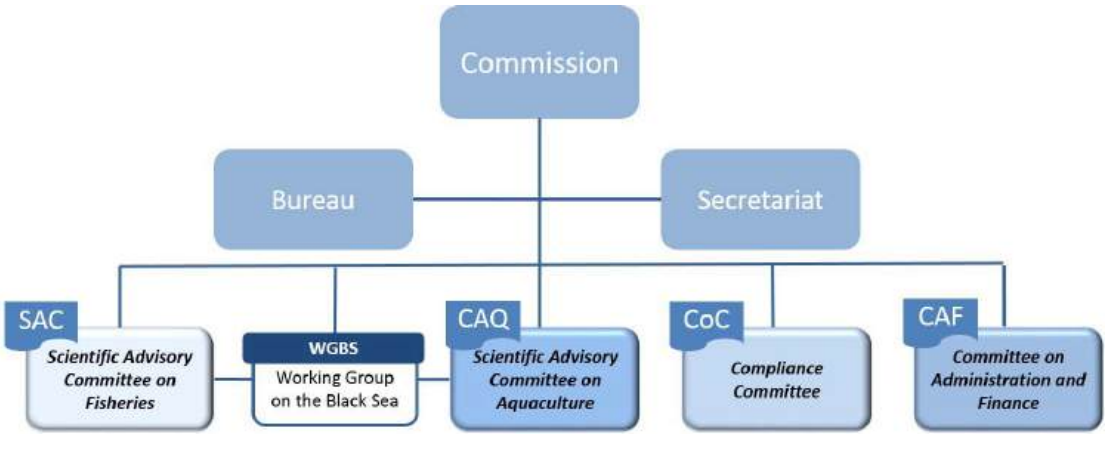
Structure

The GFCM is made up by representatives of its 24 Contracting Parties (22 Mediterranean and Black Sea States, Japan, and the European Union) and three Cooperating non-Contracting Parties, which constitute the Commission. The Commission is the central decision-making body of the GFCM, and its sessions are steered by the Bureau of the Commission. The GFCM implements its activities through its Secretariat and operates during the intersession by means of its subsidiary bodies. The four committees that support the work of the Commission are: the Scientific Advisory Committee on Fisheries (SAC), the Scientific Advisory Committee on Aquaculture (CAQ), the Compliance Committee (CoC), and the Committee on Administration and Finance (CAF). An ad hoc Working Group on the Black Sea is devoted to discuss fisheries and aquaculture issues specifically for this area (Figure 36). The Commission generally meets every year in May-June, but can hold additional extraordinary intersessional meetings. The SAC also meets annually, prior to the Commission meeting.

The SAC's mandate is to provide independent, technical and scientific advice to facilitate the adoption of recommendations and resolutions concerning the sustainable management of fisheries and ecosystems at the regional and subregional levels. The advice of the SAC takes into consideration relevant biological, environmental, social and economic aspects, as well as on issues associated with the ecosystem approach to fisheries, the impact of IUU fishing on populations and ecosystems, and the assessment of biological and ecological effects under different management scenarios.

The SAC, prior to 2014, was supported by the work of thematic subcommittees, including the Subcommittee on Marine Environment and Ecosystems (SCMEE). Following the entry into force of the 2014 amendment, GFCM moved from a thematic to a subregional approach and established subregional committees (SRCs) for the Western Mediterranean, the Central Mediterranean, the Adriatic Sea, and the Eastern Mediterranean to replace the thematic subcommittees and to support of the work of the SAC. This reorganization into subregional committees introduced a more flexible framework, under which both thematic actions and subregional issues are discussed to provide suggestions for the advice of the SAC (GFCM, 2016a).

FIGURE 36
Structure of the GFCM

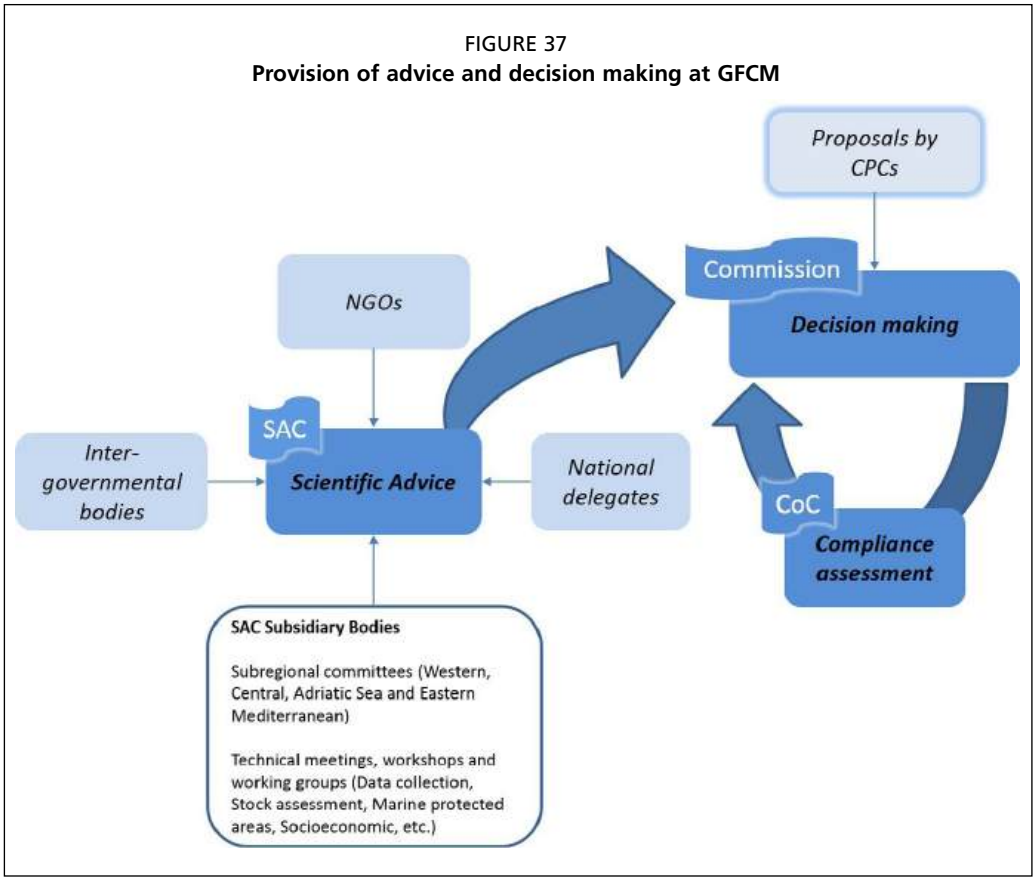


Decision process

The scientific analysis and assessments from the subregional committees (or thematic subcommittees prior to 2014) and other subsidiary expert groups such as technical meetings, working groups, or workshops is reviewed at the annual meeting of the SAC. Based on this review, the SAC then provides integrated advice on the status of stocks, fisheries and ecosystems, and technical advice on priority corrective measures when required. These measures are submitted for consideration to the CPCs, who are invited to propose recommendations and resolutions to be discussed at the annual meeting of the Commission. The overall flow of information and the coordination of the work of the different bodies is ensured by the Secretariat, in coordination with the Bureaus of SAC and the Commission. Once a recommendation enters into force, the Compliance Committee has the mandate to revise the compliance status with all existing recommendations (Figure 37).

Topics related to VMEs and protection of the marine environment and ecosystems historically fell under the mandate of the SCMEE, while more recently they have been discussed in the relevant technical meetings of the subregional committees, working groups and workshops, such as the GFCM Working Group on Marine Protected Areas (MPAs), and incorporate issues such as the relation between FRAs and MPAs, and the identification of potential areas within the Mediterranean and the Black Seas that should be protected.

FIGURE 37
Provision of advice and decision making at GFCM



Relationships with other bodies

There are other regional bodies within the Mediterranean that address issues relating to marine conservation in general. In 1975, only three years after the Stockholm Ministerial Conference that established the United Nations Environment Programme (UNEP), 16 Mediterranean countries and the European Community adopted the Mediterranean Action Plan (MAP). MAP was the first-ever plan adopted as a Regional

Seas Programme under the UNEP umbrella, and was concerned mainly with coastal areas where biodiversity conservation was considered a priority. Originally intended for protecting coastal areas against pollution, the amendment widened its remit to include the marine environment more generally throughout the Mediterranean. The Regional Activity Centre for Specially Protected Areas (RAC/SPA), which was established in 1985 and entered into force in 1999, assists the Barcelona Convention[17] in implementing protocols for specially protected areas and biological diversity. The Members of the Barcelona Convention have established a list of Specially Protected Areas of Mediterranean Importance (SPAMI) in order to promote cooperation in the management and conservation of natural areas, as well as in the protection of threatened species and their habitats.

To strengthen its cooperation with the other organizations operating in the region, the GFCM has signed a total of eleven MoUs with the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), Black Sea Commission, Eurofish, ICES, Centre for Marketing Information & Advisory Services for Fishery Products in the Arab Region (INFOSAMAK), the International Union for Conservation of Nature Centre for Mediterranean Cooperation (IUCN-Med), ATLAFCO, Network of Marine Protected Area Managers in the Mediterranean (MedPAN), Regional Advisory Council for the Mediterranean (RAC-MED), UNEP-MAP, and the World Wildlife Fund (WWF). In 2016, the GFCM, in collaboration with the Secretariats of ACCOBAMS, IUCN-Med, UNEP/MAP through RAC/SPA, and MedPAN developed a Joint Cooperation Strategy on Spatial Protection and Management Measures for Marine Biodiversity. This was to ensure that the conservation and the sustainable use of the open sea in the Mediterranean is achieved with best available knowledge and the application of the precautionary principle and the ecosystem approach, and with the aim to undertake harmonized activities in relation to the spatial-based management and conservation in the open sea in the Mediterranean (GFCM, 2016b, Paragraphs 18, 168).

OVERVIEWS

Bottom fisheries

The narrowness of the continental shelves in the Mediterranean Sea means that most fishing grounds are relatively close to the coast (Sbrana *et al.*, 2002). Bottom fisheries typically operate on the continental shelf, and extend down on the shelf slopes to a depth of around 700–1 000 m (Alemany and Alvarez, 2003; Goñi *et al.*, 2004). The two main deepwater bottom fisheries that occur between 400 and 1 000 m in the Mediterranean are the directed bottom trawl fishery for various shrimp species, and the multispecies multi-gear fishery for European hake (*Merluccius merluccius*).

The first deep-sea bottom trawl fishery in the Mediterranean was for deepwater rose shrimp (*Parapenaeus longirostris*) in the Ligurian Sea in the 1930s, and later spread to other areas for blue and red shrimp (*Aristeus antennatus*) and giant red shrimp (*Aristaeomorpha foliacea*). Catches in all areas of the Mediterranean have increased more or less steadily since the 1950s, with some notably lower catches through the 1970s and 1990s. Catches in recent years are among the highest recorded.

The multispecies hake fishery uses bottom trawls, gillnets and longlines. The trawlers operate mainly in the shallower waters on the continental shelf and slopes, whereas the gillnetters and longlines operate mainly off the shelf and below 400 m: in deeper waters not suitable for trawling. Annual catches of European hake increased from the 1950s to the 1990s, when they reached 50 000 mt, but they declined rapidly at the end of the 1990s, and are currently around half the historical maximum catches.

[17] Formally called: *Convention for the Protection of the Mediterranean Sea Against Pollution* (adopted in 1976).

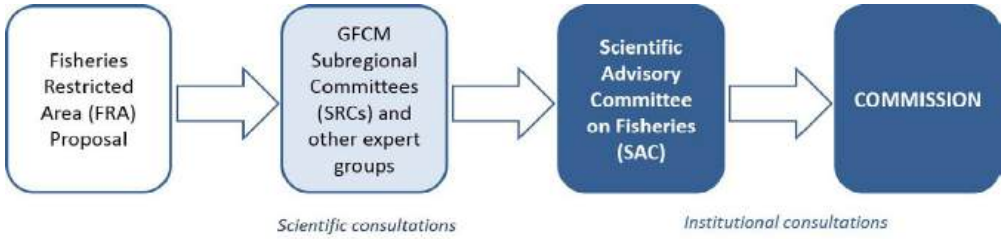
In the Black Sea, bottom fisheries are restricted in depth due to the anoxic conditions of the waters below 150–200 m depth. The maximum depth reached by demersal trawling and bottom-set gillnets in the Black Sea basin is around 100–120 m and most frequently between 80–100 m. Trawl fisheries mainly target whiting (*Merlangius merlangus*) and mullet (*Mullus barbatus*), while gillnets target turbot (*Psetta maxima*) (Knudsen *et al.*, 2010; Ceylan *et al.*, 2013).

Vulnerable marine ecosystems

GFCM has not defined VMEs within its management regulations, and there are no formally declared and adopted VMEs within the Mediterranean Sea. Instead, and through its ecosystem approach, the GFCM has adopted FRAs as a multi-purpose spatial-management tool used to restrict fishing activities in order to protect deep-sea sensitive habitats, such as VMEs, and essential fish habitats. The proposal for the establishment of a new FRA is submitted to the GFCM by a CPC, institution or scientist through a form available on the GFCM Web site (GFCM, 2016c, d), providing information on the area, site description, biological features, human activities and impacts, legal status, and objective of the FRA, including other elements. A review process is undertaken prior to the decision by the Commission regarding the adoption of the FRA (Figure 38).

The GFCM has therefore partially addressed the protection of VMEs, as described in UNGA Resolutions 59/25, 61/105, and others, principally through the establishment of FRAs in its competence area (including international waters). An FRA was defined by the tenth meeting of the SAC, in 2007, as "*a geographically-defined area in which all or certain fishing activities are temporarily or permanently banned or restricted in order to improve the exploitation and conservation of harvested living aquatic resources or the protection of marine ecosystems*" (GFCM, 2007). According to this definition, an FRA can potentially be established to protect any kind of marine resource and habitat (e.g. aggregations of vulnerable sponges, seamount areas, coralligenous formations, seagrass meadows, spawning grounds and reproduction sites for fish resources, etc.) from relevant fishing activities, therefore following criteria in accordance to those established for VMEs in the FAO Deep-Sea Fisheries Guidelines.

FIGURE 38
Process for the establishment of an FRA within GFCM



REGULATIONS AND MEASURES

Bottom fishing areas and exploratory fishing protocols

GFCM fisheries are managed using a suite of management measures that regulate the extent of fishing, and include requirements on fishing effort, VMS, minimum landing size, seasonal closures, mitigation of bycatch and incidental mortality of vulnerable species, data collection, etc. Recently, the GFCM has started to implement multiannual management plans for selected fisheries and stocks and in 2016, a first management plan addressing deep-sea bottom fisheries exploiting European hake and deep-water rose shrimp in the Strait of Sicily (GSAs 12 to 16) was adopted by the Commission. Among a suite of measures, the plan also established permanent spatial closures (i.e. FRAs, see

paragraph below). In general, the most important decision regarding deep-sea bottom fisheries is Recommendation GFCM/29/2005/1 (amended in 2016) that established of ban on using towed dredges and trawl nets below 1 000 m (GFCM, 2016b). This measure was adopted to limit the potential impact of these fisheries on poorly known deep-sea floor ecosystems, in response to the call for action by the UNGA Resolution 59/25 in 2004 to minimize or avoid the effect of trawling in deep habitats.

As a consequence of the aforementioned decision, deep-sea bottom trawl fisheries in the Mediterranean Sea cannot expand further beyond 1 000 m depth. Overall, most of the Mediterranean basin above 1 000 m is considered to be open to fisheries. GFCM has not identified "existing" and "new" bottom fishing areas and no exploratory fishing protocols for new or developing fisheries are in place. However, the spatial distribution of current fishing effort within the Mediterranean Sea is under investigation. In order to enhance the knowledge of the distribution of fishing effort in its area of application, at the moment of writing, GFCM is undertaking several actions to support and guide the implementation of monitoring, control and surveillance (MCS) practices through the integrated use of technologies in line with regional standards, including VMS and automatic identification system (AIS).

Vulnerable marine ecosystems

The GFCM has not yet adopted any specific regulations on VMEs that also include VME indicators, encounter protocols, thresholds, etc. Recently, however, the debate on the need and opportunity for GFCM to further implement the precautionary approach in managing fisheries, to prevent significant adverse impacts on VMEs, and to respond to the international calls for protecting sensitive marine habitats in light of the international obligations has restarted. At the second meeting of the GFCM Working Group on MPAs (June 2015 in Gammarth, Tunisia), the experts recommended GFCM to adopt a regional risk-based approach to prevent significant adverse impacts on VMEs from fishing activities, including the development of a comprehensive list of VME indicators for the region, and the implementation of a precautionary VME encounter protocol and move-on rule, with scientifically based thresholds (GFCM, 2015). In 2016, the SAC and the Commission, at their eighteenth and fortieth sessions, respectively, further discussed the adoption of a VME encounter protocol for the GFCM area of application and advised to advance this by preparing a list of VME indicator species for the Mediterranean Sea, and to hold a working group on VMEs (GFCM, 2016b). GFCM's commitment and willingness to align to international obligations is anticipated to lead to the adoption of precautionary management decisions on VMEs in the near future.

However, the GFCM has protected areas that are known to host organisms that would satisfy the criteria for VMEs according to the FAO Deep-sea Fisheries Guidelines. These areas have been closed to fishing with bottom contact gears, in a manner that is similar to VME closures in other regions, under the measures for FRAs (Recommendation GFCM/30/2006/3). There are also other benthic closures made under the FRA measures that, whilst undertaken to conserve essential fish habitat for commercial fish species, also may serve to protect benthic habitats (Recommendations GFCM/33/2009/1; GFCM/39/2015/2).

Scientific research

The GFCM Commission encourages, recommends, coordinates, and undertakes research and development activities, including cooperative projects in the areas of fisheries and the protection of living marine resources (GFCM, 2014, Article 8g). Research has not directly been reflected in GFCM's measures on protocols for the conduct of research in the Mediterranean and Black Seas, but it is clearly a necessary initial step in the submission of proposals for new FRAs (GFCM, 2016c, d).

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

The following areas have been afforded extra protection based on the need to protect deep-sea sensitive and essential fish habitats (Figure 39; Table 13).

FIGURE 39

Map of areas managed by GFCM that assist in the protection of vulnerable marine ecosystems

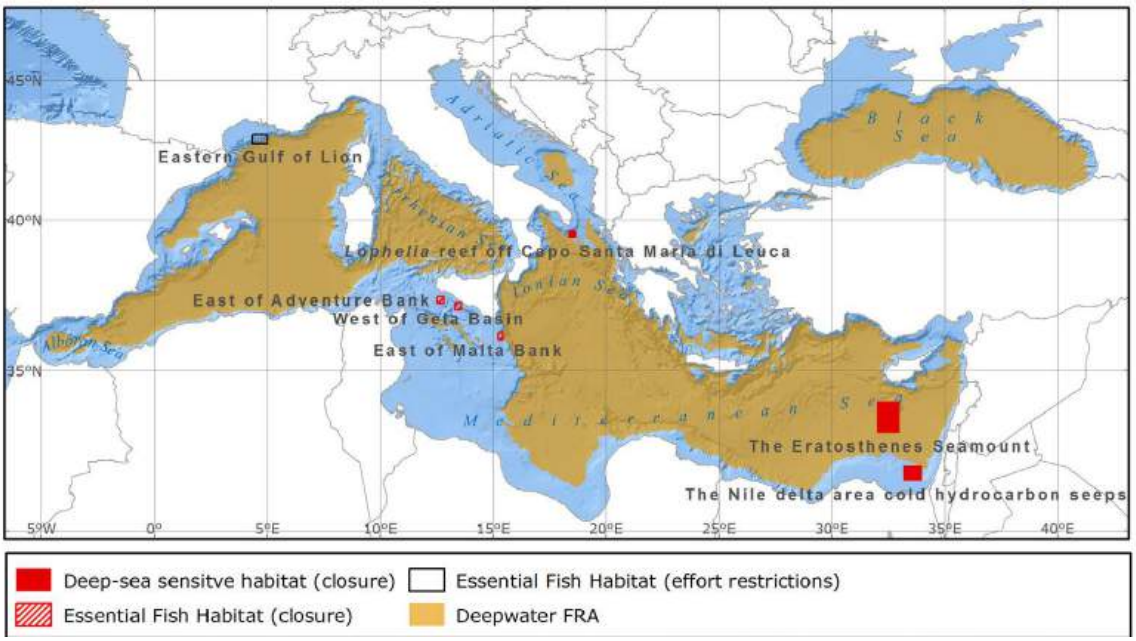


TABLE 13

FRAs regulated by GFCM

Name	Type	Year	Reason	Gear	Recommendation
Deep-water FRA	Closure	2005	To protect unknown fish stocks and deep-sea fish habitats below 1 000 m.	Towed dredges and trawl nets.	GFCM/29/2005/1
Nile delta area cold hydrocarbon seeps FRA	Closure	2006	To protect the deep-sea sensitive habitats.	Towed dredges and bottom trawl nets.	GFCM/30/2006/3
Eratosthenes Seamount FRA	Closure	2006	To protect the deep-sea sensitive habitats.	Towed dredges and bottom trawl nets.	GFCM/30/2006/3
Lophelia reef off Capo Santa Maria di Leuca FRA	Closure	2006	To protect the deep-sea sensitive habitats.	Towed dredges and bottom trawl nets.	GFCM/30/2006/3
Eastern Gulf of Lion FRA	Effort limit	2009	To protect spawning aggregations.	Towed nets, bottom and mid-water longlines, bottom-set nets.	GFCM/33/2009/1
Coastal trawl ban	Closure	2012	For the conservation of sharks and rays.	Trawl nets.	GFCM/36/2012/3
East of Adventure Bank FRA	Closure	2016	Management plan for European hake and deep-water rose shrimp.	Bottom trawl.	GFCM/40/2016/4
West of Gela Basin FRA	Closure	2016	Management plan for European hake and deep-water rose shrimp.	Bottom trawl.	GFCM/40/2016/4
East of Malta Bank FRA	Closure	2016	Management plan for European hake and deep-water rose shrimp.	Bottom trawl.	GFCM/40/2016/4

Deepwater FRA

In 2005, Recommendation GFCM/29/2005/1[18] prohibited the use of towed dredges and trawl nets at depths greater than 1 000 m. The preamble to this recommendation notes that this is mainly for the protection of fish stocks and to halt the expansion of fisheries into deeper waters when the stock status is unknown, as a precautionary measure. However, in 2004 the SAC also made reference to the protection of vulnerable habitats and "*strongly advised to refrain expanding deep water fishing operations beyond the limit of 1 000 m, in view of scientific considerations on the presence both of unmapped sensitive habitats (deep water coral banks, sea vents, sea mounts, etc.), and of the fragile nature of deep water fish assemblages as well as the presence of juveniles of different crustacean species at such depths*". This precautionary decision addresses both the management of deep-sea bottom fisheries and the protection of deep-sea benthic ecosystems. The area below 1 000 m covers a little over 1 700 000 km^2 (about 59 percent of the GFCM area of application).

Deep-sea sensitive habitat FRAs

In 2006, Recommendation GFCM/30/2006/3[19] established three FRAs in international waters in which fishing activities with towed dredges and bottom trawl nets are permanently prohibited with the aim of protecting deep-sea vulnerable habitats. They are not specifically designated as VMEs by GFCM, but the management measure applied is similar to the VME closures in other regions.

"The Nile delta area cold hydrocarbon seeps" FRA (4 378 km^2) is located in Egypt (GSA 26), in the southeastern corner of the Mediterranean Sea in waters between 300 and 800 m deep off the continental slope. The area hosts an exceptionally high concentration of cold hydrocarbon seeps supporting unique living communities of presumably chemosynthetic organisms such as polychaetes and bivalves (GFCM, 2005; Dupré *et al.* 2007).

"The Eratosthenes Seamount" FRA (10 306 km^2) is located in the eastern Mediterranean Sea, about 100 km south of Cyprus (GSA 25), between the Levantine Platform to the south and the Cyprus margin to the north, near the subduction zone of the African plate. This flat-topped seamount measures approximately 120 km in diameter at the base, and rises 1 500 m above the adjacent bathyal plain, with a summit 756 m below sea level. Studies carried out in the area revealed a rich and diverse ecosystem (Varnavas *et al.*, 1988; Galil and Zibrowius, 1998), notably comprised of two species of scleractinian corals (*Caryophyllia calveri* and *Desmophyllum cristagalli*; these were the first records of these species from the Levant Basin, and significantly extended their known depth range), a rare deepwater sponge (*Hamacantha implicans,* known previously from a canyon in the western Mediterranean Sea), a remarkably dense population of the deepwater actinarian (*Kadophellia bathyalis*), and unidentified zoantharians and antipatharians. The high faunal diversity and density indicate a uniquely rich environment in the Levant Basin, possibly an isolated refuge for relict populations of species that have disappeared from the adjacent continental slope. According to the SCMEE (GFCM, 2005), this area represents probably one the most pristine environments found in the Mediterranean Sea, and therefore its protection from fishing activities was considered a priority.

The "*Lophelia* reef off Capo Santa Maria di Leuca" FRA (976 429 km^2) is located off the Italian Coast in the Ionian Sea (GSA 19) at depths between 350 and 1 100 m. Many studies demonstrated the presence of a unique ecosystem of white coldwater corals (Tursi *et al.* 2004; Tavianiet *et al.* 2005) dominated by two colonial scleractinians

[18] On the *Management of certain fisheries exploiting demersal and deep-water species and the establishment of a fisheries restricted area below 1 000 m.*

[19] On the *Establishment of fisheries restrictive areas in order to protect the deep sea sensitive habitats.*

(*Lophelia pertusa* and *Madrepora oculata*), and by two solitary corals (*Desmophyllum cristagalli* and *Stenocyathus vermiformis*). The coral colonies consist of bioconstructed buildups mostly located on muddy mounds widespread in the study area. Other important taxa (Foraminifera, Porifera, Brachiopoda, Anellida, etc.) were identified and classed as characteristic species, associated species, accompanying species and co-occurent species (Tursi *et al*., 2004). Those species also contributed to the complexity of the *Lophelia* reef community, with the presence of many suspension feeders and a complex trophic system.

Essential Fish Habitat FRAs

In 2009, Recommendation GFCM/33/2009/1[20] established the Eastern Gulf of Lion FRA (2 018 km^2, GSA 7), where important spawning aggregations of various species (hake, monkfish, lobsters) are reported to occur. It is located in international waters in the northwestern Mediterranean Sea, between Spain and France, on the eastern part of the continental slope of the Gulf of Lion, and hosts the Estaque, Grand-Rhône, and Petit-Rhône submarine canyons, and a small part of Marti canyon.

To protect spawning aggregations of fish, the area has been protected from possible increases of fishing pressure. It was agreed that fishing effort for demersal stocks by vessels using towed nets, bottom and mid-water longlines, and bottom-set nets would be kept at its 2008 level. Relevant CPCs were asked to submit to the GFCM Secretariat lists of authorized vessels fishing in the area at that time, and were required to prohibit new vessels from fishing there so as to not increase the overall fishing effort. No studies of deep-sea ecosystems in the area were available, but the existence of rare deepwater corals such as *Lophelia pertusa* and *Madrepora oculata* was considered possible, given their recorded presence in similar areas in the western part of the Gulf of Lion (GFCM, 2008, Appendix 3).

In 2012, Recommendation GFCM/36/2012/3[21] imposed the prohibition of fishing with trawl nets within 3 nm off the coast, provided that the 50 m isobath is not reached, or within the 50 m isobath where that depth is reached at a shorter distance from the coast in order to protect coastal sharks and coastal benthic communities. Limited exceptions to this may be granted provided that there is a monitoring plan for the fishery and that there are no significant impacts on the marine environment.

In 2016, Recommendation GFCM/40/2016/4[22] established, among other relevant measures, three FRAs in international waters, across the Strait of Sicily: East of Adventure Bank FRA, West of Gela Basin FRA, and East of Malta Bank FRA. Fishing activity with bottom trawlers is prohibited in these FRAs for the conservation and management of demersal stocks, including European hake and deepwater rose shrimp. The three FRAs cover a total area of 1 698 km^2 (on average 566 km^2 each with a mean depth of 280 m, ranging from 20 to more than 1 700 m). The proposed areas have been selected on the basis of the extensive scientific knowledge on the importance and stability of the nurseries, the ecological and biological particularity of the areas for critical life history stages of overfished commercial stocks, and the long history of overfishing of demersal resources in the northern sector of the Strait of Sicily. This Recommendation, whilst not related to VMEs, also protects any vulnerable habitats that may occur within these closures.

[20] On the *Establishment of a fisheries restricted area in the Gulf of Lion to protect spawning aggregations and deep sea sensitive habitats.*

[21] On the *Fisheries management measures for conservation of sharks and rays in the GFCM area of application.*

[22] On *Establishing a multiannual management plan for the fisheries exploiting European hake and deep-water rose shrimp in the Strait of Sicily (GSA 12 to 16).*

SURVEYS

For the Mediterranean Sea, data from fishery-dependent surveys are usually available from most GFCM countries. Fishery-dependent data collection programmes usually gather data on biological as well as socioeconomic variables. However, fishery-independent scientific surveys do not yet cover the entire GFCM area of application due to their high cost, and comprehensive studies on the biological status of most demersal fish stocks in some Mediterranean Sea areas are still lacking. However, some countries, including those in the European Union, undertake regular fishery-independent surveys. Scientific survey methods and procedures applied in the Mediterranean and Black Seas are described in different manuals such as the MedSudMed (2006), SoleMon (2011), MEDiterranean Acoustic Surveys (MEDIAS) Handbook (2012), and the International Bottom Trawl Survey in the Mediterranean (MEDITS) Handbook (2013) (GFCM, 2016e). Some of the fishery-independent trawl surveys (such as MEDITS), provide some information on deep-sea species. However, there is a generally recognized scarcity of information regarding the distribution of deep-sea habitats in the Mediterranean Sea. Currently, GFCM CPCs are required to report figures for catches, discards of commercial species, incidental catches of vulnerable species (such as, but not limited to, red coral), but with no specific information on fishing depth or identification of deep-sea species (such as corals and sponges).

OTHER INFORMATION

Identification guides

Although several identification guides exist, including for scientific research on biodiversity in deep-sea Mediterranean waters (e.g. see review by Danovaro *et al.*, 2010), no specific guide identifying vulnerable benthic species is available for the Mediterranean Sea.

Data-sharing protocols

The GFCM has an open policy to sharing information relevant to the exploitation and conservation of fish stocks, subject only to the limitations imposed by GFCM Resolution GFCM/35/2011/2 on data confidentiality policy and procedures, which specifies confidentiality aspects as part of the information provided to GFCM by its CPCs. All meeting reports and most of the supporting documents for the Commission and its committees, including the SAC and subcommittees, are published on the GFCM Web site, as is summary information on catches of target species, by country and GSA, and the GFCM list of vessels presumed to have carried out IUU fishing in the GFCM area. Detailed information is also provided on the fishing vessels greater than 15 m length overall authorized to fish in the GFCM area and for vessels fishing in the Eastern Gulf of Lion FRA. Information on vessels authorized to operate within fisheries regulated by management plans, such as the ones operating in small pelagic fisheries in the Adriatic Sea and in the near future in the Strait of Sicily, is also disseminated publicly through the Web site. GFCM, through its "Guidelines on precautionary conservation measures pending the development and adoption of the GFCM multiannual management plans for relevant fisheries at subregional levels in the GFCM area", adopted in 2013 (OTH-GFCM/37/2013/1) provides guidance on sharing data and carrying out preliminary scientific analyses (GFCM, 2013). These are to be presented to the appropriate subcommittees in an agreed format, using the SAC Stock Assessment Forms. GFCM's data confidentiality and access policy is further explained in the DCRF (GFCM, 2016e).

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THE PACIFIC OCEAN

North Pacific Ocean

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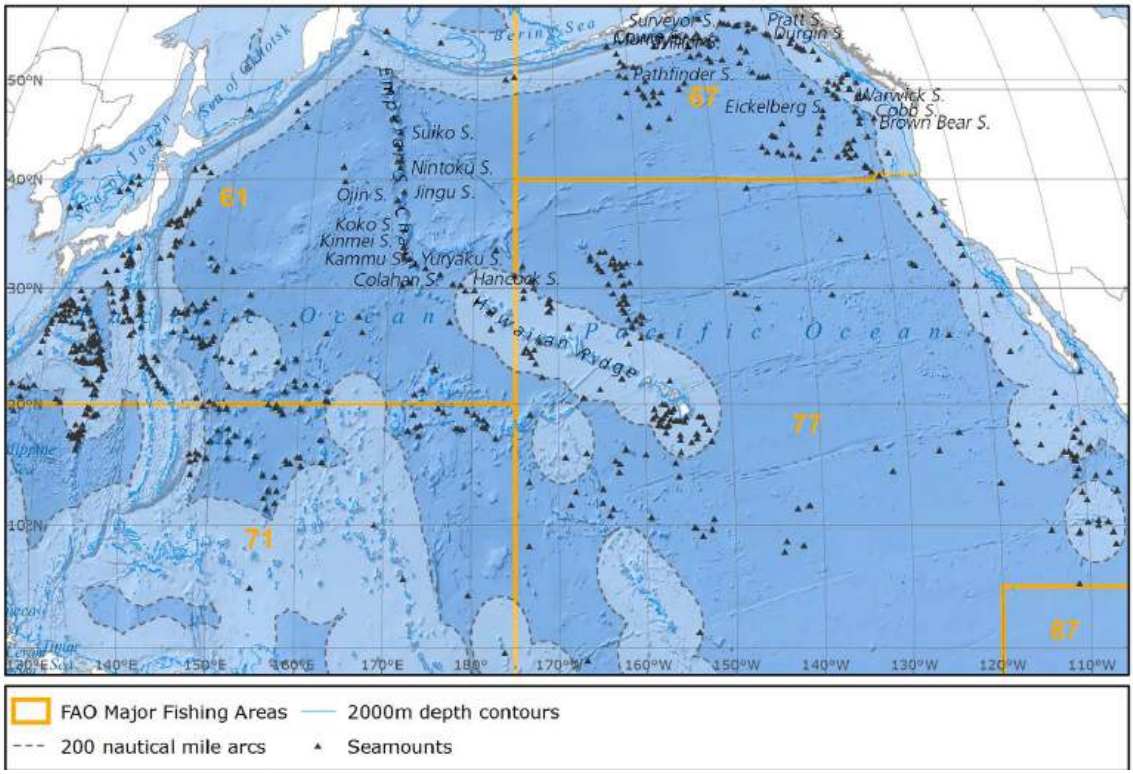
REGIONAL GEOGRAPHY AND BATHYMETRY

The North Pacific Ocean extends from the equator northwards to the Aleutian Island chain and the Bering Sea. It is bounded on the west by Asia and on the east by North America (Figure 40). There are several major marginal seas to the west and north: clockwise from the southwest they are the South China Sea, East China Sea, Yellow Sea, Sea of Japan, Sea of Okhotsk and Bering Sea to the north. All of these, except for the central portion of the Bering Sea, lie within national EEZs. There are also several islands or island groups in the central North Pacific Ocean each with their EEZs.

The bathymetry of the North Pacific Ocean is characterized by several notable features that lie along the edge of the Pacific tectonic plate. There are very deep trenches on the western and northern edges of this plate, with the Pacific Trench (to 10 300 m) to the south of the Kamchatka Peninsula and the Aleutian Trench (to 8 000 m) to the south of the Aleutian Islands. There is a prominent submarine ridge that cuts through the western and central Pacific Ocean, starting with the Emperor Seamount chain in the north and extending southeast to form the Hawaiian

FIGURE 40
North Pacific Ocean showing FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



Seamount chain and the Hawaiian Ridge, which terminate in the Hawaiian Islands. The Hawaiian-Emperor Seamount chain is a well-known example of a large seamount and island chain created by hot-spot volcanism. Each island or submerged seamount in the chain is successively older toward the northwest. Near Hawaii, the age progression from island to island can be used to calculate the motion of the Pacific Oceanic plate toward the northwest. The youngest seamount of the Hawaiian chain is Loihi, which presently is erupting from its summit at a depth of 1 000 **m**. In addition to this, there are groups of seamounts to the northeast of Hawaii, in the northwest Pacific Rim off the Kuri-Kamchatka Trench, and in the Mid-Pacific Mountains in the central western half of the North Pacific Ocean. There are several major fracture zones, mainly in the eastern half of the North Pacific Ocean, which run in a generally west-east direction. There is no mid-ocean ridge in the Pacific Ocean.

The FAO Major Fishing Areas in the North Pacific Ocean include the Northwest Pacific (67), Northeast Pacific (61), the northern parts of the Western Central Pacific (71), the Eastern Central Pacific (77), and the Southeast Pacific (87).

NORTH PACIFIC FISHERIES COMMISSION

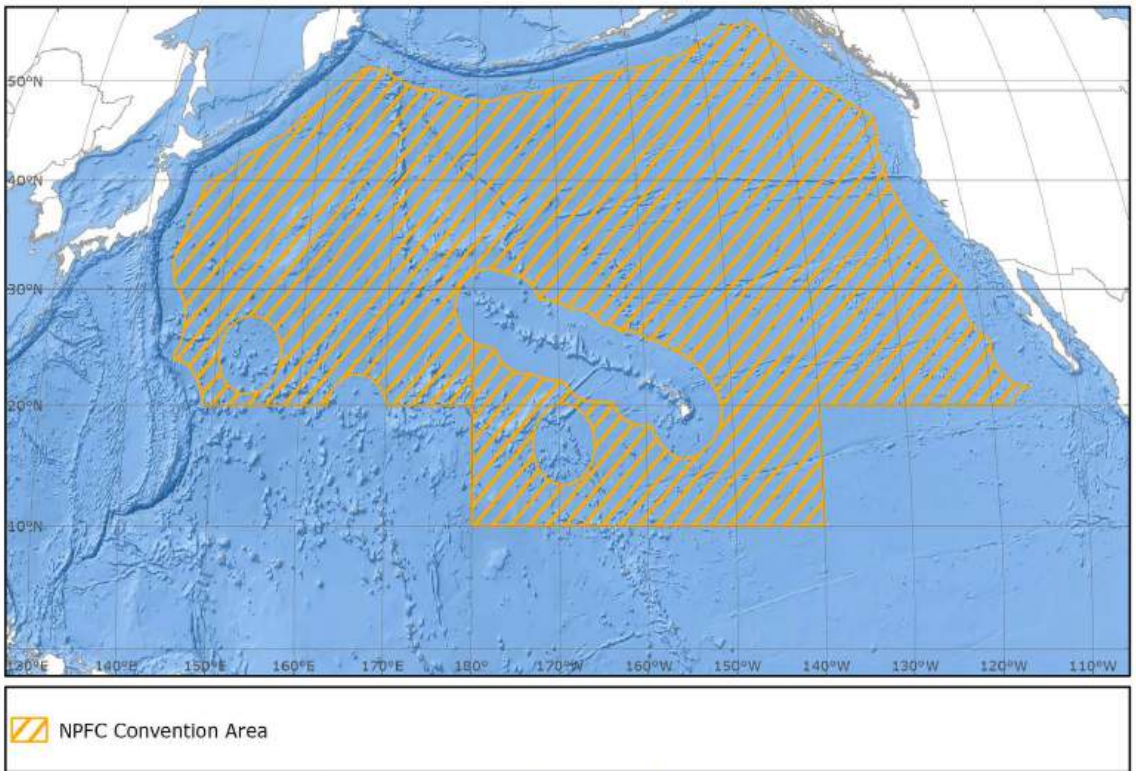
Mandate

The primary deep-seas fisheries regional body in the North Pacific Ocean, north of 10°N, is the North Pacific Fisheries Commission (NPFC), whose Convention entered into force in 2015. However, note that the convention area of SPRFMO extends into the North Pacific Ocean to 10°N on the western side and to 2°N on the eastern side. Details relating to this organization are provided in the South Pacific chapter. There are portions of the North Pacific, lying between the NPFC and SPRFMO areas on the western and eastern sides that are not presently covered by a regional fisheries body.

In response to Paragraph 69 of UNGA Resolution 59/25, which called on states to urgently *"cooperate in the establishment of new regional fisheries management organizations or arrangements, where necessary and appropriate, with the competence to regulate bottom fisheries and the impacts of fishing on vulnerable marine ecosystems in areas where no such relevant organization or arrangement exists"*, the first intergovernmental meeting for this purpose in the North Pacific Ocean was held in 2006. The Convention text was adopted after nine additional meetings in 2012. Subsequently and prior to the entry into force of the Convention in July 2015, several Preparatory Conference meetings were held to continue developing the organization and manage the fisheries on an interim and voluntary basis. Canada, China, Japan, the Republic of Korea, the Russian Federation, the United States of America, and Chinese Taipei negotiated on the Convention.

When the negotiations for the Convention started in 2006, its scope and area were limited to bottom fisheries in the Northwest Pacific Ocean, covering FAO Major Fishing Area 61, since this was the primary area for bottom-trawl fisheries in the North Pacific Ocean. However, in 2009, the scope was expanded to include the Northeast Pacific Ocean and to include all fisheries not currently managed under other international regimes (i.e. not be limited to bottom fisheries). The Convention Area is shown in Figure 41. The Convention on the Conservation and Management of High Seas Fisheries Resources in the North Pacific Ocean, which established the NPFC, entered into force on 19 July 2015. The objective of the Convention (Article 2) is *"to ensure the long-term conservation and sustainable use of the fisheries resources in the Convention Area while protecting the marine ecosystems of the North Pacific Ocean in which these resources occur."* The General Principles (Article 3) reinforce aspects relating to the identification and protection of VMEs through *"…(d) assessing the impacts of fishing activities on species belonging to the same ecosystem or dependent upon or associated with the target stocks and adopting, where necessary, conservation and management measures for such species with a view to maintaining or restoring*

FIGURE 41
The Convention Area of the NPFC



the populations of such species above levels at which their reproduction may become seriously threatened; (e) protecting biodiversity in the marine environment, including by preventing significant adverse impacts on vulnerable marine ecosystems, taking into account any relevant international standards or guidelines including the FAO International Guidelines; (g) ensuring that complete and accurate data concerning fishing activities, including with respect to all target and non target species within the Convention Area, are collected and shared in a timely and appropriate manner…" (NPFC, 2012).

Regulatory capacity

The Commission held its first meeting in early September 2015. That was the first opportunity for Members of NPFC to adopt legally binding conservation and management measures. During the meeting, the Commission adopted two conservation and management measures. The first measure requires each member of the Commission to maintain a record of fishing vessels entitled to fly its flag and authorized to be used for fishing activities in the Convention Area in accordance with the agreed information requirements for vessel registration. The second measure adopted was a conservation and management measure for the Pacific saury (*Cololabis saira*) pelagic fishery. It calls on Members of the Commission to refrain from rapid expansion, in the Convention area, of the number of fishing vessels entitled to fly their flags and authorized to fish for Pacific saury for the existing level until a stock assessment by the Scientific Committee has been completed[23]. However, prior to this and in accordance with UNGA Resolution 61/105, which calls on states participating in negotiations to establish, no later than 31 December 2008, a RFMO/A competent to regulate bottom fisheries to

[23] The Commission held its second meeting in August 2016. The outcomes of that meeting were not available at the time of publication.

adopt measures consistent with Paragraph 83 of the same resolution. The participants in the intergovernmental meetings had developed and adopted *New Mechanisms for Protection of Vulnerable Marine Ecosystems and Sustainable Management of High Seas Bottom Fisheries in the Northwestern Pacific Ocean* (northwestern Interim Measures) *and Interim Measures for Protection of Vulnerable Marine Ecosystems in the Northeastern Pacific Ocean* (northeastern Interim Measures). These interim measures set out the objectives of the long-term conservation and sustainable use of the fisheries resources and the protection of VMEs, in accordance with the UNGA Resolutions (NPFC, 2009a, 2011).

The Interim Measures are voluntary, and exist to guide the participants into adopting their own national measures governing the behaviour of their fishing vessels. States are asked to report on their implementation of the voluntary measures, but there is no penalty for violations. Also, both northwestern and northeastern Interim Measures contain the statement "*Nothing in this mechanism affects, or should be interpreted as affecting, the rights and obligations of States under international law including UNCLOS.*"

Structure

The participants met during 2006–2011 in intergovernmental meetings and, after the adoption of the Convention text, during 2012 in Preparatory Conferences. In 2007, the Scientific Working Group (SWG) was established to provide scientific support and advice to the intergovernmental group on scientific matters necessary to manage the fishery and the ecosystem in which fisheries occur. Other science-related meetings have also been convened to discuss specific issues on target species or ecosystems, including stock status and fisheries for Pacific saury and North Pacific armorhead, as well as VMEs. In 2014, a Technical and Compliance Working Group was also formed to support the related work of the Preparatory Conference (Figure 42(a)).

The Convention entered into force in July 2015. The Commission, which is the decision-making body of the NPFC, consists of the Members. The Convention also establishes a Scientific Committee and a Technical and Compliance Committee, and the Commission may establish "*any other subsidiary bodies from time to time to assist in meeting the objective of this Convention*" (Figure 42(b)).

FIGURE 42(a)
Structure of the interim NPFC before the Convention entered into force on 19 July 2015

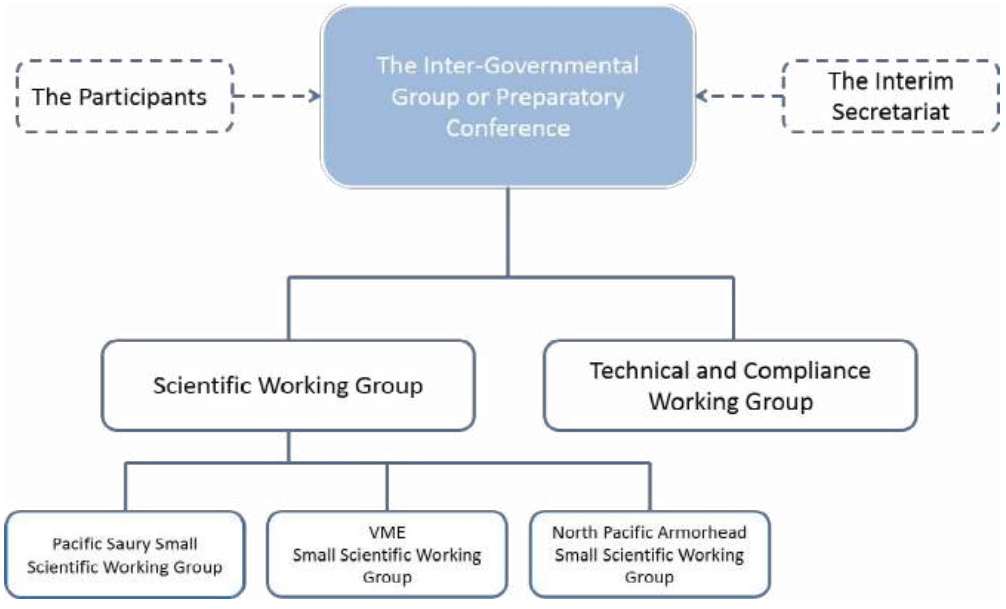
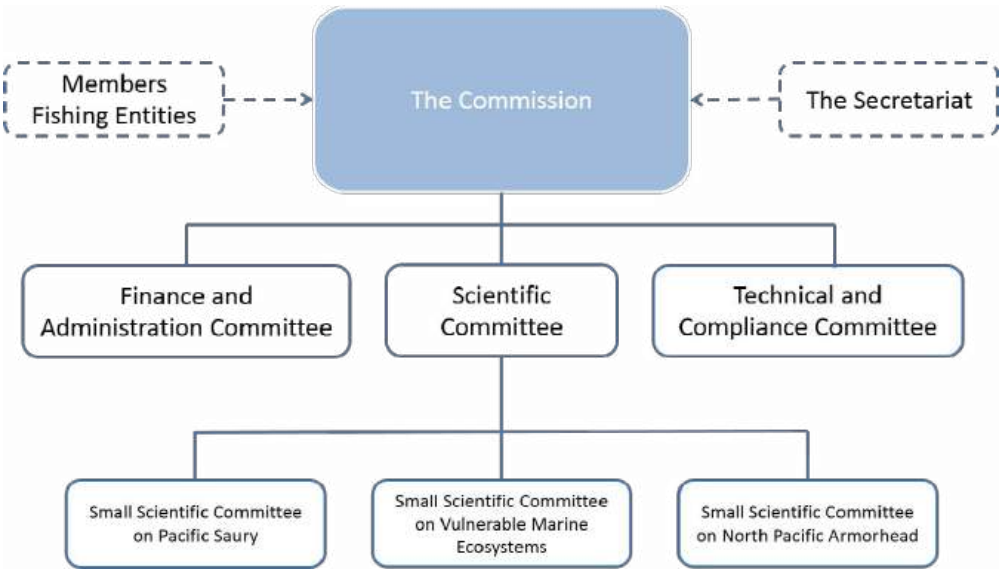


FIGURE 42(b)
Structure of NPFC after the Convention entered into force on 19 July 2015



The Interim Secretariat, which supported the work of the participants during the pre-Convention phase, was located in Tokyo, Japan; the Permanent Secretariat, established after the Convention entered into force, continues at that location.

Decision process

At its first meeting in 2007, the SWG developed its Terms of Reference (ToRs), which guide the group's work and the provision of advice and recommendations (Box 3). They were approved later that same year by the 2nd Intergovernmental Meeting.

At its first meeting, the SWG also identified, in more detail, the work necessary to obtain the information requested at the First Intergovernmental Meeting. This involved the collection and compilation of current and historical information on the bottom fisheries of the northwestern Pacific Ocean, and the associated biological information on the species concerned to develop assessments of stock status. The initial focus was on alfonsino (*Beryx splendens*) and North Pacific armorhead (also known as pelagic armorhead and boarfish, *Pseudopentaceros wheeleri*), both in terms of assessing stock status and of the status of associated and dependent species affected by these fisheries, which include not only the more typical bycatch of finfish, but also of deep-sea corals and sponges. This is elaborated upon more specifically for VMEs and the information

BOX 3
Key elements of the ToRs of the Scientific Working Group

1. To assess the status of key fish stocks affected by bottom fisheries on the high seas within the northwestern Pacific Ocean
2. To assess the status of associated and dependent species affected by these fisheries
3. To determine whether bottom fishing activities would affect the long-term sustainability of these marine species
4. To identify VMEs including, inter alia, sea mounts, hydrothermal vents and cold water corals
5. To assess whether bottom fishing activities would have a significant adverse impact on such VMEs

necessary to identify them. The SWG's initial mandate was to focus its analyses on the northwestern Pacific Ocean, but that was expanded at the 9th Intergovernmental Meeting in 2010 to include providing scientific advice relating to all fisheries in the area covered by the draft Convention in the North Pacific Ocean.

Prior to the Convention entering into force, the *modus operandi* was that the SWG undertakes the work necessary to fulfil its ToRs and agreed work plans. The work was detailed in reports and submitted to the Intergovernmental or Preparatory Conference meetings for any necessary decisions. In general, the Intergovernmental Meetings and Preparatory Conferences also operated under a system whereby texts for agenda items reached meetings through draft working and information papers, developed by Participants or the Interim Secretariat, which were then discussed. The system of specific proposals by participants for consideration by the meeting was used less frequently. That said, until very recently, the participants have been operating in an interim pre-Convention period and that the Rules of Procedure, will guide future processes and work.

After the Convention entered into force, the 1st meeting of the Scientific Committee took place in April 2016. In association with that meeting the 1st meeting of the Small Scientific Committee on Vulnerable Marine Ecosystems, the 1st meeting of the Small Scientific Committee on North Pacific Armorhead and the 1st meeting of the Small Scientific Committee on Pacific Saury, also took place.

Relationships with other bodies

There are a number of other regional intergovernmental bodies operating in the North Pacific Ocean, some of which have regulatory functions. They include the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea (CCBSP), Inter-American Tropical Tuna Commission (IATTC), International Pacific Halibut Commission (IPHC), North Pacific Anadromous Fish Commission (NPAFC), and Western and Central Pacific Fisheries Commission (WCPFC), all with specific fisheries management roles, but not overlapping with species under NPFC's mandate. There is also a regional scientific body covering the North Pacific Ocean called the North Pacific Marine Science Organization (PICES). This organization does not currently address issues relating to the provision of scientific advice to regional fisheries bodies in the North Pacific Ocean; however, PICES has recently established a Working Group on Biodiversity of Biogenic Habitats aimed at advancing understanding of the distribution of deep-sea coral and sponge taxa in the North Pacific and their contribution to seafloor biodiversity.

OVERVIEWS

Bottom fisheries

The fisheries in the North Pacific Ocean have been relatively small, and are described on the NPFC Web site and in Bensch *et al.* (2009). Table 14 lists the main bottom fisheries, by gear, and their target species. Other deepwater species for which catch information has been requested by the NPFC are butterfish (*Hyperoglyphe japonica*), grenadiers (*Coryphaenoides* spp.), mirror dory (*Zenopsis nebulosa*), pencil cardinalfish (*Epigonus denticulatus*), and scorpionfishes (*Scorpaena* spp.).

The trawl fisheries over the Emperor Seamounts were first initiated by Russian commercial trawlers in 1967. In 1969, the Japanese trawlers commenced exploratory fishing operations near the Milwaukee Seamounts, which consists of Yuryaku and Kammu seamounts. The United States managed a permit application bottom trawl fishery for foreign trawlers (inside the US EEZ) that was conducted at the Hancock Seamounts during 1978–1984. Bottom trawlers from Japan were the only participants in this fishery. Since 1986, a commercial fishing moratorium on seamount groundfish has been in effect at the Hancock Seamounts and will continue until North Pacific

TABLE 14
Main bottom fisheries in the North Pacific Ocean

Fishing gear	Target species
Bottom trawl	Alfonsino *Beryx* spp.; North Pacific (= pelagic) armorhead (*Pseudopentaceros wheeleri*)
Bottom gillnet	Warty oreo (*Allocyttus verrucosus*); alfonsino (*Beryx* spp.); North Pacific (= pelagic) armorhead (*Pseudopentaceros wheeleri*)
Bottom longline	Deep-sea sharks; channeled rockfish (scorpionfish) (*Setarches guentheri*); rockfishes nei (*Helicolenus avius, Hozukius guyotensis*, etc.); skilfish (*Erilepis zonifer*)
Traps/pots	Deep-sea (red) crabs (*Geryon* spp.); deep-sea crabs (*Paralomis* spp.)
Coral tangle net	Red/pink corals (*Corallium* and *Paracorallium* spp.) were fished in the ES-NHR area from the mid-1960s to the late 1980s and is possibly still fished by non-participating Participating States.
Hook and line, longline trap	Sablefish (*Anoplopoma fimbria*)

armorhead stocks are rebuilt. A stock assessment research was conducted in 1985–1993 at Southeast Hancock Seamount to determine and monitor population abundance and recruitment. The United States has never had a commercial fishery or conducted commercial fishing operations for seamount fish at the Hancock Seamount or other seamounts to the north.

Some of these seamounts to the northwest have been fished with bottom set gillnets as well as other seamounts that have sharply pointed peaks and in the vicinity of these seamounts trawl fishery could not be operated. These include mainly Koko, Milwaukee, Colahan and C-H, with minor effort on Suiko and Kimmei Seamounts. The bottom trawling and gillnetting occurs mainly around 300–900 m depth, though gillnets are set down to 1 500 m. Catches by gillnets are small compared to catches by bottom trawling. In recent years, only one gillnet-vessel (by Japan) has operated in the area. The number of vessels that actually fished in the Emperor Seamounts area in the recent five years is 1-2 by Korea and 5-7 by Japan; even though a longer vessel list that may be authorized to fish has been reported by Korea, Japan and Russia (NPFC, 2015a).

The two main species caught by bottom fishing gear in the Emperor Seamount-North Hawaiian ridge area are the North Pacific armorhead and alfonsino. Catches of North Pacific armorhead were high in the late 1960s and early 1970s and in a few years exceeded 150 000 mt. These high catches are no longer seen. After a drastic decline from 50 000 mt to 1 000 mt in a matter of a few years (from 1976-1978), catches remained low for 13 years when they dropped to the 1 000–2 000 mt range. An increase to 15 000 mt catch occurred in 1992. This was followed by another 8–9 years of 2 000 mt level catches before 14 000 mt catch was achieved in 2004. Catches have varied over shorter time periods since 2004 and spiked to 20 000 mt twice (in 2010 and 2012). This pattern of catch indicates that catches are fueled by the fish that recruits into the fishery at ages 1–2 years. The alfonsino fishery started soon after the decline of the North Pacific armourhead fishery in the mid- to late 1970s and, after initial higher catches, has fluctuated around 300 mt per year. The information reported to FAO is incomplete and also includes catch records from the whole of the northwestern Pacific Ocean including national waters.

Canada has also fished on seamounts in the high seas waters off the coast of western Canada and the Gulf of Alaska for sablefish (*Anoplopoma fimbria*) using longline hook and longline trap gear (Anon., 2013). The fishery began in the 1970s and four seamount aggregations have been fished since Canada joined NPFC: Eickelberg Seamounts, Warwick Seamount, Cobb Seamount, and Brown Bear Seamount. This fishery is seasonal and is subject to Canadian management regulations that control fishing effort through seasonal closures, permitted gears, and minimum landing sizes. There is also real-time and verified monitoring of catches via electronic monitoring systems. Other seamounts fished by Canada from 1992–2009 in Gulf of Alaska include: Surveyor, Pratt, Durgin, Cowie, Murray, Miller, and Pathfinder.

It is known that there was a coral tangle net fishery for precious red/pink coral *Corallium* and *Paracorallium* spp. in the Emperor Seamount Chain and North Hawaiian Ridge area from the 1960s to the 1980s. The exact locations of many of the fished areas are unknown and this fishery has largely, if not entirely, ceased.

Vulnerable marine ecosystems

Interim Measures were adopted in 2007 and 2009 for the northwestern Pacific, and in 2011 for the northeastern Pacific. These remained in force until 2016 and supported UNGA Resolution 61/105 and the FAO Deep-sea Fisheries Guidelines. Participants have reported on implementation of these measures. Reports on the identification of potential VMEs by Canada, Japan, the Republic of Korea, the Russian Federation, and the United States of America can be found in the national reports on VMEs and the assessments of impacts caused by bottom fishing activities (NPFC, 2015b).

REGULATIONS AND MEASURES

Background

The intergovernmental negotiations which resulted in the establishment of NPFC started in 2006, and concluded in 2011 with the adoption of the Convention text. Prior to the entry into force of the Convention on 19 July 2015, the interim measures adopted by the Participants were applied on a voluntary basis. The Participants have met about twice a year since 2006. NPFC have not adopted binding measures since entering into force, and the voluntary measures continue on an interim basis. Considerable effort has been made to abide by the calls made in the UNGA Sustainable Fisheries Resolutions related to bottom fisheries and the protection of VMEs, in particular UNGA Resolutions 59/25, 61/105, and 64/72.

The Interim Measures for the northwestern Pacific Ocean adopted by the Participants in February 2007, and subsequently revised in October 2007, October 2008 and February 2009, among other things: (1) limit fishing effort in bottom fisheries 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, and (2) limit bottom fisheries to seamounts located south of 45°N latitude and prohibit bottom fisheries from expanding into areas of the northwestern Pacific Ocean where no such fishing is currently occurring. Exceptions to these restrictions may be granted in cases where it can be shown that any fishing activity beyond such limits or in any new areas would not have significant adverse impacts on marine species or VMEs. Such fishing activity is subject to an exploratory fishery protocol.

Interim Measures for the northeastern Pacific Ocean were adopted in March 2011. Among other things, they (1) prohibit vessels from engaging in directed fishing on four orders of coral as well as any other indicator species for VMEs as may be identified, and (2) call for the closure of areas where VMEs are known to occur or are likely to occur, based on the best available scientific information, unless conservation and management measures have been established to prevent significant adverse impacts on VMEs.

Bottom fishing areas

Paragraph 7 of the northwestern Interim Measures requests information from participating States on fished areas, including gear deployed and fishing effort for 2002–2006, for the purpose of defining the fishing footprint (NPFC, 2009a). At the 4th Intergovernmental Meeting in 2008, the existing trawl footprint was identified as the summits, and the bottom gillnet footprint as the summits and slopes, of the following seamounts: C-H, Colahan, Jingu, Kammu, Kimmei, Koko, Nintoku, Northern Koko, Ojin, [Showa], Suiko, Younei, and Yuryaku (NPFC, 2008).

These Interim Measures also limit bottom fisheries to the seamounts already fished in areas south of 45°N, and prohibit bottom fisheries in other areas of the western

North Pacific covered by the new Convention (i.e. north of 45°N (NPFC, 2009a, Paragraph 4B)). New fishing areas are defined as "*Any place other than the fished seamounts above is to be regarded as a new fishing area.*" (NPFC 2009a, Annex 2, 4(2)).

The northeastern Interim Measures do not define fished and unfished areas (NPFC, 2011).

Exploratory fishing protocols

An Exploratory Fishing Protocol was adopted at the 6th Intergovernmental Meeting in 2009 (NPFC, 2009a, Annex 1). It applies to both the northwestern and northeastern Pacific Ocean, as per Paragraph 10 of the northeastern Interim Measures. The Interim Measures define exploratory fisheries as bottom fishing in new fishing areas or with bottom gear not previously used in existing fishing areas. Exploratory fisheries are to be precautionary in nature, and are subject to prior approval of a fishing plan by the SWG. Any such plan has to follow the guidelines in Annex 2 of the Interim Measures. "*Science-based Standards and Criteria for Identification of VMEs and Assessment of Significant Adverse Impacts on VMEs and Marine Species*", which is assessed in accordance with the criteria in Annex 3 of the Interim Measures "*SWG Assessment Review Procedures for Bottom Fishing Activities*". Exploratory fisheries are permitted if it can be shown that they would not have significant adverse impacts VMEs or other marine species. Vessels conducting the fisheries must be equipped with a satellite monitoring device and carry an observer, and the State participating in the exploratory fishery must provide a report to the SWG within three months of the end of the fishery or 12 months after its commencement, whichever is sooner. The SWG then makes a recommendation, to the Intergovernmental (or Preparatory Conference) meeting who make a decision on the future of the fishery, and adopt any additional measures as required. States adopt their own measures, as appropriate.

Vulnerable marine ecosystems

The definition and identification of VMEs, as well as the assessment of significant adverse impacts on VMEs, are provided in Paragraphs 3–5 of Annex 2 of the northwestern Interim Measures, which follow the criteria in the FAO Deep-Sea Fisheries Guidelines. In addition to these criteria, the assessment of whether a specific seamount that has been fished is a VME or contains VMEs could include pictures collected by cameras on remotely operated underwater vehicles (ROVs) or drop cameras, biological samples and bathymetry maps. Identification of VMEs in new fishing areas is also taken into account in the exploratory fishing protocol.

Encounter protocols

Paragraph 4F of the northwestern Interim Measures contains a protocol for encounters with cold-water corals which requires fishing vessels to cease fishing and move at least 5 nm away prior to further fishing, in order to avoid additional encounters with that VME. The location and species in question must be reported to the Interim Secretariat, which notifies the other Participants so that appropriate measures can be adopted.

There is no encounter protocol in the northeastern Interim Measures.

Vulnerable marine ecosystem indicators

While Annex 2 of the northwestern Interim Measures provides examples of species groups, communities' and habitat-forming species that are documented or considered sensitive and potentially vulnerable to deep-sea fisheries on the high seas, and which may contribute to forming VMEs, VME indicators have not been agreed upon by the Participants. However, the northeastern Interim Measures prohibit directed fishing on four orders of coral (Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia), as well as any other indicator species for VMEs as may be identified. Furthermore, those same four

orders of coral have been included in the encounter clause in the northwestern Interim Measures.

Thresholds

No threshold levels have been agreed by the Participants.

Impact assessments

The northwestern Interim Measures require assessments of the impacts of fishing activity on marine species and VMEs, for existing as well as for new and exploratory fisheries. Impact assessments are to be undertaken in accordance with science-based standards and criteria, as defined in the Interim Measures. The results of any impact assessments are to be made publicly available through agreed means.

The impact assessments called for in the northeastern Interim Measures are required for all existing fisheries and for those that are likely to take place. Here impacts are defined as significant adverse impacts on VMEs, and with Paragraph 83(a) of UNGA Resolution 61/105 and the FAO Deep-sea Fisheries Guidelines. As with the northwestern Interim Measures, the results of any impact assessments are to be made publicly available through agreed means.

Impact assessments on VMEs and marine species undertaken by Canada, Japan, the Republic of Korea, the Russian Federation, and the United States of America are available online (NPFC, 2015b). No current fisheries are reported to be having significant adverse impacts on VMEs, although it is acknowledged that information is limited, and that the Participants have not reached agreement on identifying VMEs.

Observers

The northeastern Interim Measures call for 100 percent observer coverage of bottom fishing vessels operating in the Convention Area. The northwestern Interim Measures do not contain a required percentage for observer coverage, but stress "*the importance of a high level of observer coverage in order to obtain the most accurate and complete data and information possible on ongoing fishing activities. In reviewing assessments on impacts of fishing activity on marine species or any VMEs, the presence of observers on board vessels should be a critical factor in assessing the accuracy and completeness of the data and information in support of such assessments.*" The collection of observer data is guided by Annex 4 (*Format of National Report on Observer Program*) of the northwestern Interim Measures.

> Article 13(6) of the Convention stipulates that "*Fishing vessels engaged in bottom fishing in the Convention Area shall have one hundred (100) percent coverage under the Observer Program.*"

Scientific research

The northwestern Interim Measures, Paragraph 7B, specify that the collection of scientific information from each bottom fishing vessel operating in the area specified should include catch and effort data and related information such as time, location, depth, temperature, etc. They also state that, as appropriate, information collected by research vessels should also include physical, chemical, biological, oceanographic, meteorological, etc. and ecosystem surveys.

The northeastern Interim Measures state that scientific research activities for stock assessment purposes are to be conducted in accordance with a research plan that has been provided to the SWG prior to the commencement of such activities.

Review procedures

The Interim Measures are constantly under review, subject to the advice of the SWG as and when it receives new information that will assist in the protection of VMEs.

Other regulations that also protect benthic areas

No other regulations that also protect benthic areas have been adopted by the Participants.

Gear restrictions

No fishing gear restrictions that help reduce impacts on benthic species have been adopted by the Participants.

Other spatial management measures

No other spatial bans on gears that would help to protect benthic species have been adopted by the Participants.

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

Closed areas

The Participants have not agreed to close any areas for the protection of VMEs (see "Domestic Measures" below).

Bottom fishing areas

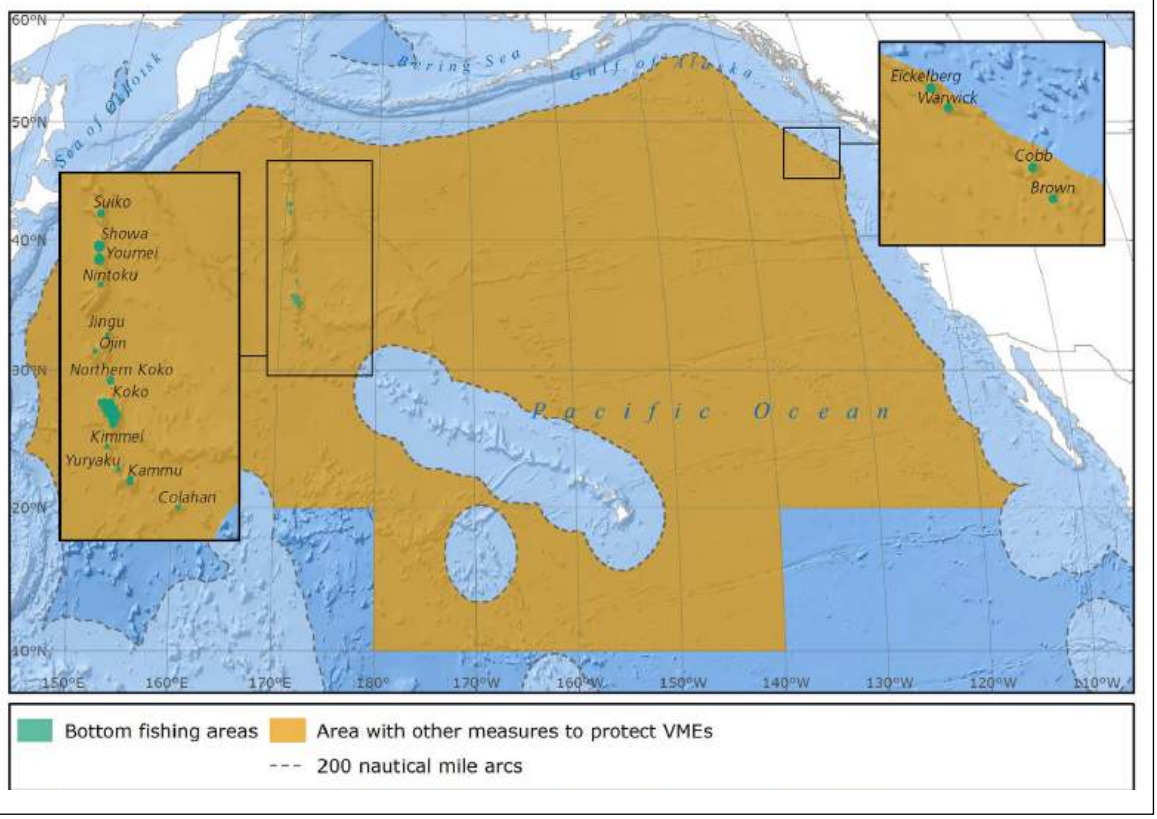
The Participants have identified areas that have been fished in the high seas part of the North Pacific Ocean, and all are located on seamounts (Figure 43).

Other access regulated areas

The Participants have identified high-seas areas in the North Pacific Ocean in which there are other interim measures to identify and protect VMEs where they are not currently known to exist (Figure 43).

FIGURE 43

Map showing the location of the identified bottom fishing areas that are along the Emperor-Hawaiian Seamount chain in the northwestern Pacific and on four seamounts in the northeastern Pacific, and the areas subject to other measures to protect VMEs



SURVEYS

In order to collect detailed information about the resources, Japanese, Korean, Russian (including the former USSR), and United States research vessels have conducted surveys since the initiation of the fisheries on the distribution and biology of the North Pacific armorhead and alfonsino resources, directed at identifying and quantifying fishable resources and associated environmental conditions. The first phase of these exploratory fishery surveys contributed to the development of the trawl fishery at several seamounts, including C-H, Colahan, Jingu, Kammu, Kimmei, Koko, Showa, Youmei, and Yuryaku in the Emperor Seamount Chain from 30° to 46°N. Since 2009, Japan is the only country that carries out an annual survey over the Emperor Seamounts area that provided information on fishable stocks and benthic habitats. Very few of these surveys have been published and are available to the public, although most have been submitted to the SWG (Table 15).

In addition, Korea has had scientific observers on its two fishing vessels since 2012 to collect coral specimens and make observations of their catches and fisheries impact on corals and VMEs.

OTHER INFORMATION

Reported encounters

There have been no reported instances of encounters with VMEs.

Exploratory fishing

There have been no applications to conduct exploratory fisheries.

Identification guides

Field guides were discussed during the fourth and fifth meetings of the SWG, where Japan and the United States of America presented two existing guides, "*An Easy Identifying Guide to Corals in Emperor Seamount Area*" (SWG5/WP10/J) and "*A Field Guide to Alaska Corals*" (SWG5/WP10/US). The two countries provided a joint draft of the "*Field Guide to Corals*" (SWG6/WP5). This guide, which is still being developed and is not currently publicly available, is not intended to be an identification guide, but a tool to assist observers and other onboard personnel with collecting the necessary data and provide guidance on the preferred ways to preserve specimens for future identification by experts. Furthermore, Canada and the United States of America have developed a photo-documented species inventory list for Cobb Seamount (Du Preez *et al.* 2015).

Data sharing protocols

The northwestern Interim Measures contain a reference in Paragraph 7D, to the agreed Interim Data Handling and Data Sharing Protocols that are contained in the report of the 2nd meeting of the SWG in 2007.

Domestic measures

Some states have adopted domestic measures that support the protection of VMEs, specifically:

- Japan and Korea prohibit fishing at depths greater than 1 500 m (TCWG1/WP4/K and Japan (2008a))
- Japan has increased the required distance between the sea floor and bottom-set gillnets from 70 to 100 cm (Japan, 2008b)
- Japan and Korea will apply their own standards, based on the NAFO encounter protocol, modified to suit the fished seamounts in the western North Pacific (NPFC, 2009b)

TABLE 15
Surveys undertaken in the North Pacific Ocean to survey the resources and gather information on benthic habitats

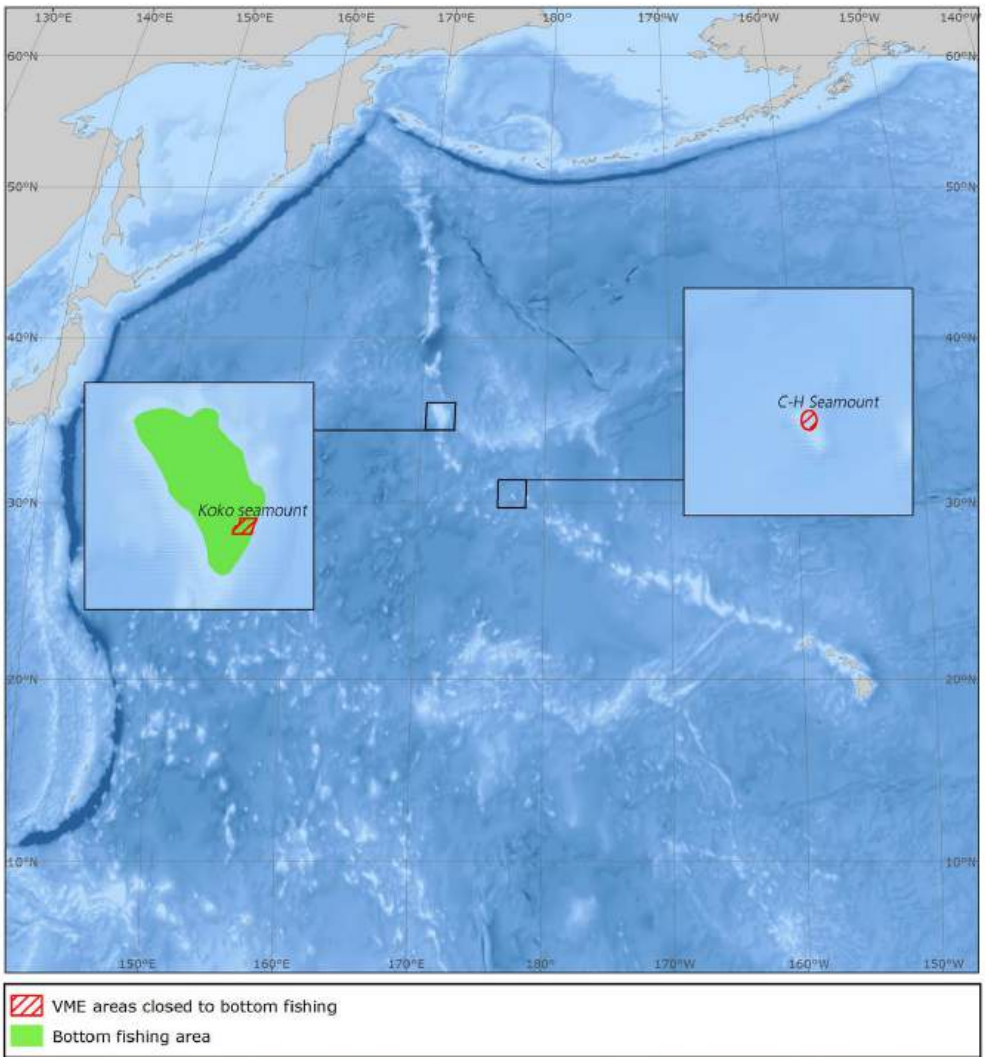
1972-2007	Japan: Several bottom trawl surveys since 1972 (SWG1) for bottom fish resources (Sasaki, 1986).
2002	USA: National Oceanic and Atmospheric Administration expedition to Warwick Seamount that highlighted the unique nature of the ecosystems in this area (SWG9).
2004	Korea: scientific surveys for fisheries resources by three vessels, one research vessel, one bottom trawler and one bottom longliner on the high-seas areas of the northwestern Pacific Ocean (SWG1, 2). 235,085 kg of fish were caught by the three vessels, and 46 species were identified (NWPBT/02/SWG-01).
2006	Japan: ROV survey conducted in 2006 by *RV Kaiyo Maru* to observe bottom environment. Invertebrate benthos sampled by the survey were identified to lowest possible taxonomic rank, and number of animals were counted (NWPBT/02/SWG-04).
2007	Japan: *RV Kaiyo Maru* survey on the Emperor seamount chain for accurate topographical map by GPS and acoustic data (NWPBT/03/SWG-07) and ROV survey (NWPBT/03/SWG-08).
2008	Japan: *RV Kaiyo Maru* survey of the Emperor seamount chain for underwater camera observation, benthos sampling and acoustic measurements of seafloor topography (SWG4/WP8/J). Russia: data on locations of incidental coral captures (SWG4/WP19/R). Russia: data on locations of net loss or hang-ups (SWG4/WP20/R). USA: Drop-camera photography over SE-NHR seamounts showed low density of *Corallium* spp. (SWG4/WP21). Japan: Species list of invertebrates observed by ROV in the North Pacific Seamounts group (SWG4/WP23). Japan: Location of net loss or hang-up from Japanese research vessels (SWG5/WP5/J) Russia: Vertical profile data associated with research surveys (SWG5/WP11/R and SWG6/WP10/R). Korea: Location of net loss or hang-up (SWG6/WP12/K).
2009	Korea: coral research (SWG 6). Russia: *Tiburon* undertaking research survey. Report given at SWG9 (SWG9/WP8/R) Japan: Preliminary results of the Japanese scientific observer survey in the northwestern Seamounts area during 2005–2008 (SWG7/WP6/J). Japan: Scientific surveys of the Emperor Seamount Chain for underwater camera observation of deep sea corals, benthos sampling and acoustic measurement of seafloor topography (SWG9/WP4/J)
2010	Japan: Scientific surveys of the Emperor Seamount Chain for underwater camera observation of deep sea corals, benthos sampling and multi-beam sonar measurements of seafloor micro-topography (SWG10/WP4/J). Japan: New seamount bathymetries of the northwestern Pacific Seamounts (SWG8/WP3/J).
2011	Japan: Scientific surveys of the Emperor Seamount Chain for underwater camera observation of deep sea corals, benthos sampling and multi-beam sonar measurements of seafloor micro-topography (SWG10/WP5/J). Russia: Koko seamount (SWG10/WP11/R). Korea: Commercial vessels in Emperor Seamounts in 2010-2012 (0.3-2.5 kg corals per haul) (SWG10).
2012	Canada/USA: ROV and AUV survey on Cobb Seamount (21-26 July 2012) (SWG10; Curtis *et al.* 2015). Japan: Scientific surveys of the Emperor Seamount Chain for underwater camera observation of deep sea corals, benthos sampling and multi-beam sonar measurement of seafloor micro-topography (SWG11/WP3/J). Russia: Result of investigation of bottom sediment and organisms (SWG10/WP11/R).
2013	Japan: Scientific surveys of the Emperor Seamount Chain for ROV and underwater camera observation, benthos sampling, multi-beam sonar measurement of seafloor micro-topography (SWG12/WP7/J).
2014	Japan: Scientific surveys of the Emperor Seamount Chain for ROV and underwater camera observation, benthos sampling, multi-beam sonar measurement of seafloor micro-topography.

Note: There are references in this table to NWPBT/… or SWGx/… documents that are available only to Members of NPFC. They are included here as a source for Members and for completeness.

- Korea, Japan and the Russian Federation voluntarily closed an area on the southeast side of Koko seamount (south of 34°57′N, east of the 400 m isobaths, east of 171°54′E, north of 34°50′N) to bottom fishing in 2009 (Figure 44). Surveys have found higher densities of corals have been found in this area, which lies below (east of) the 400 m isobaths (NPFC, 2009b). Although there is no limit to the east direction, its area will be about 180–190 km^3 if the east boundary is set at the 1 500 m isobaths (Japan, 2008a)

FIGURE 44

National closure by Japan, Korea and Russia to protect known or likely VMEs and the approximate existing fishing area on the seamount (the lower depth boundary of the closures are shown here at 1 500 m depth, but not actually given in NPFC (2009b))



- Korea, Japan and the Russian Federation voluntarily closed the C-H Seamount to bottom fishing in 2009, mainly to protect North Pacific armorhead. The closure area has no delimited boundaries (NPFC, 2009b)
- Taiwan Province of China does not authorize vessels to operate a coral drag fishery that was once used to catch red corals *Corallium* spp. (NPFC, 2009c).

New measures for 2017

The NPFC Commission met on 24-26 August 2016 and adopted measures for bottom fisheries and the protection of VMEs in the northwestern and northeastern Pacific Ocean (NPFC, 2016a, b, c). These new measures are binding and are based on the previous voluntary interim measures that were adopted in 2009 and 2011 respectively. There are, however, some important changes.

VME Indicators, threshold levels, and the move-on rule

The interim measures for the northwestern Pacific Ocean note that VMEs are, in particular, seamounts, hydrothermal vents and cold water corals, and that cold water corals include Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia. Whereas,

the northeastern interim measures makes reference to the FAO Deep-sea Fisheries Guidelines for characteristics of VMEs. There are no threshold values given in the interim measures. The new measures for both areas do not specifically associate VMEs with physical features, but retains the list of cold water coral species. The new measures also provide a threshold value of 50 kg of cold water corals in one gear retrieval that identifies an encounter and elicits reporting and a move-on rule, which is now set at 2 nm. The move-on distance in the northwestern interim measures was 5 nm whereas the northeastern interim measures had no encounter protocols or move on rule.

Bottom fishing areas
These measures remained unchanged except that the new measures prohibit bottom fishing below 1 500 m unless undertaken under an exploratory fishing protocol in the northwestern Pacific Ocean.

VME Closures
The southeastern part of the Koko seamount, which was a closure implemented by a State, is now closed to NPFC members to protect VMEs. The C-H seamount, which was originally closed to mainly protect Pacific Armorhead, is now also closed to protect VMEs. However, both seamounts can be fished subject to the provisions of an exploratory fishing protocol. There are no closures in the northeastern Pacific Ocean.

Bottom fishing and gear restrictions
The new measures prohibit bottom fishing from November to December and require that gillnets be set with the footrope at least 70 cm above the sea floor for the northwestern Pacific Ocean. There is also a restriction on the catch on Pacific Armorhead in the northwestern Pacific Ocean. No similar measures were adopted for the northeastern Pacific Ocean.

Observers
The new measures require observer coverage on all vessels undertaking bottom fishing in the northwestern Pacific Ocean, and only on exploratory fishing vessels in the northeastern Pacific Ocean.

New structure
The new measures have been updated to reflect the current committee structure of NPFC following its entry into force in 2015.

ACKNOWLEDGEMENTS

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South Pacific Ocean

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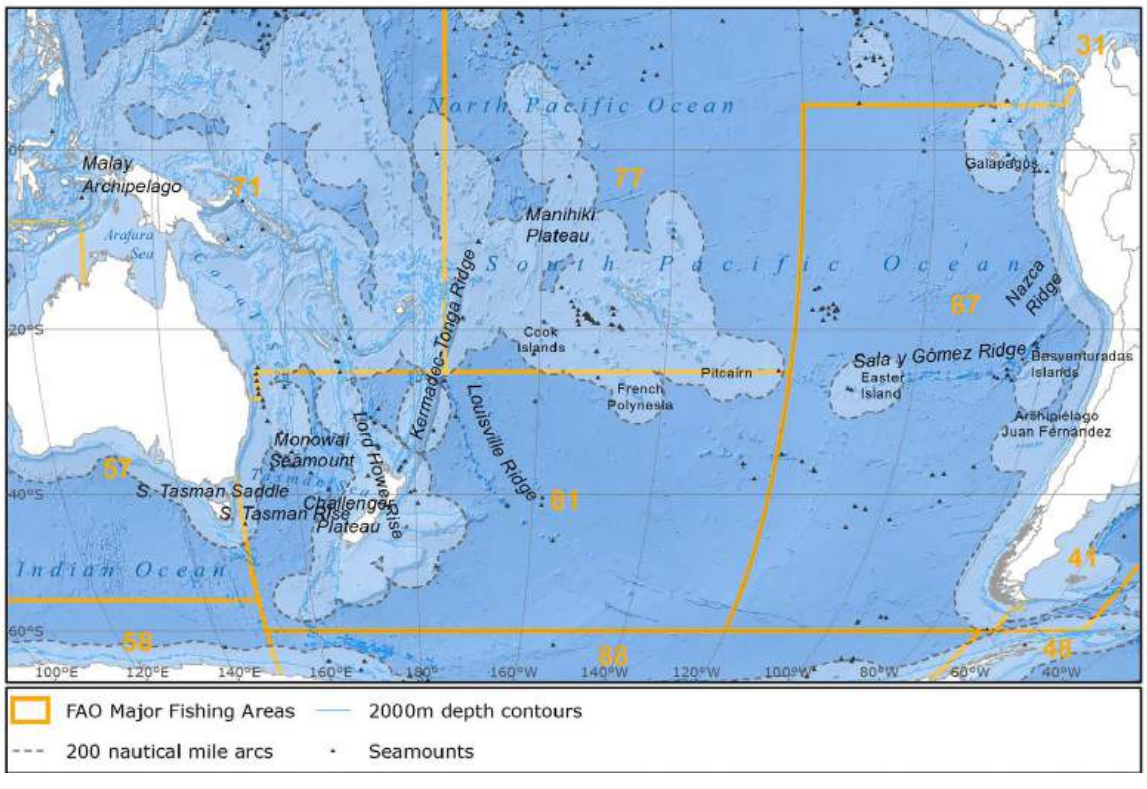
REGIONAL GEOGRAPHY AND BATHYMETRY

The South Pacific Ocean is bounded by the equator to the north, the Southern Ocean to the south, the Malay Archipelago, Australia, and a line south from Tasmania at 146°55'E in the west, and the coast of South America in the east. The South Pacific Ocean includes five FAO Major Fishing Areas (71, 77, 87, 81, and 57), many of which extend into other ocean regions (Figure 45). There are over 30 000 islands in the South Pacific Ocean, many of them are isolated and remote. To the west are the islands and island groups of Australia and the Malay Archipelago. In the western central South Pacific Ocean are the islands and island groups of Oceania, comprising Melanesia, Micronesia, and Polynesia,

FIGURE 45
South Pacific Ocean showing FAO major fishing areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



many of which are associated with the boundary between the Australian and Pacific tectonic plates. The band of islands in Polynesia extends more or less eastwards and includes Niue, French Polynesia, Cook Islands, and Pitcairn Island, and ends at the very remote Easter Island. The islands of the South Pacific are often divided into the high islands, of volcanic origin, and low islands, which are reefs or atolls. The main island group on the eastern side of the South Pacific are the Galapagos Islands to the north-east, and the Desventuradas Islands and Juan Fernández Islands off Chile.

The bathymetry of the South Pacific Ocean is complex, particularly nearer to land and within national EEZs, with many large and important seamounts, ridges, and underwater plateaus. The high seas area is dominated by abyssal waters with average depths of 4 000-5 000 m that include a number of fracture zones running roughly east-west that give rise to some of the islands groups and seamount chains. There are about 1 500 seamounts in the south Pacific. Notable features in the high seas, listed from west to east, include the South Tasman Rise, Lord Howe Rise, Challenger Plateau, West Norfolk Ridge, Kermadec-Tonga-Louisville Junction, Monowai Seamount, Manihiki Plateau, the seamounts of the Central and Southern Louisville Ridge, and the Salas y Gomez and Nazca Ridges. A number of these features have been proposed as ecologically or biologically significant areas (EBSAs) (CBD, 2015).

SOUTH PACIFIC REGIONAL FISHERIES MANAGEMENT ORGANISATION

Mandate

The South Pacific Regional Fisheries Management Organisation (SPRFMO) is the regional body mandated to manage the fisheries for non-highly migratory species in the ABNJ of the South Pacific Ocean, part of the North Pacific Ocean, and the easternmost part of the Indian Ocean. Areas of the ocean that are under national jurisdiction are not part of the SPRFMO Convention Area.

SPRFMO is an intergovernmental organization that currently consists of 14 Members: Australia, Republic of Chile, People's Republic of China, Cook Islands, Republic of Cuba, Republic of Ecuador, Kingdom of Denmark (in respect of the Faroe Islands), European Union, Republic of Korea, New Zealand, Republic of Peru, Russian Federation, Chinese Taipei, and the Republic of Vanuatu. It also has four Cooperating non-Contracting Parties (CNCPs) (Republic of Colombia, Republic of Liberia, Republic of Panama, and the United States of America) who participate in the work of SPRFMO and attend meetings, but are not entitled to vote. Since 2013, the SPFRMO has extended an invitation to non-Contracting Parties with fishing interests in its Convention Area to become Members or CNCPs.

The SPRFMO existed as an interim body from 2006 to 2012, when international consultations and preparatory conferences were conducted. The Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean (SPRFMO, 2015) was adopted in 2009 and entered into force on 24 August 2012, and the SPRFMO held its first meeting in 2013.

The SPRFMO Convention applies to waters of the South Pacific and small areas of the North Pacific and eastern Indian Oceans beyond national jurisdiction. The extent of the Convention Area is described in Article 5 of the Convention (Figure 46; SPRFMO, 2010). The SPRFMO Convention Area overlaps with five FAO major fishing areas (Table 16). The objective of SPRFMO Convention is to ensure, through the application of the precautionary approach and an ecosystem approach to fisheries management, the long-term conservation and sustainable use of fishery resources and, in so doing, safeguard the marine ecosystems in which these resources occur. These fishery resources include all fish, molluscs and crustaceans, but exclude sedentary species (in so far as they are subject to the national jurisdiction of coastal States), highly migratory species (e.g. tunas), anadromous and catadromous species, and marine mammals, reptiles and seabirds.

FIGURE 46
Map of the SPRFMO Convention Area

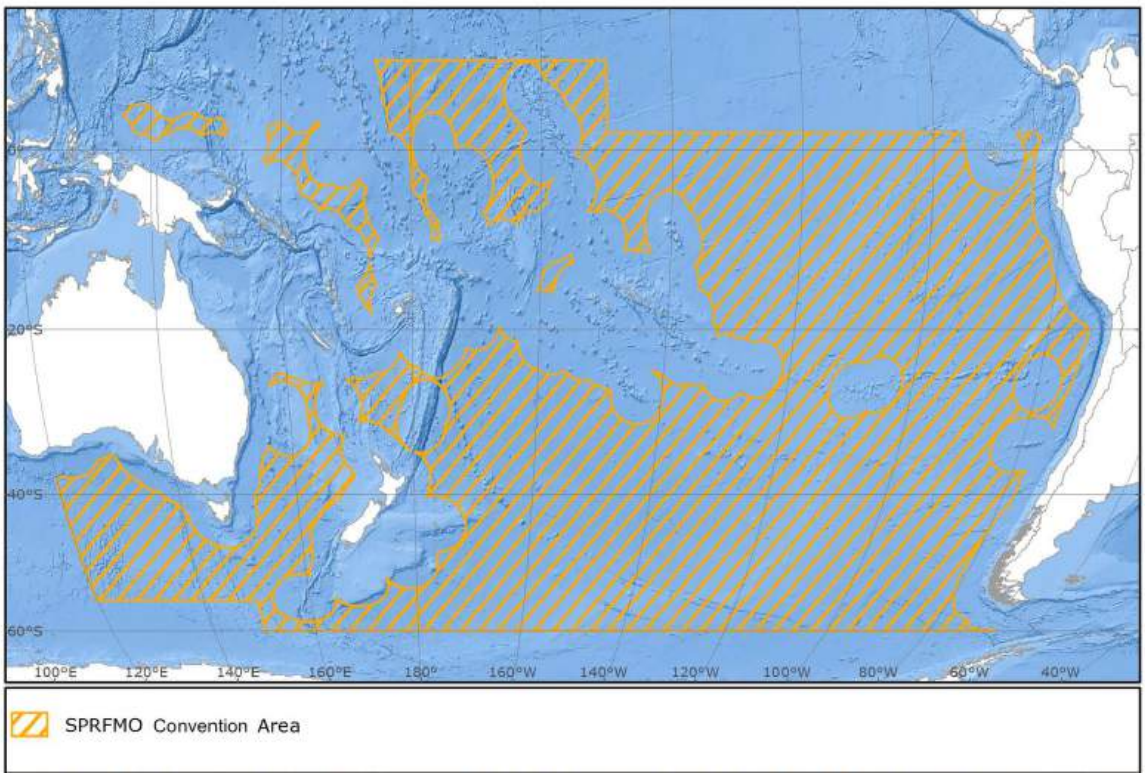


TABLE 16
The SPRFMO Convention Area in relation to the different oceans and FAO major fishing areas

FAO major fishing area	Description	Description
57	Eastern Indian Ocean	Parts of the easternmost FAO Subarea 4 south of eastern Australia lie within the SPRFMO Convention Area
71	Western Central Pacific	The southern half lies in the South Pacific Ocean and SPRFMO Convention Area
77	Eastern Central Pacific	The southern half lies in the South Pacific Ocean and SPRFMO Convention Area
81	Southwest Pacific	All within the SPRFMO Convention Area
87	Southeast Pacific	All but the very northernmost part lies within the SPRFMO Convention Area

Some of the species occurring within the SPRFMO Convention Area but which are not under SPRFMO's mandate are the responsibility of other intergovernmental bodies: the International Whaling Commission (IWC), the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and, for tunas and tuna-like species, the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Inter-American Tropical Tuna Commission (IATTC), and the Western and Central Pacific Fisheries Commission (WCPFC). All of these other bodies cover areas which extend beyond the South Pacific and the SPRFMO Convention Area.

Regulatory capacity

The SPRFMO strives to make its decisions by consensus, but has a voting procedure for cases where consensus cannot be reached. Decisions become binding 90 days after Members have been notified of the decision by the Executive Secretary. There is an

objection period of 60 days from the date of notification, but objections are only admissible on the grounds of unjustifiable discrimination or legal inconsistencies with the Convention or international law. The SPRFMO Conservation and Management Measures (CMMs) are binding on Members, and CNCPs must cooperate fully with the implementation of CMMs.

During 2006–2012, while the Convention was being negotiated, the participants at the negotiations adopted a number of comprehensive voluntary interim measures for pelagic and bottom fisheries, which were not binding on Member States (SPRFMO, 2012).

Structure

In its interim phase, SPRFMO was supported by two technical working groups, the Science Working Group (SWG) and the Data and Information Working Group (DIWG), which assisted in the development of aspects of the organization and its responsibilities. In 2008 the SWG adopted terms of reference for two SWG subgroups, the jack mackerel subgroup and the deepwater subgroup (Figure 47(a)). The SWG, through its subgroups, developed species profiles, prepared a Bottom Fishery Impact Assessment Standard to guide participants in the preparation of the bottom fishery assessments required under the interim measures, adopted guidelines for annual national reports, and evaluated benthic impact assessments prepared by participants involved in bottom fishing activities within the proposed SPRFMO Area. The DIWG drafted Data Standards for the collection and provision of fisheries and observer data to SPRFMO.

The SPRFMO formalized its structure when the Convention entered into force on 24 August 2012. The Commission, as the decision-making body, established a number of subsidiary bodies, as required by the Convention: the Scientific Committee (SC), the Compliance and Technical Committee (CTC) the Eastern Subregional Management Committee, the Western Subregional Management Committee, and the Finance and Administration Committee (FAC). The Scientific Committee, the scientific advisory replacement for the SWG, established two working groups, the jack mackerel working group and the deepwater working group, to assist it in its duties (Figure 47(b)). To date, the SC has met annually during October, and the Commission some three months later, in late January or early February. The two SC working groups have met during the SC meetings as well as conducting some intersessional activities.

Representatives of CNCPs, relevant intergovernmental and non-governmental organizations, including environmental and fishing industry organisations with an interest in matters pertaining to the Commission, may participate in meetings of the Commission, and its subsidiary bodies, as observers.

Decision process

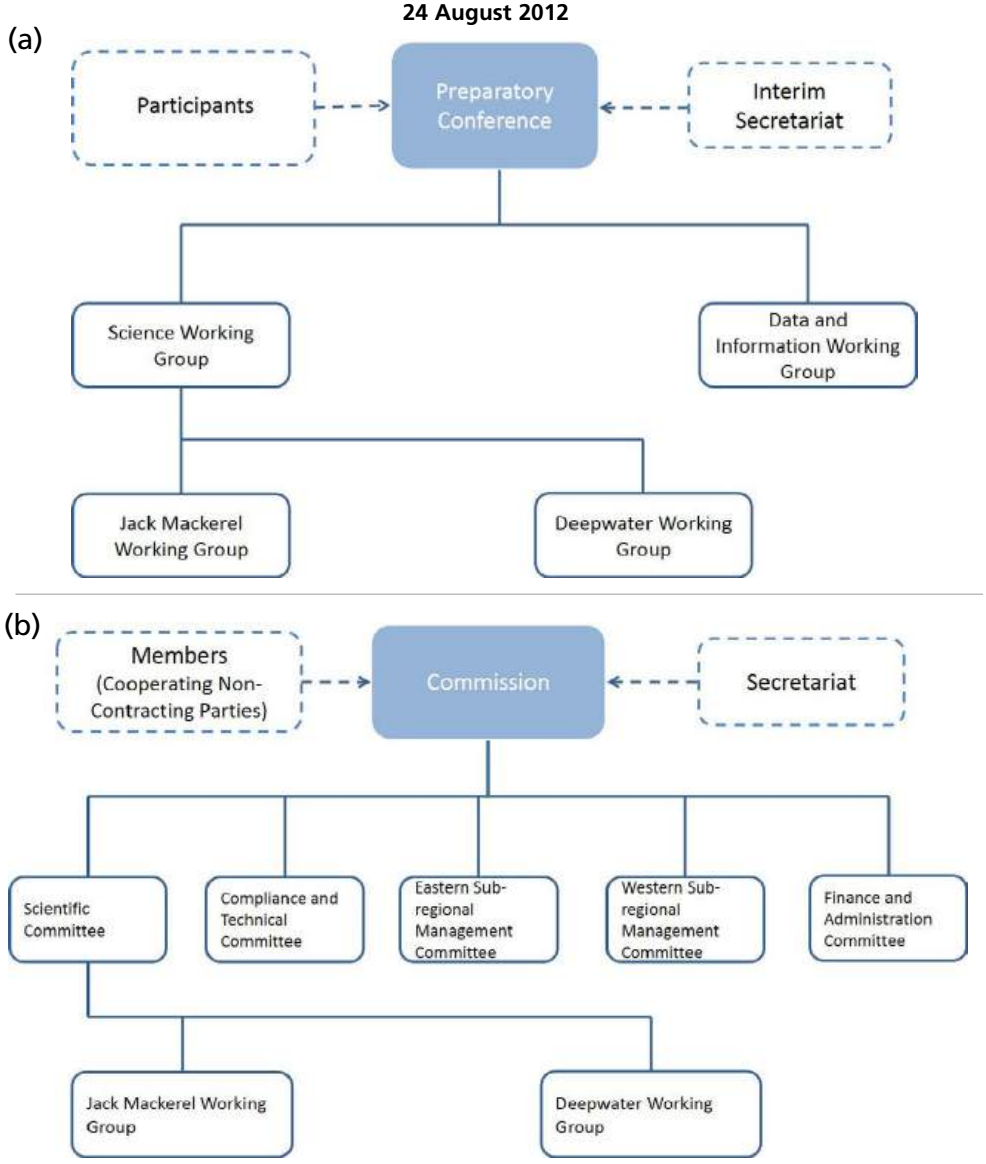
Proposals to be discussed at the meetings of the Commission and its subsidiary bodies must be submitted 50 days before meetings. Proposals can be amendments to an existing decision or CMM, and may be submitted by Members or CNCPs. All proposals are circulated to all Members, CNCPs and observers. Papers submitted by observers are regarded as information documents. Recommendations on CMM proposals are made by the CTC and, where relevant, are based on the advice of the SC.

The SC also provides advice to the Commission and other bodies, and its work plan is guided by an annual workplan developed each year by the Commission. The SC agrees on its advice by consensus, or if this is not achieved, the alternative views of its members are presented in its report to the Commission.

Relationships with other bodies

Currently SPRFMO has two MoUs, one with the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and one with CCAMLR. In addition, all RFMOs

FIGURE 47
Structure of SPRFMO (a) before and (b) after the Convention entered into force on 24 August 2012



operating in the Pacific, as well as other interested Inter-Governmental Organizations (IGOs), are invited to attend the SPRFMO meetings as observers. In the past, the following IGOs have attended the SPRFMO meetings: the Permanent Commission for the South Pacific (CPPS), the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Pacific Islands Forum Fisheries Agency (FFA), the Inter-American Tropical Tuna Commission (IATTC), the Secretariat of the Pacific Community (SPC), the Western and Central Pacific Fisheries Commission (WCPFC), and the FAO.

NGOs are also invited to attend SPRFMO meetings after having been accepted as observers in accordance with the Rules of Procedure.

OVERVIEWS

Bottom fisheries

There have been sporadic high seas bottom fisheries in the South Pacific Ocean since the late 1970s, which only became commercially important in the 1990s. Virtually every feature within fishable depths is thought to have been explored, but fisheries

have concentrated on major seamounts, ridges, and plateaus, which are often areas of nutrient upwelling and higher productivity. The prominent features that have been substantially fished are the South Tasman Rise, Lord Howe Rise, Challenger Plateau, West Norfolk Ridge, Three Kings Ridge, the seamount chain of the Louisville Ridge, and the Salas y Gomez and Nazca ridges. The South Pacific high seas bottom fisheries are demersal, mainly targeting fish on or close to the seabed in the depth range of 100 m to about 1 500 m, with some exploratory fishing at greater depths. The bottom fishing methods used have included trawling, longlining, dahn lining, and drop-lining. Currently, in 2015, fishing is by bottom and midwater trawls and longlines. Orange roughy dominate the fish taken by trawling, with alfonsino and oreo species taken in much smaller amounts. Lining methods generally target morwongs, bluenose warehou and wreckfish. There have also been some minor fisheries for toothfish (*Dissostichus* spp.) by longling, and possibly bottom trawling, in the high seas of the southern part of FAO Area 81 since 1995. Catches were mainly Patagonian toothfish (*Dissostichus eleginiodes*) and were generally very low, less than 10 tonnes per year, with no catches recorded in many years. However, an exception to the low catches was a catch of 1 145 tonnes recorded in 1996 (Anon., 2015). A summary of bottom fishing in the south Pacific Ocean is provided in Table 17.

TABLE 17
Summary of bottom fishing activities in the South Pacific Ocean

Deepwater species	South Pacific distributions	Fishing depths	Fishing gear
Orange roughy (*Hoplostethus atlanticus*)[a]	Shelf edge south of Tasmania, on ridge and hill features in the Tasman Sea between Australia and New Zealand, on the Louisville seamount chain and other ridges and hill features east of New Zealand, and within the Chilean EEZ	Seldom < 500 m, most commonly 700–1 100 m	Catch mainly taken by trawlers using bottom trawls designed to cope with rough ground using bobbins and rockhopper gear. Use of increasingly sophisticated fish-finding and net-monitoring electronics
Morwongs (*Nemadactylus* spp.)	Continental Plateau and shelf edge features on the Challenger Plateau, West Norfolk Ridge, and Three Kings Ridge	Down to depths of 400 m	Various lining methods
Bluenose warehou (*Hyperoglyphe Antarctica*)[a]	Shelf edge south of Tasmania, on ridge and hill features in the Tasman Sea between Australia and New Zealand, on the Louisville seamount chain east of New Zealand and possibly on the Foundation seamounts in the mid-south Pacific	200–750 m	Mostly caught by lining methods
Wreckfish (*Polyprion oxygeneios, P. americanus*)	Plateau and shelf edge features on the Challenger Plateau, West Norfolk Ridge, and Three Kings Ridge	200–600 m	Various lining methods
Oreos – smooth, black, and spiky (Oreosomatidae)[a]	Black and Spiky oreos are found close to seabed in deepwater. Adults form large shoals over rough ground near pinnacles and canyons. Smooth oreos inhabit deep continental slopes, with adults occurring near the bottom, often in large schools near pinnacles and canyons	600–1 000 m, with smooth oreo down to 1 400 m	Bottom trawls (bycatch in orange roughy fishery)
Alfonsino (*Beryx* spp.)[a]	On ridge and hill features in the Tasman Sea between Australia and New Zealand, on the Louisville seamount chain and other ridges and hill features east of New Zealand, Juan Fernández off Chile	Seldom < 200 m, most commonly 300–700 m	Historically, about 85% of catch by bottom trawl and 15% by mid-water trawl. Some experimental longlining has been tried. Now targeted by mid-water trawls fished close to the seabed
Toothfish – mainly Patagonian (*Dissostichus eleginoides*)	A minor fishery on Hjort Trench and the Southwest Pacific Basic, and possibly other sites towards the southern boundary of FAO Area 81	500–1 500 m (possibly exploratory fisheries to 2 500 m)	Mainly longlines, possibly some bottom trawling in the 1990s

[a] Profiles of the species can be found on the SPRFMO website www.sprfmo.int/meetings/international-consultationsand-preparatory-conference/new-meetingpage-Science-Working-Group/swg-profiles/species-profiles/

Catch statistics for deepwater species in the South Pacific Ocean are available from FAO (including for years prior to the establishment of SPRFMO) and SPRFMO (SPRFMO, 2016). FAO statistics correspond to FAO Major Fishing Areas, which include EEZs and high seas. SPRFMO statistics usually, but not always, correspond to the SPRFMO Convention Area. Catches of the species listed in Table 17 within EEZs have been substantially greater than high seas catches, particularly in the western South Pacific, so FAO statistics largely reflect EEZ catches and not high seas catches. SPRFMO data, particularly since about 1990, provide better estimates of high seas catches in the SPRFMO area, and are the basis for the catch estimates below.

High seas demersal fisheries started at different times in different areas, with fishing initially being concentrated on the larger South Tasman and Lord Howe Rises and the Challenger Plateau, closer to what are now EEZ boundaries. The most important demersal fishery was for orange roughy which started in the mid-1970s, though probably from areas that are now within EEZs. This fishery ceased by 1987, and was replaced from 1990 onwards by New Zealand and Australian fisheries, as extensions of their EEZ fisheries, with high seas catches of orange roughy peaking again at just over 11 000 tonnes in 1995 before declining steadily to current levels of less than 1 500 tonnes. Minimal high seas catches of orange roughy have been recorded from elsewhere in the South Pacific.

It is more difficult to distinguish high seas and EEZ catches of the other demersal species in the SPRFMO area, particularly during the period 1970–2000, when various fleets made substantial catches within what are now the New Zealand and Australian EEZs, either prior to the establishment of EEZs or under fishing arrangements. From the mid-1970s to the mid-1980s there was a substantial fishery for oreos (of at least three species: smooth, black, and spiky), as an alternative target to orange roughy, in the western South Pacific. Oreo catches reported to SPRFMO, which probably included substantial catches within current EEZs, peaked at around 28 000 tonnes in 1978, declining to around 100 tonnes by 1990. Recent high seas oreo catches have been below 50 tonnes, largely taken as bycatch in the orange roughy fishery.

Alfonsino is caught throughout the South Pacific, though are concentrated in the western South Pacific and are more sporadic elsewhere. Reported catches, which probably included catches within current EEZs, peaked at about 11 000 tonnes in 1979. No alfonsino catch has been reported to SPRFMO for the 1986-1991 period, after which a small high seas fishery targeting alfonsino developed in the Tasman Sea, peaking at about 1 500 tonnes in 2008, and currently producing about 250 tonnes annually.

Vulnerable marine ecosystems

> Article 20 of the SPRFMO Convention establishes that CMMs adopted by the Commission "*shall include measures to … protect the habitats and marine ecosystems in which fishery resources and non-target and associated or dependent species occur from the impacts of fishing, including measures to prevent significant adverse impacts on vulnerable marine ecosystems and precautionary measures where it cannot adequately be determined whether vulnerable marine ecosystems are present or whether fishing would cause significant adverse impacts on vulnerable marine ecosystems*".

Prior to the establishment of the SPRFMO, and as required by UNGA Resolution 61/105 on Sustainable Fisheries, participants at the 3rd International Consultation in May 2007 adopted interim measures that laid out the precautionary actions, including assessments, needed to protect identified VMEs or areas likely to contain VMEs, and established move-on rules and reporting requirements when evidence of VMEs was encountered during the course of fishing operations. In September 2007, an interim benthic assessment framework was adopted to guide bottom fishing assessments and to enable the Science Working Group to evaluate and comment on submitted

assessments. In February 2012, at the 3rd Session of the Preparatory Conference, this framework was expanded into the SPRFMO Bottom Fishery Impact Assessment Standard (BFIAS), which contains guidance on detecting evidence of VMEs, evaluating interactions with VMEs, and evaluating the likelihood of significant adverse impacts.

At its 2nd Meeting in January 2014, the Commission adopted CMM 2.03 (CMM, 2014) for the management of bottom fishing in the SPRFMO Convention Area. SPRFMO adopted CMM 4.03 at its 4th Commission meeting, held in January 2016, to update the review date to 2017 (CMM, 2016a, Paragraph 27). It incorporates and expands on the earlier voluntary interim measures, and contains specific requests for information by the SC to enable the Commission to review the CMM. The measure promotes the sustainable management of bottom fisheries, including target fish stocks and non-target species taken as bycatch, and the protection of the marine ecosystems in which those resources occur, including the prevention of significant adverse impacts on VMEs.

REGULATIONS AND MEASURES

Bottom fishing areas

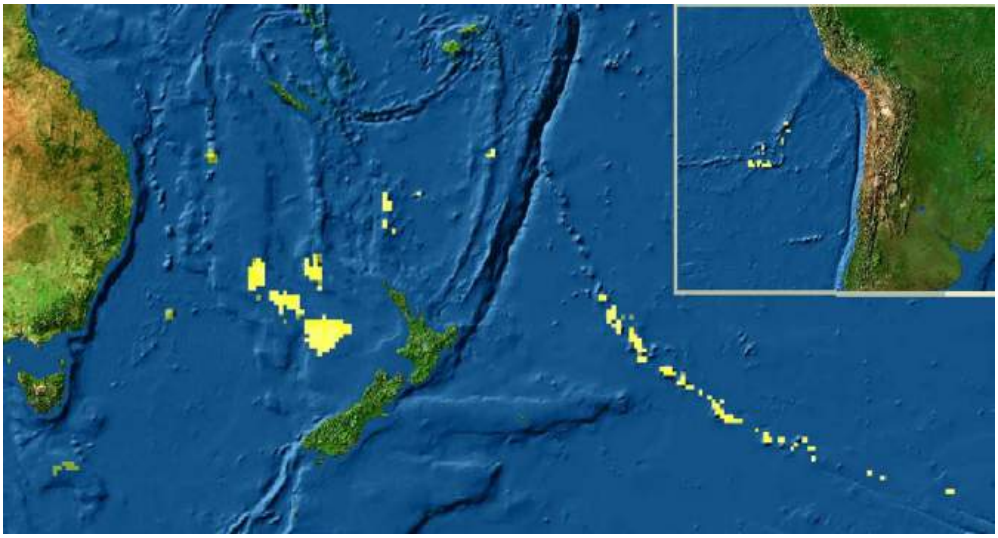
The CMM 4.03 limits catches by each Member to their annual average during 2002–2006, and also restricts Members to fishing within their national bottom fishing footprint, defined as the spatial extent of their bottom fishing conducted during 2002–2006.

Australia, Republic of Chile, the Republic of Korea, and New Zealand, have prepared and submitted the required bottom fishing footprint maps at a 20-minute resolution. However, only Australia and New Zealand have currently completed bottom fishing impact assessments, and are the only Members currently bottom fishing in the SPRFMO area. More than 99 percent of the SPRFMO area is outside bottom fishing footprints and is thus currently closed to bottom fishing activities.

In 2011, the Secretariat produced a joint bottom-trawl fishing footprint map, presented as an information document for the 10th Meeting of the Scientific Working Group (SPRFMO, 2011b), using trawl data for the 2002–2006 period provided by Australia, Chile, the Republic of Korea, and New Zealand (Figure 48). This map did

FIGURE 48

Map showing the distribution of joint bottom trawl footprints for the period 2002–2006 (SPRFMO, 2011b). This map has not been adopted by SPRFMO. National bottom fishing footprints are seen in Figure 49a-d



www.sprfmo.int/assets/Meetings/Meetings-before-2013/Scientific-Working-Group/SWG-10-2011/SWG-10-INF-10-Joint-Bottom-Footprint.pdf

not include New Zealand's demersal lining data, although most New Zealand bottom lining has occurred within the New Zealand trawl footprint, whereas Australia's data was for trawl and line combined. In response to requests from stakeholders, a detailed analysis of the effects and implications of using alternative mapping reference periods and spatial resolutions was presented to the 1st Scientific Committee (Penney, 2013). This joint bottom-trawl fishing footprint was not formally adopted by the Commission.

Exploratory fishing protocols

Protocols for new or exploratory fishing outside the footprint or above the 2002–2006 catch levels were in place from 2014 (CMM, 2014, 2016a). Members and CNCPs are required to submit proposals for expanding a fishery 60 days before an SC meeting. The SC then assesses proposals and recommends to the Commission whether they should be approved or not. The requirements for the management of new and exploratory fisheries were adopted in 2016 and must be followed by fishing vessels through an application made by their flag State. This framework will ensure that there is sufficient information to evaluate the long-term potential to evaluate impacts on target stocks and non-target and associated species. These fisheries can then develop in a precautionary and gradual basis and be managed sustainably, as new information is gathered (CMM, 2016b).

During 2014 and 2015, New Zealand submitted an application to conduct exploratory fishing for Toothfish outside its existing footprint. After the SC had accessed this application in 2014, the Commission adopted CMM 4.14.

Vulnerable marine ecosystems

The SPRFMO has not yet closed or otherwise protected particular VME areas in accordance with Article 20 of the Convention and CMM 4.03 on bottom fishing. The SPRFMO SC has recommended that move-on rules should not be relied on to prevent significant adverse impacts on VMEs, and should be considered to be temporary measures until spatial protection measures can be implemented (SPRFMO, 2013, Section 8.2). The bottom fishing measures (CMM, 2014, 2016a) request the SC to develop maps of VME distribution in the Convention Area and to "*provide advice and recommendations to the Commission on the most appropriate response to a VME encounter, including* inter alia *closing particular areas to a particular gear type or types*".

Encounter protocols

SPRFMO requires vessels to cease bottom fishing activities within 5 nm of any site in the Convention Area where evidence of a VME is encountered above thresholds during the course of fishing operations (for the purpose of this publication, this measure will be called the "move-on rule"). Details of the encounter are reported to the Secretariat (Table 18), so that appropriate action can be taken in respect of the relevant site. To date, no SPRFMO-wide definition has been provided of "evidence of a VME" and it has been left to flag States to develop national protocols for detecting encounters with possible VMEs.

As part of the implementation by flag States of the SPRFMO measures, Australia and New Zealand have developed separate VME encounter protocols, which were reviewed and compared at the 1st Scientific Committee Meeting in 2013 (Hansen *et al.*, 2013). While both protocols establish a 5 nm move-on from sites where "*evidence of vulnerable marine ecosystems is encountered*", as required by SPRFMO (CMM, 2014, 2016a), there are notable differences in the interpretation of "evidence" and in the details of the move-on requirement.

Australia and New Zealand apply different bycatch weight thresholds to indicate evidence of encounter with a VME (see next section). New Zealand applies the move-

TABLE 18
Guidelines for the Preparation and Submission of Notifications of Encounters with VMEs

1. General information:	Include contact information, nationality, vessel name(s) and dates of data collection
2. VME location:	Start and end positions of all gear deployments and/or observations. Maps of fishing locations, underlying bathymetry or habitat and spatial scale of fishing Depth(s) fished
3. Fishing gear:	Indicate fishing gears used at each location
4. Additional data collected:	Indicate additional data collected at or near the locations fished, if possible. Data such as multibeam bathymetry, oceanographic data such as CTD profiles, current profiles, water chemistry, substrate types recorded at or near those locations, other fauna observed, video recordings, acoustic profiles, etc.
5. VME taxa:	For each station fished, provide details of VME taxa observed, including their relative density, absolute density, or number of organisms if possible

on rule only within 30 percent of its bottom trawl footprint designated as move-on blocks. The New Zealand vessels are required to move 5 nm away from the end of the trawl in which evidence of a VME is encountered, and this 5 nm radius closure remains active only for that vessel and only for the duration of that particular trip. Australia applies the move-on rule to all gears across the entire Australian footprint, and vessels are required to move five nautical miles away from the entire length of the trawl tow or line set, and the resulting closure remains in force for all vessels fishing under the Australian flag for the remaining duration of the annual fishing permits.

Vulnerable marine ecosystem indicators

In 2014, SPRFMO defined that, for the purposes of CMM 2.03, "*the term 'vulnerable marine ecosystem' (VME) means a marine ecosystem that has the characteristics referred to in paragraph 42 and elaborated in the Annex of the FAO* International Guidelines for the Management of Deep-Sea Fisheries in the High Seas." No list of VME indictors has been formally adopted to date, and SPRFMO asks the SC to provide further advice and recommendations on VME indicator species (CMM, 2014, 2016a).

As part of its *Vulnerable Marine Ecosystem (VME) Evidence Process*, New Zealand has developed and adopted a list of eight primary VME and two habitat indicator taxa that is used by on-board observers to detect encounters with VMEs (Penney *et al.*, 2009). This list was reviewed in a paper submitted to the second SC meeting (Penney, 2014). Australia currently uses corals and sponges as its VME indicator taxa. Based on an updated analysis of benthic taxa reported by observers aboard New Zealand bottom trawl vessels in the SPRFMO area since 2002 (Hansen *et al.*, 2013), it has been recommended that the New Zealand list of VME taxa be reviewed by the SC for wider SPRFMO use, with the possible addition of further potentially vulnerable taxa such as cidaroid sea urchins, as has been done by CCAMLR. It is likely that lists of VME indicator taxa would need to be different for the western and eastern South Pacific.

Thresholds

Currently, the SPRFMO has not adopted thresholds indicating evidence of encounters with VMEs, and the SC will provide advice and recommendations on such threshold levels. As noted above, New Zealand and Australia have developed and implemented separate national encounter protocols, with different encounter thresholds.

The New Zealand VME Evidence Process uses a scoring system for a specified list of eight high-level (Phylum, Class, or Order) primary taxa and two habitat indicator taxa, with threshold weights for the primary taxa based on an analysis of historical observer data for New Zealand high seas bottom trawling (Anon., 2008; Penney *et al.*, 2009).

Encounter thresholds for primary species are set at 50 kg for sponges, 30 kg for stony corals, 6 kg for hydrocorals, and 1 kg each for black corals and soft corals. The other taxa do not have threshold weights but are recorded as absent or present. Scores are allocated for bycatches of primary taxa exceeding their threshold weights (score of 3), and for presence of other taxa (score of 1), with a move-on being triggered by a total score of 3 or greater. The New Zealand protocol therefore provides direct measure of biodiversity, in addition to using weights of primary taxa to indicate evidence of a VME.

The Australian fleet operates under an encounter protocol based on the CCAMLR protocol, with a single bycatch weight threshold of 50 kg of corals and/or sponges in a single trawl. The Australian high seas fishery makes more use of bottom longlines and drop lines than the New Zealand fishery does and, for non-trawl vessels, this threshold is reduced to 10 kg of corals and/or sponges per 1 000-hook section of line or 1 200 m section of line, whichever is shorter.

Impact assessments

The SPRFMO and its Members have placed a high priority on assessing the impact of bottom fisheries on target stocks and VMEs. In the 2007 interim measures, the participants resolved to assess whether individual bottom fishing activities would have significant adverse impacts on VMEs and, if so, to ensure that they are managed to prevent such impacts, or not authorized to proceed. The measures required participants to submit bottom fishing impact assessments to the SWG for review, and requested the SWG to prepare an interim standard for reviewing such assessments.

In 2007, the SWG developed and adopted an interim Benthic Assessment Framework to guide such assessments (SPRFMO, 2007, Annex 3). Following publication of the FAO Deep-sea Fisheries Guidelines, the SPRFMO benthic assessment framework was expanded and revised to incorporate relevant aspects of the Guidelines. The resulting SPRFMO *Bottom Fishery Impact Assessment Standard* (BFIAS) was agreed by the SWG in 2011 (SPRFMO, 2011a) and adopted at the 3rd Session of the Preparatory Conference in February 2012.

As of April 2016, assessments have been undertaken by Australia, the European Union, and New Zealand (SPRFMO, 2014).

Observers

The SPRFMO CMM 3.02 (CMM, 2015) on Standards for the Collection, Reporting, Verification and Exchange of Data requires Members and CNCPs to develop, implement, and improve Observer Programmes to attain the objectives specified in the measure. The Annex 7 of that measure specifies the vessel information and tow-by-tow data to be collected for each fishing operation, including information on gear type and deployment, catch and effort of species retained on board, bycatch of species of concern (marine mammals, seabirds, reptiles, etc.), and catches of VME species (sponges, sea-fans, corals). This information is to be provided to the SPRFMO Secretariat no later than 30 September in the year following data collection.

Pending the development of a SPRFMO observer programme, coverage requirements for national observer programmes are specified in the bottom fishing measures (CMM, 2014, 2016a). Participants are required to ensure 100 percent observer coverage for vessels using trawl gear, and at least 10 percent coverage in each fishing year for each other bottom fishing gear type.

Scientific research

At its first meeting in 2013, the Commission adopted a "roadmap for the Scientific Committee" that outlined work priorities and identified areas where the Commission required advice. The same format was used by the Commission at its second meeting in

2014, to guide the work of the SC and to identify requests for advice. Further requests for specific advice may be included in CMMs, such as the CMM 4.03. The SC uses such requests from the Commission to maintain and update its own research plan, which guides SC members in the conduct of appropriate intersessional research.

Review procedures

The CMM 4.03 will be reviewed by the Commission in 2017 based on the advice received from the SC. Review procedures for the management of specific VME areas will be included in any appropriate spatial measures for managing specific known or potential VME sites.

Other regulations that also protect benthic areas

Gear restrictions

In 2013, the SPRFMO adopted measure CMM 1.02 (CMM, 2013) to ban the use of gillnets, including deepwater gillnets, in the Convention Area in order to protect fishery resources, bycatch species and deep-sea habitats.

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

The SPRFMO has not yet established any specific managed or closed areas within its Convention Area.

As part of its management approach to preventing significant adverse impacts on VMEs, as permitted by CMM 4.03, New Zealand has mapped the 20-minute blocks constituting their bottom fishing footprint for trawl gear during 2002-2006 (Figure 49a). The blocks were then classified in terms of bottom trawl intensity into blocks that had been lightly, moderately, or heavily fished (Figure 49b), with about one-third of blocks falling into each category. From this, New Zealand developed a three-tier management system in which heavily fished blocks were open to bottom fishing, moderately fished blocks were open to bottom fishing with a move-on rule under New Zealand's VME Evidence Process, and lightly fished blocks were closed to bottom fishing (Figure 49c). The status of three blocks was amended in 2015, and restrictions extended to apply to deep mid-water trawls as well as bottom trawls (Anon., 2015b). The Republic of Chile, the Republic of Korea[24], and Australia undertook a similar fishing effort mapping exercise and also submitted their fishing footprint during the reference years 2002–2006 to SPRFMO (Anon., 2008b; Williams *et al.*, 2011; Figures 49d and 49e). Australian fishing effort by all methods is confined to within the Australian footprint. The Republics of Chile and Korea are not currently undertaking bottom fishing operations in the SPRFMO area.

Following the depletion of the orange roughy resources on the South Tasman Rise, this area was closed to Australian vessels under an Australian orange roughy conservation plan, and subsequently closed to both Australian and New Zealand vessels in 2007 under a joint agreement (Williams *et al.*, 2011). This has resulted in the closure of nine of the 20-minute blocks in the Australian SPRFMO bottom fishing footprint (Hansen *et al.*, 2013). These are currently unilateral flag state measures implemented under national management arrangements, and do not apply to the vessels of other flag States.

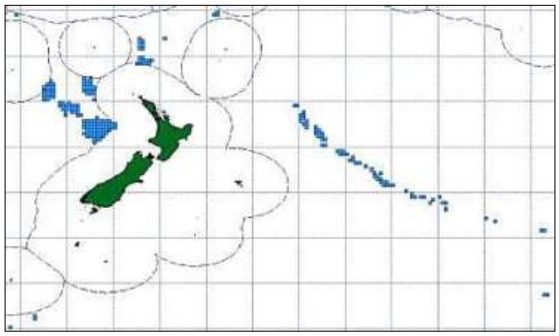
SURVEYS

Under their research plan, the SC has recommended that predictive modelling be conducted to produce maps of predicted VME occurrence in the SPRFMO area. New Zealand has conducted such modelling for the areas fished by New Zealand vessels and conducted a benthic survey on the central Louisville Ridge in 2014 to assist in the

[24] The Republic of Korea's bottom fishing footprint is not currently publicly available.

FIGURE 49a

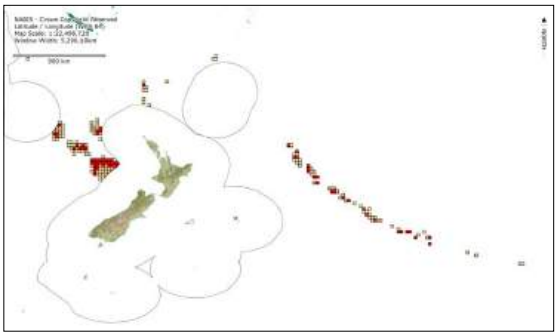
New Zealand's historical bottom fishing footprint for all gears combined for 2002-2006 (blue) in the SPRFMO Convention Area



Reproduced with permission (Anon., 2008a, Figure 15).

FIGURE 49b

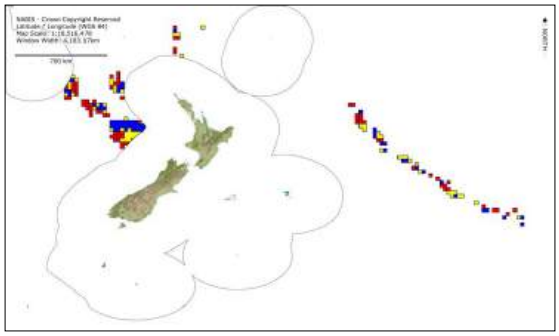
New Zealand's bottom fishing trawl footprint for 2002–2015 in the SPRFMO Convention Area



Red = heavily fished, orange = moderately fished, yellow = lightly fished. *Reproduced with permission (NABIS, 2016).*

FIGURE 49c

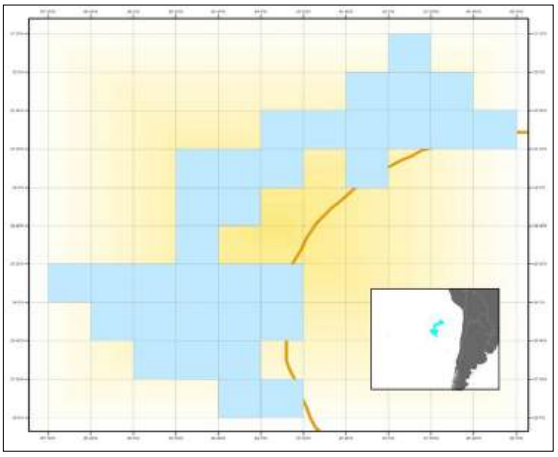
New Zealand's bottom fishing trawl footprint showing the status of the blocks



Blue = open to bottom and deep mid-water trawl fishing; yellow = open with move-on rule; red = closed to bottom and deep mid-water trawl fishing. *Reproduced with permission (Anon., 2015b).*

FIGURE 49d

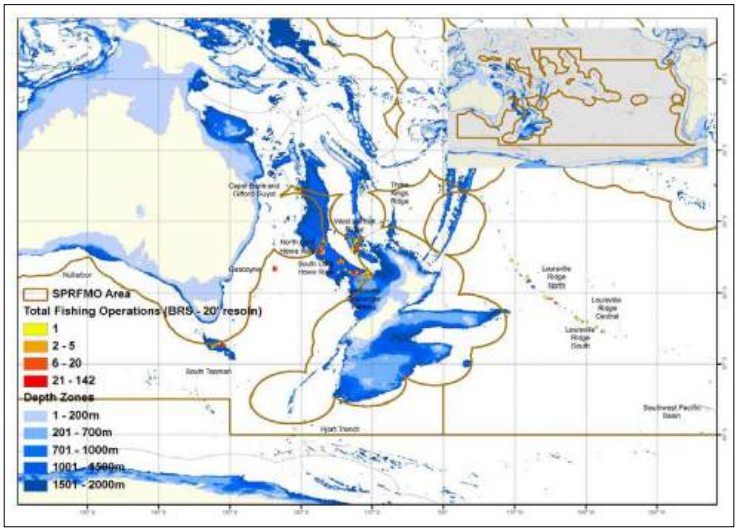
Chile's historical bottom fishing footprint for all gears combined for 2002-2006 in the SPRFMO Convention Area



Reproduced with permission (Anon., 2008b, Figure 1, inset added).

FIGURE 49e

Australia's historical bottom fishing footprint for all gears combined for 2002–2006 in the SPRFMO Convention Area



Reproduced with permission (Williams et al., 2011, Figure 3.1.2.1).

mapping of VMEs and for the purpose of validating and improving initial predictive modelling results.

New Zealand has also been conducting acoustic surveys to estimate the biomass of orange roughy on the Westpac Bank (Challenger Plateau). This work, reported to SPRFMO, supports stock assessments of the Challenger Plateau orange roughy and specifically addresses the need to provide for management of the orange roughy stock that straddles across from this part of the SPRFMO Convention Area into the New Zealand EEZ. This straddling stock is being managed by New Zealand.

OTHER INFORMATION

Reported encounters

The SPRFMO CMMs requires Members to report to the Secretariat all sites where evidence of VMEs is encountered, so that appropriate measures can be adopted in respect of such sites. New Zealand has reported annually in its national reports VME encounters that resulted in triggering of their move-on rule under its VME Evidence Process. The 2014 New Zealand National Report (New Zealand, 2014) included six move-on events out of 192 tows conducted within designated move-on blocks during 2008–2013. Australia has not reported any VME encounters to the Secretariat, and has stated in its national reports that VME evidence thresholds were not reached during either 2012 or 2013. No other Members have fished in the SPRFMO area with bottom fishing gear since 2010.

A detailed analysis of 23 benthic taxa recorded by observers aboard New Zealand bottom trawlers fishing in the western SPRFMO area between 1987 and 2014 was presented at the second SC meeting (Penney, 2014). This analysis showed that, in the New Zealand bottom trawl tows that recorded some bycatch of benthic species, 65 percent reported a single taxon, and that median bycatch weights ranged from about 0.1 to 1.9 kg for the various VME taxonomic groups.

Exploratory fishing

To date, there has been only one application for the development of a new toothfish fishery in 2016 and 2017 by New Zealand (CMM, 2016c). This was approved by SPRFMO with a precautionary catch limit of 30 tonnes of toothfish per year for a single named fishing vessel. Protocols for monitoring bycatch of VME species and seabirds are included along with the appropriate mitigation measures.

Identification guides

New Zealand produced a *Classification guide for potentially vulnerable invertebrate taxa in the SPRFMO Area*, as part of its bottom fishery impact assessment presented at the 7th Scientific Working Group Meeting (New Zealand, 2009, pp. 96–97). This is a rapid assessment guide based on the comprehensive *A Guide to Common Deepsea Invertebrates in New Zealand Waters* (Tracey *et al*., 2007), and observers aboard New Zealand vessels bottom fishing in the SPRFMO area are trained in the use of the guide to detect encounters with key VME taxa under New Zealand's VME Evidence Process. This rapid assessment guide was made available for use by all SPRFMO participants at the 8th Meeting of the Scientific Working Group in 2009 (SPRFMO, 2009).

Data sharing protocol

CMM 3.02 also establishes the regulations for submitting and sharing data and information within and outside SPRFMO. This includes vessel data that must be supplied to SPRFMO by Members and CNCPs, and current and historical catch and effort statistics for targeted and bycatch species. Protocols for the transmission of VMS information are also established. Additionally, methods of verification and systems for cross-checking form an important component of this measure.

The measure states that the Secretariat is to "*compile and disseminate accurate and complete observer data to ensure that the best scientific evidence is available, while maintaining confidentiality where appropriate*". It specifies what information is considered to be in the public domain and what is considered confidential.

The information in the public domain includes:

i. data on fishing activities, aggregated by flag State and month and 1° by 1° areas, except in those cases where such data describes the activities of fewer than three vessels (in which case a lower resolution will be used);
ii. data for vessels authorised by Members and CNCPs i.e. current flag, name, registration number, international radio call sign, IHS-Fairplay (IMO) number, previous names, port of registry, previous flag, type of vessel, types of fishing methods, when built, where built, length, length type, moulded depth, beam, gross tonnage (and/or gross register tonnage), power of main engine(s), hold capacity, vessel authorization start and end dates; and
iii. the occurrence of bottom fishing within a 20-minute block (without specifying flag, any vessel identification, or measure of fishing effort).

All other information is considered confidential, and can be disseminated only in response to a written request from the Commission or with the authorisation of the Member or CNCP that originally provided the data.

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THE INDIAN OCEAN

Indian Ocean

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REGIONAL GEOGRAPHY AND BATHYMETRY

The Indian Ocean is the third largest of the world's oceans. It is bounded on the west by Africa, on the north by Asia, and on the east by Indonesia and Australia. The southern boundary is normally taken to be 60°S where it meets the Southern Ocean (Figure 50). The Indian Ocean includes the Arabian Sea, the Red Sea, the Gulf and the Bay of Bengal. The islands of Madagascar, Sri Lanka, Mauritius, and La Réunion, Seychelles, Bahrain, Comoros and the Maldives, all lie within it. There are also some other smaller islands and island groups, including the isolated Île Amsterdam and Île Saint-Paul, which lie in the south-central portion of the Indian Ocean.

The Indian Ocean comprises the African, Arabian, Indian, and Australian tectonic plates. Many of the subsurface features of the high seas part of the Indian Ocean are associated with the plate boundaries, such as the Carlsberg, Southwest, Central, and Southeast Indian Ridges. The Southeast Indian Ridge is wide and relatively flat. The other ridges, and in particular the Southwest Indian Ridge, have extensive fracture zones and seamounts, some with peaks at only 100-500 m deep. The other prominent ridges in the high seas of the Indian Ocean are the Ninety East Ridge, running north-south at longitude 90°E, and Broken Ridge, which runs almost due east from the southern end of the Ninety East Ridge. There is also a smaller ridge system running southwest from the intersection of the above two ridges towards Île Amsterdam and Île Saint-Paul. Seamounts are plentiful along these ridges, with some peaks at 400-600 m deep at the southern end of Ninety East Ridge, and even shallower along its southwest extension. Seamounts on Broken Ridge are slightly deeper, with some peaks reaching depths of up to 600-800 m. There are also many deeper seamounts on the Carlsberg Ridge, at the northwest corner of the Indian Ocean, and shallower ones on the Chagos-Laccadive Ridge, which lies within national waters. Hydrothermal vents are known to occur along the Carlsberg, Southwest, Central, and Southeast Indian Ridges. The main shallower plateau areas are the Mascarene and Madagascar Plateaus, northeast and south of Madagascar, respectively, both of which encompass areas of national waters and the high seas.

The Indian Ocean is covered by FAO Major Fishing Areas 51 (Western Indian Ocean) and 57 (Eastern Indian Ocean), which extend south to 45°S between 30° and 80°E and 55°S between 80° and 150°E, respectively. Area 58 (Antarctic and southern Indian Ocean) lies along the southern border of the Indian Ocean.

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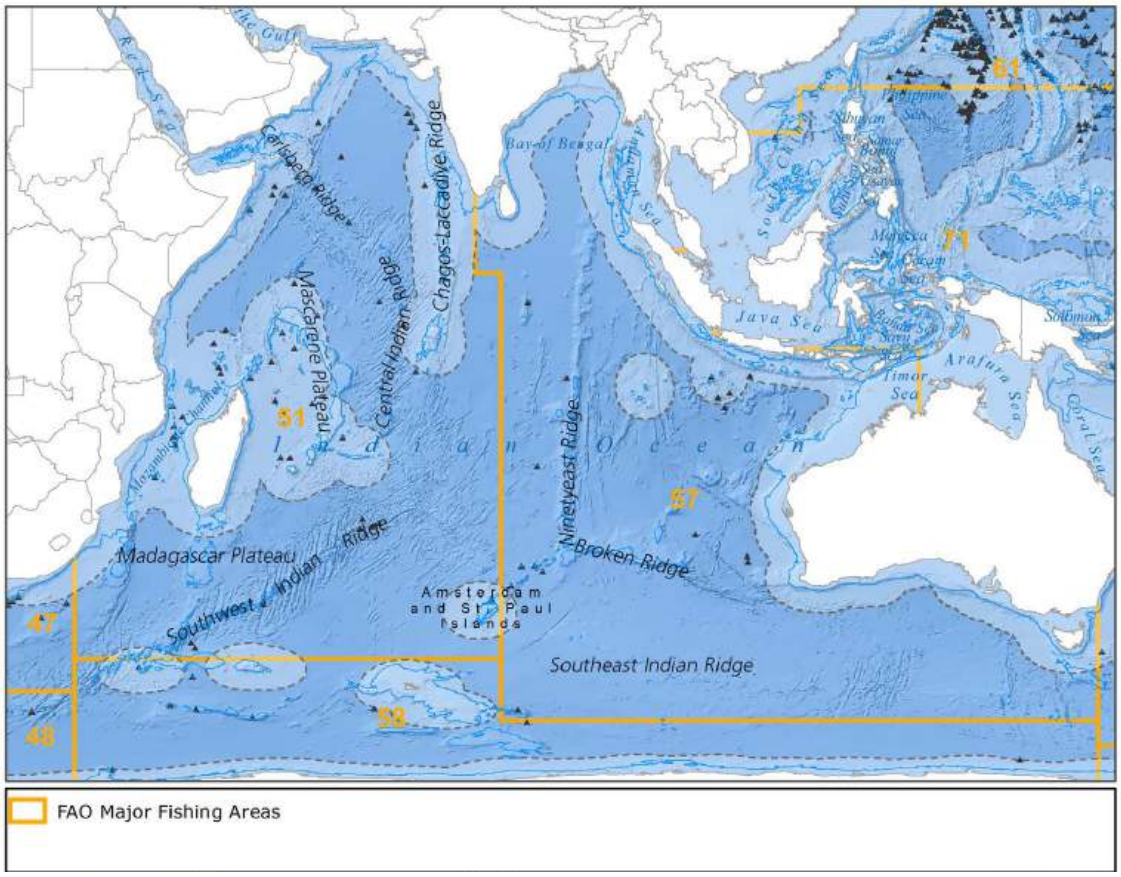
FIGURE 50
The Indian Ocean. The map shows the FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nmile arcs



SOUTHERN INDIAN OCEAN FISHERIES AGREEMENT

Mandate

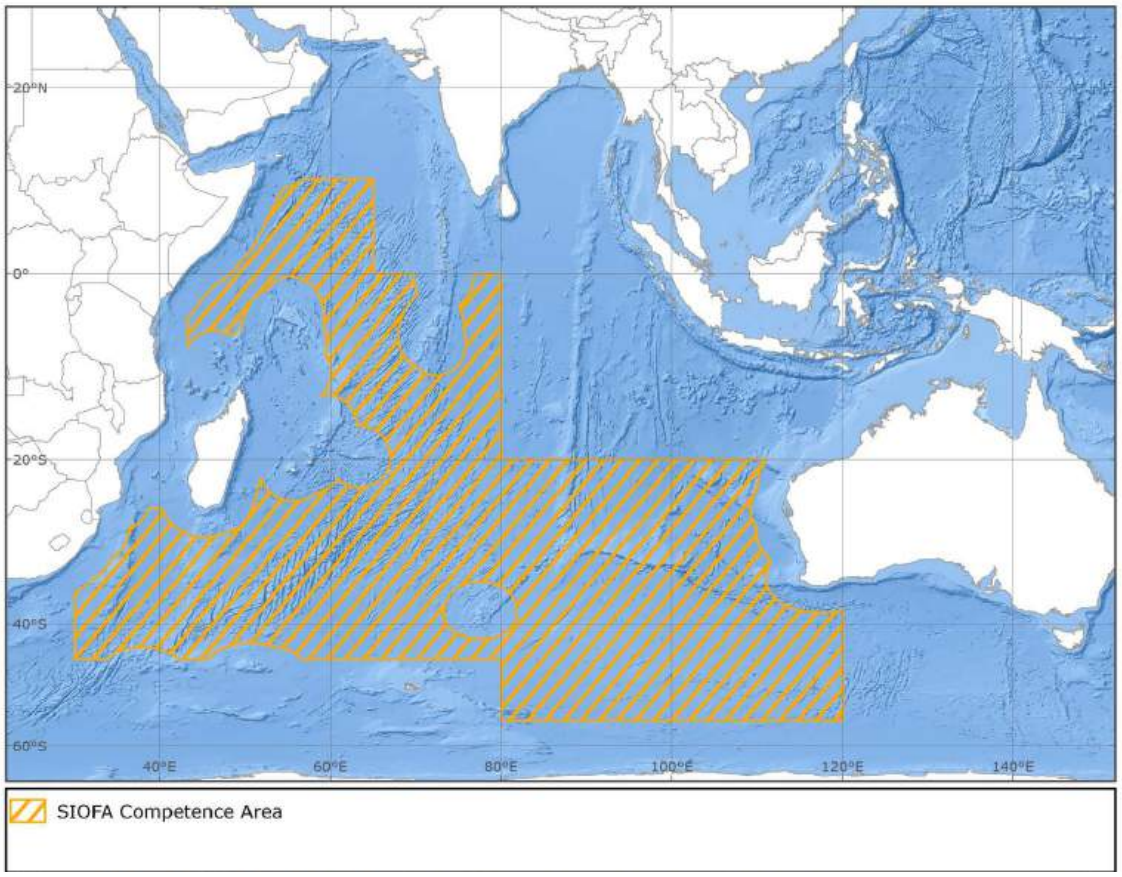
The Southern Indian Ocean Fisheries Agreement (SIOFA) was adopted in 2006 and entered into force in 2012. The Contracting Parties to the Agreement are Australia, Cook Islands, the European Union, France (Territories), Japan, the Republic of Korea, Mauritius, and Seychelles.

The objectives of SIOFA are "*to ensure the long-term conservation and sustainable use of the fishery resources*" [25], "*through cooperation among the Contracting Parties, and to promote the sustainable development of fisheries, taking into account the needs of developing States that are Contracting Parties to the Agreement, and in particular, the least-developed among them and the small island developing States*" (SIOFA, 2006).

The SIOFA area of application covers the southern two-thirds of the Indian Ocean between Africa and Australia; it includes parts of FAO Major Fishing Areas 51 and 57, but excludes the Arabian Sea, the Gulf, the Bay of Bengal, and the northeast Indian Ocean (Figure 51). It is bounded to the south by CCAMLR, to the southwest by SEAFO, and to the southeast by SPRFMO.

[25] Resources of fish, molluscs, crustaceans and other sedentary species within the competence area, but excluding: i) sedentary species subject to the fishery jurisdiction of coastal States pursuant to article 77(4) of the 1982 UN Convention on the Law of the Sea, and; ii) highly migratory species listed in Annex I of the 1982 UN Convention on the Law of the Sea.

FIGURE 51
SIOFA area of application within the Indian Ocean



The Agreement also includes the need for consideration of non-Contracting Parties. Those identified as Cooperating Non-Contracting Parties (CNCPs) and Participating Fishing Entities (PFEs) are normally subject to the same measures as the Contracting Parties.

Regulatory capacity

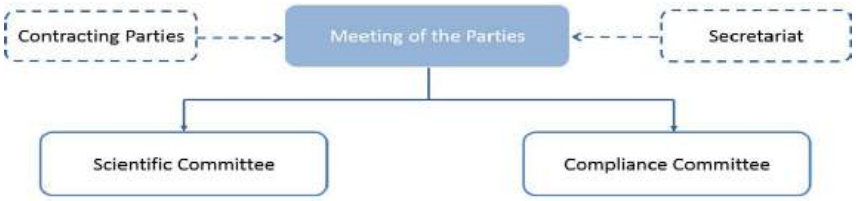
SIOFA is responsible for the assessment and management of fishery resources within its area of application, with the exception of the sedentary species that are under the jurisdiction of coastal States, and highly migratory species. In the Indian Ocean, tunas and tuna-like species, the main highly migratory fish, are managed by the Indian Ocean Tuna Commission (IOTC).

The Contracting Parties to SIOFA are required to develop and adopt management measures, based on scientific advice and in accordance with the precautionary approach and the ecosystem approach to fisheries, to ensure the long-term conservation and sustainable use of the fishery resource. Fishing practices and management measures must recognize the need to minimize harmful impacts on the marine environment and on biodiversity specifically. These measures are legally binding for its members.

Structure

The main decision-making body is the Meeting of the Parties, and is required to meet at least annually. Its functions include reviewing the state of the fishery resources, evaluate impacts of fishing, adopting measures to manage the fisheries and protect biodiversity from any associated impacts, to collect data and promote research necessary for the management of the fisheries, and to promote compliance.

FIGURE 52
Structure of SIOFA



The Agreement provides for a Scientific Committee, whose functions include assessing fishery resources and the impact of fishing on the marine environment, providing advice and recommendations for formulating conservation and management measures, monitoring of fishing activities, and defining standards and formats for data collection. The first meeting of the Scientific Committee took place in March 2016, and discussions focused on the development of a work plan and a plan for the long term research priorities (SIOFA, 2016a). This will then allow for the provision of advice on which to base fisheries management measures.

The Agreement also provides that, once measures are adopted, a Compliance Committee shall be established to verify the implementation of, and compliance with, such measures. The Compliance Committee reports, advises, and makes recommendations to the Meeting of the Parties (Figure 52).

Three Meetings of the Parties have been held to date, and many of the processes necessary for operating a regional fisheries body have been agreed. The second Meeting of the Parties in 2015 decided the arrangements for secretariat services, and agreed to establish a Secretariat based in La Réunion Island (SIOFA, 2015). The third meeting of the Parties in 2016 selected an Executive Secretary to manage the Secretariat and adopted several conservation and management measures (CMMs) (SIOFA, 2016b).

Decision process

Proposals for action, including those related to conservation and management measures, are submitted by Contracting Parties to the Meeting of the Parties. Advice, recommendations, and proposals, including those stemming from the Scientific Committee, are presented at the Meeting of the Parties, where amendments and proposals are adopted, either by consensus or by a simple majority vote of the Contracting Partiers present, depending on the nature of the proposal. The Meeting of the Parties also gives the Scientific Committee any guidance necessary for it to carry out its functions. At the third conference of parties in June 2016, it was agreed that, Consistent with Article 7(1)(e)(iii) of the Agreement the Scientific Committee could review the scientific aspects of CMMs and also agreed that Scientific Committee is not a venue to develop a CMM text. CMMs become binding 90 days after their transmission to Contracting Parties following their adoption at the Meeting of the Parties, subject to this objection period being satisfied.

Relationships with other bodies

There are other regional fisheries bodies and conservation bodies operating in or adjacent to the area of competence of SIOFA, including the IOTC. The Southwest Indian Ocean Fisheries Commission (SWIOFC) is an advisory body promoting the sustainable development and utilization of coastal fishery resources off the shores of East Africa and several island states of the region, as well as responsible management and regional cooperation on fisheries policy. The Agreement specifically requires Contracting Parties to cooperate with related organisations having mutual interests, and particularly with SWIOFC and other adjacent organisations managing fisheries in the high seas (SIOFA, 2006).

OVERVIEWS

Bottom fisheries

Bottom fisheries on the high seas of the southern Indian Ocean started when vessels of the former Union of Soviet Socialist Republics (USSR) fished the area using trawls, bottom longlines, traps, and other gears, in the late 1960s and 1970s (Romanov, 2003; SIODFA, 2015). These fisheries were slow to develop because of the distance to the then major markets and the difficulties of fishing the poorly-charted areas at depths mainly in the 600–1 500 m range. The fish targeted were mainly alfonsino (*Beryx splendens*), rubyfishes (*Emmelichthys nitidus* and *Plagiogeneion rubiginosum*), butterfish (generally *Centrolophus niger* and *Hyperoglyphe antarctica*), and pelagic armourhead (*Pseudopentaceros richardsoni*). Commercial catches of orange roughy (*Hoplostethus atlanticus*) were not recorded at that time. Ukrainian vessels continued to fish into the early 1990s.

The technology for deep-sea trawl fishing evolved in the 1980s, with capabilities to accurately identify locations of deep-sea features and the ability to precisely place trawls on the sea floor, or just above the sea floor, at great depths. These improvements in technology were introduced into the Indian Ocean in the 1990s. Bottom trawls now normally fish on the seabed for only 5-15 minutes at speeds of 3.5-4 knots, use sophisticated electronics to monitor their exact position, and require considerable investments in terms of money and knowledge to fish successfully and sustainably (Shotton, 2009). The fishery was intensive during the 1990s, with relatively high catches being pursued by only one to three vessels. The number of vessels increased in the late 1990s and early 2000s, and peaked at 35-53 vessels in 2000-2001. Catches started to decline rapidly and only five vessels remained by 2004. The fleet has remained at more or less this level ever since (SIODFA, 2015, SIOFA, 2016a). These vessels fished for toothfish with bottom longlines, orange roughy with bottom trawls, and alfonsino and other species with deep mid-water (semi-pelagic) trawls (Romanov 2003; SIODFA 2015; SIOFA, 2016a). The targeted fishery for orange roughy only started in the late 1990s and was in decline by the early 2000s. A total of some 11 bycatch species are caught and sold and include snappers and jobfish (Lutjanidae), cardinal fish (Apogonidae and Epigonidae), warehou (*Hyperoglyphe antarctica*), groupers (Serranidae), and bonnetmouths and rubyfish (Emmelichthyidae). The history of the Indian Ocean toothfish fishery is unclear. The high catches reported in the late 1990s and early 2000s may have been due to misreporting. Nevertheless, there is currently a small fishery for Patagonian toothfish in the south of the Indian Ocean.

The FAO FishStat database provides the officially reported catches for Major Fishing Areas 51 and 57, including both national and high seas waters (FAO, 2015). It is possible, using selected species and fishing nations, to gain some idea of catches in the high seas part of the Indian Ocean. Preliminary estimates of catches in the SIOFA area were also reported to SIOFA in 2016, and generally gave much higher catches (SIOFA, 2016a). It is also believed that many catches were not reported in the early years, and in more recent years the catches of some fishing nations were not reported to FAO for reasons of confidentiality, thus providing an inconsistent overview of the development of total catch. Further estimates of catches are reported on the Southern Indian Ocean Deepsea Fishers Association (SIODFA) Web site. There are large differences in the reported catches among the published sources, and annual catches of many species vary widely. Overall, there were high total catches in the early 1980s, and again in the 1990s, with annual landings being around 3 000-6 000 tonnes during the peak periods. Alfonsino catches appear to be highest in the late 1990s and again more recently since 2010, often reaching officially reported levels of 2 000-4 000 tonnes per year. Catches of orange roughy were stable at low levels in the 1980s and early 1990s, and again since 2010. However, they increased dramatically from 1998 to 2005, ranging from 3 000 to 7 000 tonnes per year. Reported catches of toothfish peaked in

2001-2002 at around 7 500 tonnes, but immediately dropped and have been around the 100 tonnes level since. As stated above, there is suspicion that the high catches of toothfish are the result of misreporting (unpublished information). It is believed that the Indian Ocean toothfish may represent a shared straddling stock with the Southern Ocean Patagonian toothfish (SIOFA, 2016a). Recent annual catches for all species are around the 5 000 tonnes level and appear to be stable and target mainly of alfonsino, with lesser components of orange roughy and Patagonian toothfish (FishStat, 2015). The most recent review of current fishing effort in the high seas of the Indian Ocean was also presented at the SIOFA Scientific Committee meeting (SIOFA, 2016a).

Vulnerable marine ecosystems

The importance of identifying and managing VMEs was recognized in preliminary discussions at the second Meeting of the Parties (SIOFA, 2015). Australia, the European Union, Japan and the Republic of Korea, expressed their interest in working intersessionally to develop a conservation and management measure on VMEs. Australia prepared a report on bottom fishery impact assessments in the southern Indian Ocean (Williams *et al*., 2011), and presented a proposal at the first meeting of the Scientific Committee where several aspects in relation to addressing impacts of bottom fisheries on VMEs were discussed (SIOFA, 2016a). This included the constraints and opportunities of using habitat mapping and predictive modelling for the identification of VMEs, and the process that led to delineation of the industry designated benthic protected areas (BPAs) in the Indian Ocean and if these areas contained VMEs. Also discussed was information on fishing effort and the identification of fished areas, as the technical basis for impact assessments.

REGULATIONS AND MEASURES

Introduction

SIOFA entered into force in 2012 and adopted its first measure relating to bottom fishing and VMEs, CMM 2016/01, at the third Meeting of the Parties in 2016 (SIOFA, 2016b). This measure, which contains the necessary general provisions and definitions, outlines the duties of the Scientific Committee and the Contracting Parties, CNCPs and PFEs required to develop the full suite of bottom fishing measures. As such, CMM 2016/01 refers to "interim measures" in the knowledge that these will be developed further as information is acquired.

Work of the Scientific Committee

The bottom fishing measure, CMM 2016/01[26], instructed the Scientific Committee to conduct specific work on bottom fishing for subsequent consideration by the Meeting of the Parties (Table 19).

TABLE 19
SIOFA's Scientific Committee work plan to develop and provide advice and recommendations to the Meeting of the Parties (CMM 2016/01)

By 2017	By 2019	By 2020
SIOFA Bottom Fishing Impact Assessment Standard (BFIAS). Maps of where VMEs are known or likely to occur. Guidelines for evaluating and approving electronic observer programs for scientific data collection. Standard protocols for the designation of protected areas.	Status of deep-sea fishery resources (and bycatch and incidental species as feasible). VME encounter protocols, indictors and thresholds. Management options in response to VME encounters	Identification of bottom fishing footprint. SIOFA Bottom Fishing Impact Assessment (SIOFA BFIA).

[26] The SIOFA 2016 CMMs enter into force on 18 October 2016 (subject to no objections).

Bottom Fishing Areas

SIOFA initiated the process of identifying the spatial extent of the areas that have been subject to bottom fishing by Contracting Parties, CNCPs and PFEs. Bottom fishing "*means fishing using any gear type likely to come in contact with the seafloor or benthic organisms during the normal course of operations*.". This will lead to the 'SIOFA bottom fishing footprint which is "*a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, CNCPs and PFEs over a period to be defined by the Meeting of the Parties.*" (CMM 2016/01). Scientific Committee will identify the footprint by 2020.

Exploratory fishing protocols

The measures on bottom fishing provide the protocols for Contracting Parties, CNCPs and PFEs with vessels fishing at variance with the established measures. Typically this would mean fishing in an area not previously fished, with a different gear, or above existing levels. This requires an application to Scientific Committee at least 30 days prior to fishing giving anticipated impacts according to the SIOFA Bottom Fishing Impact Assessment. The MoP, based on advice from the Scientific Committee, shall decide if the new fishery can proceeded, and attach any conditions necessary.

Vulnerable marine ecosystems

The bottom fishing measures provide interim arrangements for the closures of areas known or likely to contain VMEs, though at this early stage, this is mainly limited to collecting and sharing relevant information. VMEs, in the context of SIOFA, are defined by the criteria given in paragraph 42 of the FAO Deep-sea Fisheries Guidelines. As part of the interim bottom fishing measures under CMM 2016/01 (Paragraph 36), "*The Meeting of the Parties recommends that all Contracting Parties note the advice from the first meeting of the Scientific Committee in relation to Benthic Protected Areas*". The advice provided by SC was to consider closing the SIODFA BPAs to fishing (subject to reservations) (SIOFA, 2016a). In general, it was however felt that more information was needed prior to MoP selecting its VME areas.

Encounter protocols

The interim measures state that vessels should cease fishing upon encountering evidence of a VME with catches above threshold levels within 2 nm of a bottom or mid-water trawl track, 1 nm from the mid-point of the line segment for pots and longlines, and 1 nm from the mid-point of the operation for other gears. Details of encounters and actions taken should be included in the National Reports submitted to the Scientific Committee. Guidelines for the preparation and submission of notifications of encounters with VMEs are provided in Annex 1 of CMM 2016/01.

Vulnerable marine ecosystem indicators and thresholds

Under the measures for bottom fishing, States are to apply their own threshold levels to catches of VME indicators until SIOFA have adopted their own levels. The Scientific Committee will advice on this by 2019.

Impact assessments

The interim measures outline the information required for the bottom fishing impacts assessments (BFIA) (Paragraph 18, CMM 2016/01). All BFIAs, including the SIOFA BFIA, shall:

- be prepared, to the extent possible, in accordance with the FAO Deep-sea Fisheries Guidelines;

- meet the standards of the SIOFA BFIAS (if the BFIA is prepared after the Meeting of the Parties has adopted the BFIAS);
- take into account areas identified where VMEs are known or are likely to occur in the area to be fished;
- take into account all relevant information provided pursuant to Paragraphs 13 and 35, and in addition, for the SIOFA BFIA, Paragraph 14;
- be updated when a substantial change in the fishery has occurred, such that it is likely that the risk or impacts of the fishery may have changed;
- assess, to the extent possible, the historical and anticipated cumulative impact of all bottom fishing activity in the Agreement Area, if applicable;
- address whether the proposed activities achieve the objectives described in paragraph 1 of this CMM and Article 2 of the Agreement; and
- be made publicly available on the SIOFA Web site, once developed.

The Scientific Committee will develop and advise on the SIOFA BFIA Standard by 2017 and make an assessment of impacts over SIOFA's area by 2020.

Observers

The interim measures requires that each Contracting Party, CNCP and PFE will ensure that flagged vessels have 100 percent scientific observer coverage for vessels using trawl gear and 20 percent for other gears. SIOFA have also defined an electronic observer programme, that allows for electronic monitoring equipment to be used in place of, or in conjunction with, human observers. Once the protocols and guidelines for the electronic observer programme are developed, parties may apply to SIOFA for their flagged vessels to use this method of collecting information according to the SIOFA Data Standards CMM 2016/02 (SIOFA, 2016b).

Scientific research

The Agreement includes the harvesting of the fishery resource for scientific research as a fishing activity (Article 1(g)(ii)) and Contracting Parties may allocate catch quantities for this (Article 6.3(b)) (SIOFA, 2006). The Meeting of the Parties promotes research activities on the fishery resource and on shared stocks (Article 6.1(b)), and endorsed in 2016 the work plan for the Scientific Committee to provide the necessary information to advise on the management of the fishery (SIOFA, 2016b).

Review procedures

The bottom fishing measure, CMM 2016/01, containing the measures for the conduct of bottom fishing and the protection of VMEs, will be reviewed by 2019.

Other regulations that also protect benthic areas

Gear restrictions

In 2016, the Meeting of the Parties agreed in CMM 2016/05 to prohibit the use of large-scale pelagic driftnets, and to recommend that Contracting Parties, CNCPs and PFEs do not use deepwater gillnets (SIOFA, 2016b).

Effort restrictions

CMM 2016/01 set out interim measures requesting each Contracting Party, CNCP and PFE, unless otherwise approved by the Meeting of the Parties, to establish and apply specific measures to limit the level and spatial extent of the bottom fishing effort of vessels flying their flag. This includes constraining the spatial distribution of bottom fishing effort, excluding bottom longlines and traps, to recently fished areas and to avoid expansion.

Data collection, sharing and confidentiality

SIOFA adopted measure CMM 2016/02 specifying the type of information required to manage the bottom fisheries, including information related to the protection of VMEs and CMM 2016/03 on issues that relate to the confidentiality and use of this information (SIOFA, 2016b).

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

At the time of writing there are no designated VME areas in the high seas areas of the southern Indian Ocean that are managed by international agreement to protect benthic habitats from possible significant adverse impacts from fishing with bottom contact fishing gears. There are also no regional measures identifying the SIOFA bottom fishing footprint, though the process to develop this has started. Currently, the area measures are under the control of individual States (see "Domestic measures" below).

SURVEYS

The existing information on the deep-sea habitats of the Indian Ocean has been recently summarised in three meetings of the CBD to describe EBSAs in the Indian Ocean (CBD, 2016). This shows that there have been no extensive deepwater surveys, though information is available from isolated studies. Deepwater corals were reported in the Andaman Sea and the inter-reef areas in the Maldives, in the Northeast Indian Ocean. More is known for the southern Indian Ocean and deepwater corals have been reported from the Atlantis Seamount, Agulhas slope and seamounts, Coral Seamount and fracture zone region in the sub-Antarctic region, Middle of What Seamount, Fools' Flat and at Rusky (CBD, 2016). Many of these sites fall within the industry-designated BPAs. It is not currently known if any of these areas meets SIOFA's criteria for VMEs. Other sources of information for biological work relevant to VMEs in the Indian Ocean are given in FAO (2013).

The most extensive survey work has been undertaken by vessels within the SIODFA group, who have documented many features (Shotton, 2006). The bathymetric work has been supported by side-scan sonar imagery and more recently by cameras attached to bottom trawls.

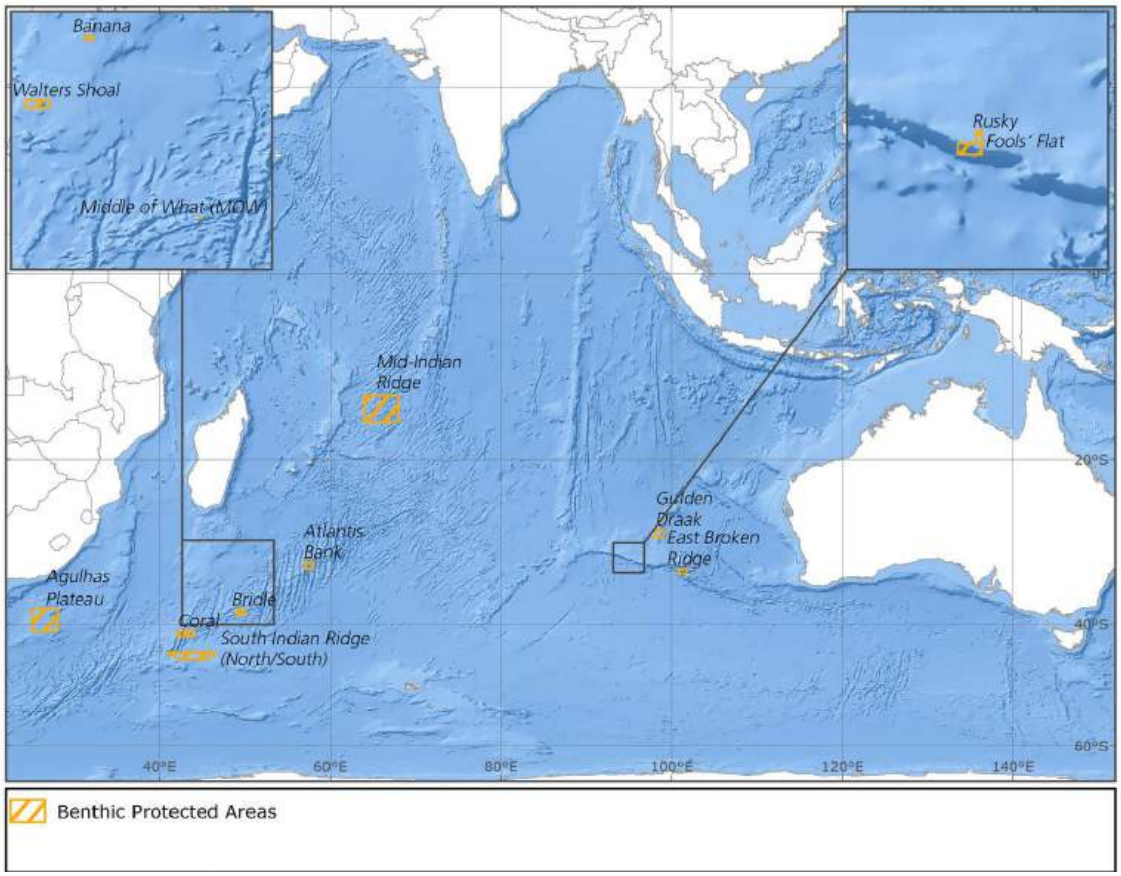
OTHER INFORMATION

Southern Indian Ocean Deepsea Fishers Association (SIODFA)

In 2006, a group of fishing companies with longer-term interests in fishing in the Indian Ocean came together to form the SIODFA. Their objectives are to develop an understanding of the deep-sea fisheries in the Indian Ocean, to fish the resources in a sustainable and responsible manner, and to protect the environment in which these harvested species occur. Through their work, they have identified a total of 13 benthic areas, called Benthic Protected Areas (BPAs), where the organization prohibits fishing by its members (Figure 53). Twelve of these sites are in the Indian Ocean. Ten were identified in 2006 and named Gulden Draak, Rusky, Fools' Flat, East Broken Ridge, Mid-Indian Ridge, Atlantis Bank, Bridle, Walters Shoal, Coral, and Southern Indian Ridge, were identified in 2006. Two further Indian Ocean sites, called the Banana Seafloor feature and Middle of What, were identified in 2013 (SIODFA 2013). The 12 BPAs in the southern Indian Ocean cover a total area of 223 942 km^2. A further site, the Agulhas Plateau BPA, lies to the south of South Africa and just west of the Indian Ocean (Shotton, 2006).

This information, subject to commercial confidentiality, will be reviewed by SIOFA as part of their work to identify VMEs.

FIGURE 53
Benthic Protected Areas identified by SIODFA where the industry members have agreed to prohibit bottom trawling



Domestic measures

The Governments of Australia and the Cook Islands attach special conditions to permits issued to their flagged vessels to fish on the high seas of the Indian Ocean. The Ministry of Marine Resources of the Cook Islands recognizes the BPAs established by SIODFA, and applies special conditions to vessels granted high seas fishing authorizations that prohibit fishing activities in BPAs, require notification when transiting BPAs, and ensure that gear is stowed when transiting BPAs. The special conditions, while not specifically mentioning the term 'BPA', identify the names and locations of the 11 BPAs in (and just west of) the southern Indian Ocean identified by SIODFA in 2006, and do not permit vessels to fish in those areas.

Australia has undertaken a bottom fishing risk assessment for its fishing in the SIOFA area. Australia has also established a fishing footprint, move-on rules and recognised the BPAs and prohibits fishing activities in these areas.

Other parties may also currently have domestic measures that apply to their high seas fishing vessels operating in the Indian Ocean. The new interim Bottom Fishing measures will result in further domestic measures by Contracting Parties, CNCPs and PFEs.

Other activities that might impact vulnerable marine ecosystems

There is mining for polymetalic nodules in the Central Indian Ocean Basin, and for polymetallic sulphides in the Southwest Indian Ridge and Central Indian Ridge (ISA, 2016). These operations are probably all below fishable depths and it is not well known how these activities interact with deep water benthic habitats.

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THE SOUTHERN OCEAN

Antarctic and Southern Ocean

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REGIONAL GEOGRAPHY AND BATHYMETRY

The Southern Ocean surrounds the continent of Antarctica and constitutes about 10 percent of the world's total ocean surface, or about 35 716 100 km^2 (CCAMLR, 2014). Its northern boundary is the Antarctic Polar Front (or Antarctic Convergence) between 45°S and 60°S, where cold waters from the south encounter the relatively warmer waters of the Atlantic, Indian, and Pacific Oceans. The Antarctic Convergence forms a boundary for biota, and therefore has isolating effects, which in turn accounts for the high number of endemic benthic invertebrate species in the Southern Ocean.

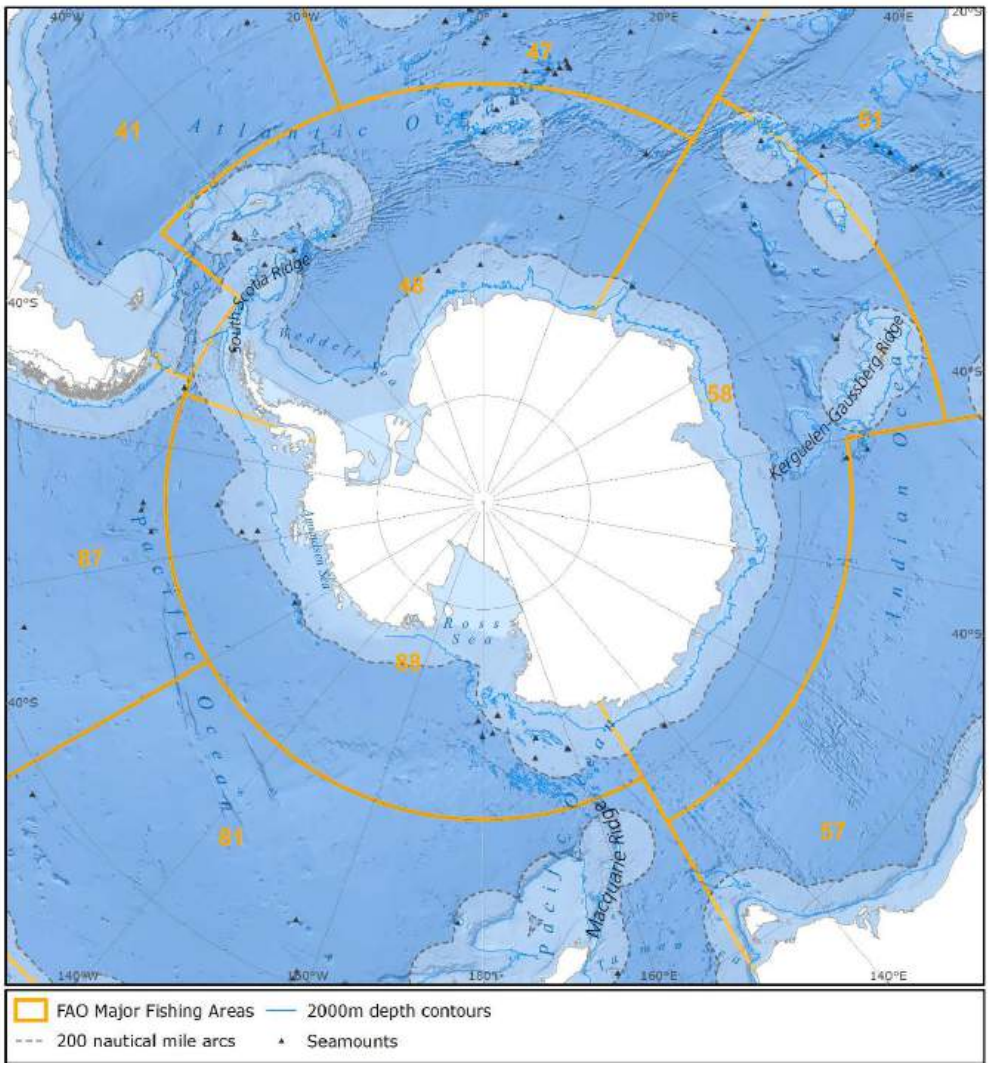
The Southern Ocean consists of a system of deep basins separated by three large mid-oceanic ridges: the Macquarie Ridge south of New Zealand and Tasmania; the Kerguelen-Gaussberg Ridge at about 80°E; and the Scotia Ridge, or Scotia Arc, extending from the southern Patagonian shelf in an eastward arc to the South Shetland Islands and the Antarctic Peninsula (Figure 54). Except in parts of the Weddell, Ross, Amundsen, and Bellingshausen Seas, the continental shelf is narrow: it accounts for 3 to 5 percent of the total area of the Southern Ocean (CCAMLR, 2014). The shelf is also unusually deep, averaging 500 m in depth compared to the global average of 100 m.

Throughout the region there are shelf areas, seamounts and oceanic rises, slope regions, and canyons where bottom fishing may occur. At present, there is insufficient information to predict areas or likely features where VMEs may be expected to occur. However, as currently defined, all marine habitats have the potential to support VMEs.

Sea ice, which can impede fishing, covers vast regions of the Southern Ocean, spreading over 18 000 000 km^2 in winter, and receding during summer to 3 000 000 km^2 at its minimum extent. The extent of the sea ice is usually greatest in September and least in February, although the dynamics of sea ice in a changing environment are an area of active research in the Southern Ocean (Parkinson and Cavalieri, 2012).

The Southern Ocean ecosystem is uniquely significant because all the major ocean basins converge here (Rintoul *et al.*, 2001). The region is divided into three FAO major Statistical Areas: Area 48, Southern Atlantic Ocean; Area 58, Southern Indian Ocean; and Area 88, Southern Pacific Ocean.

FIGURE 54
The Southern Ocean showing the FAO fishing major areas, larger seamounts, 2 000 m depth contour and 200 nm arcs



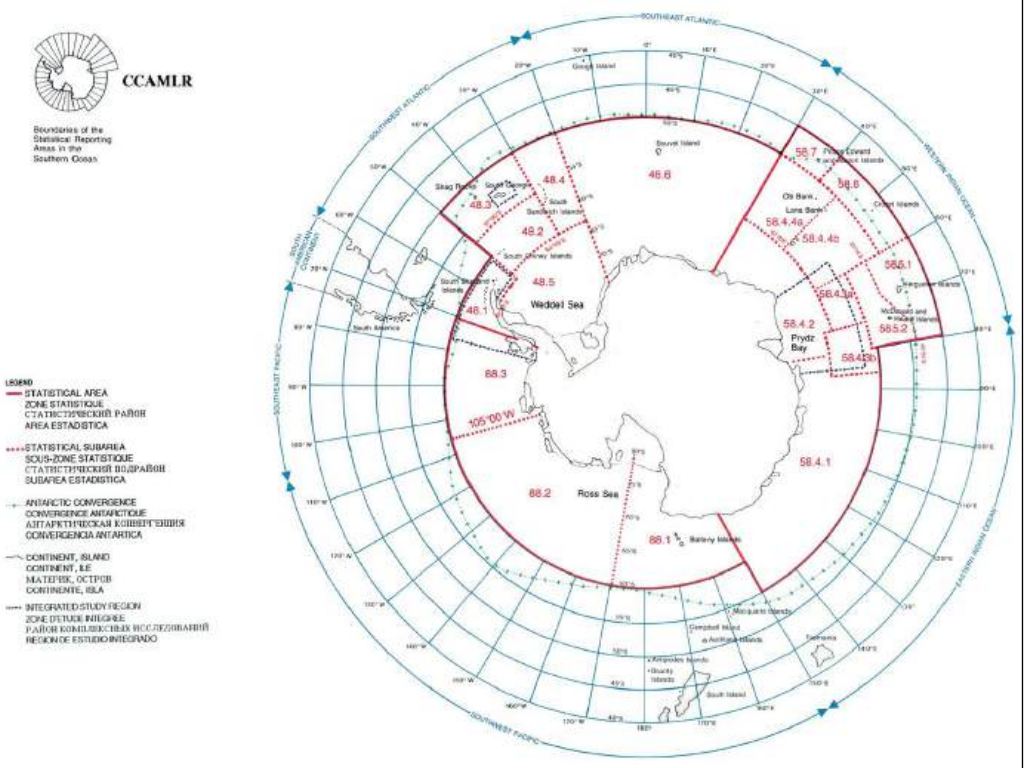
COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

Mandate

Harvesting Southern Ocean marine living resources commenced as early as 1790, when fur seals were hunted for their pelts. Within 30 years some populations of fur seals were close to extinction, and sealers turned to hunting elephant seals and some species of penguins for their oil. Whaling began in 1904 and, though much reduced, has continued into the twenty-first century.

In 1961, the Antarctic Treaty entered into force with the intention to promote scientific cooperation, establish measures to protect the environment, and provide a forum for consultations on operational issues of shared interest. The first convention applicable to Southern Ocean marine life was the 1972 Convention for the Conservation of Antarctic Seals (CCAS), which aimed to promote and achieve the objectives of protection, scientific study, and rational use of Antarctic seals, and maintain a sustainable balance within the ecological system. In 1982, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established by an international

FIGURE 55
CCAMLR Convention Area in the Southern Ocean



Source: from www.ccamlr.org/en/document/organisation/map-ccamlr-convention-area

convention (CAMLR Convention), with the objective of conserving marine life in the Southern Ocean. This was followed in 1991 by the Protocol on Environmental Protection to the Antarctic Treaty, which is primarily concerned with the protection of the terrestrial environment south of 60°. In addition, whaling is managed by the International Whaling Commission (IWC) under the 1946 International Convention for the Regulation of Whaling, and much of the research undertaken in the Antarctic is coordinated through the Scientific Committee on Antarctic Research (SCAR) of the International Council of Scientific Unions.

Membership of CCAMLR was initially open to States that participated in the Conference on the Conservation of Antarctic Marine Living Resources between 1978 and 1980. New Members have joined since that time, and CCAMLR currently has 25 Members, comprising 24 States and the European Union. Members contribute to CCAMLR's annual budget and participate in the decision-making process. CCAMLR is also open to Acceding States, which are legally bound by the terms of the Convention but do not contribute financially to the organisation or participate in decision-making. Furthermore, Acceding States are not permitted to fish in the CAMLR Convention Area (Figure 55). The Commission includes 11 Acceding States, for a total of 36 Contracting Parties.

Regulatory capacity

It is the task of CCAMLR to ensure the conservation of Antarctic marine life, whilst managing and monitoring fishery resources such as krill and finfish. Activities related to whaling and sealing are managed by the IWC and through CCAS, respectively.

The early history of human endeavour in Antarctica, from the 1790s to 1970s, was one of successive and explosive exploitation of marine resources. Concerns about how such exploitation affected both the ecosystem and the harvested species led to an

ecosystem-based approach to management, which seeks to maintain the well-being of the marine ecosystem and targeted species.

The CAMLR Convention applies to all Antarctic populations of finfish, crustaceans, molluscs, other invertebrates and sea birds found in the Southern Ocean. The marine resources managed by CCAMLR specifically exclude whales and seals which are the subject of other conventions – namely, the International Convention for the Regulation of Whaling and the Convention for the Conservation of Antarctic Seals. The objective of the Convention is the conservation of Antarctic marine living resources, where the term 'conservation' includes rational use (Article II). The emphasis is different from that of the conventions of most regional fisheries bodies (RFBs), which have a remit focused on managing fisheries and any impacts they may have on the environment. Furthermore, CCAMLR has the mandate to operate in a much wider context to conserve populations or ecosystems that are not only directly related to harvested marine resources, but also dependent and related populations.

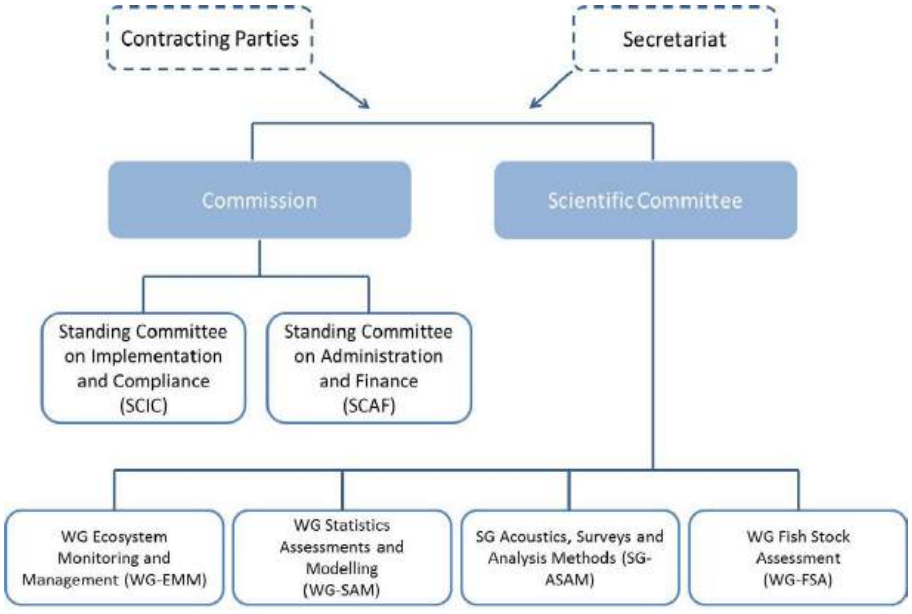
Nonetheless, the practical measures established by CCAMLR to manage fisheries are of a similar style and nature to those of RFBs, as is the process for developing and adopting such measures.

CCAMLR manages the harvesting of marine living resources through Conservation Measures, including gear and area restrictions and precautionary catch limits, that are developed on the basis of the best available scientific advice. Such measures are adopted by consensus and are binding on Members (Article IX) and, if appropriate and applicable, to Acceding States.

Structure

CCAMLR is maintained by its Contracting Parties, which are either Members or Acceding States, in addition to a permanent Secretariat which supports the activities of the Commission and Scientific Committee (Figure 56). The Commission is the decision-making body, and adopts Conservation Measures and Resolutions that are in accordance with the Articles of the Convention. The Commission takes into account of recommendations and advice provided to it by the Scientific Committee. Each Member is represented at both the Commission and the Scientific Committee by one individual, who may be accompanied by alternate representatives and advisors (Article VII).

FIGURE 56
Structure of CCAMLR



The Scientific Committee, established in the Convention, is an independent consultative body to the Commission. It is made up of suitably qualified scientific representatives of Members, who may be accompanied by other experts and advisors. The activities of the Scientific Committee are guided by the Commission and include, among other things, assessing marine living resources (including harvested species), monitoring ecosystem effects, and advising the Commission on measures and research required to achieve the objectives of the Convention.

The Commission and the Scientific Committee may also develop cooperative working relationships, as appropriate, with intergovernmental and non-governmental organizations that could contribute to their work.

The Scientific Committee may establish subsidiary bodies to assist in the performance of its functions. The work of the Scientific Committee is currently assisted by four Working Groups (one of which is referred to as a Subgroup). Consideration of VMEs, and the benthic ecosystem as a whole, falls under the auspices of two of these bodies: the Working Group on Ecosystem Monitoring and Management (WG-EMM) and the Working Group on Fish Stock Assessment (WG-FSA). The WG-EMM, which was established in 1995 and meets annually, is responsible for assessing populations of krill and populations of dependent and related species, to evaluate predator-prey-fisheries interactions, coordinate research priorities, evaluate proposed VMEs, and develop associated management advice. The WG-FSA undertakes finfish stock assessments and evaluates, *inter alia*, the potential adverse impact of bottom fishing on VMEs. The other two bodies assisting the Scientific Committee are the Working Group on Statistics, Assessments and Modelling (WG-SAM) and the Subgroup on Acoustics, Surveys and Analysis Methods (SG-ASAM), both of which provide specialised advice on analytical methods. Additional specialist groups may be established from time to time, often for a limited duration, to deal with specific focus topics.

The Commission, Scientific Committee, and subsidiary bodies are assisted by a Secretariat, based in Hobart, Tasmania, Australia, whose duties include facilitating communications with and among Members, producing and distributing publications, monitoring fisheries, administering notifications including VME notifications, receiving and managing CCAMLR data, managing regulation-related tools, including VMS and a Catch Documentation Scheme (which was implemented to combat IUU fishing), and monitoring compliance with Conservation Measures and other decisions by the Commission.

Decision process

The Scientific Committee allocates its main scientific work to the appropriate Working Groups, which, intersessionally and at their meetings, produce analyses and assessments which are used to develop advice for the Scientific Committee and other Working Groups. Proposals to the Commission by a Contracting Party or Parties are made through documents submitted at relevant meetings, where they are discussed and appropriate advice is provided.

The Scientific Committee reviews the advice of its Working Groups and presents its recommendations to the Commission. The Commission then discusses these recommendations, along with proposals made by Contracting Parties, and adopts, *inter alia*, the necessary revisions or additions to Conservation Measures and Resolutions.

Relationships with other bodies

Although its Convention Area extends beyond the area covered by the Antarctic Treaty System, CCAMLR is an integral component of that System. CCAMLR regularly collaborates with the other components, primarily the Antarctic Treaty Consultative Meeting and the Committee for Environmental Protection to the Antarctic Treaty, which is chiefly concerned with the protection of the marine and

terrestrial environment south of 60°S. CCAMLR undertakes periodic consultations and exchanges of information, including attending the regular meetings of CCAMLR, with the Agreement on the Conservation of Albatrosses and Petrels (ACAP), the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Council of Managers of National Antarctic Programs (COMNAP), the FAO, the Inter-American Tropical Tuna Commission (IATTC), the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Intergovernmental Oceanographic Commission (IOC), the International Union for Conservation of Nature (IUCN), the South East Asia Regional Plan of Action on IUU Fishing (RPOA-IUU), the Scientific Committee on Oceanic Research (SCOR), SEAFO, SIOFA, SPRFMO, the United Nations Environment Programme (UNEP), the Western and Central Pacific Fisheries Commission (WCPFC), and the IWC.

International non-governmental organizations that regularly exchange information with CCAMLR include the Association of Responsible Krill harvesting companies (ARK), the Antarctic and Southern Ocean Coalition (ASOC), and the Coalition of Legal Toothfish Operators (COLTO).

OVERVIEWS

Bottom fisheries

CCAMLR currently manages fisheries for krill (*Euphausia superba*), mackerel icefish (*Champsocephalus gunnari*), and toothfish (*Dissostichus eleginoides* and *D. mawsoni*). The krill fisheries are pelagic, while the icefish fisheries currently operate in waters less than about 350 m deep and use semi-pelagic trawls around South Georgia and bottom trawls around Heard Island and McDonald Island. The area where bottom trawling currently occurs is relatively small and impacts from the fishery are managed by gear measures and by the presence of the Heard Island and McDonald Island Marine Reserve, which is intended to protect sensitive benthic habitats.

Historically, catches of *E. superba* and finfish, including rock cod (*Lepidonotothen squamifrons* and *Notothenia rossii*) and *C. gunnari*, from the Convention Area were both high and erratic, with annual catches of between 20 000 and 200 000 tonnes, giving rise to concerns about overfishing in the 1970s and 1980s.

Bottom fisheries have operated within the CAMLR Convention Area since the 1970s, and the main fisheries currently target both species of toothfish: *Dissostichus eleginoides* and *D. mawsoni*. These species have circumpolar distributions, and are fished using bottom-set longlines at depths of 600–1 800 m and, to a limited and occasional extent, using pots (traps). Toothfish fisheries occur in specific locations in the Convention Area (FAO Statistical Areas 48, 58, and 88), and catches increased slowly to a plateau that has remained relatively stable at around 11 000 tonnes per annum since the late 1990s for *D. eleginoides* and 4 000 tonnes per annum since the mid-2000s for *D. mawsoni* (CCAMLR, 2015a). *D. eleginoides* is caught mainly around sub-Antarctic islands in Areas 48 and 58, whereas *D. mawsoni* is caught predominantly along the Antarctic coast in all three areas. Commercial bottom trawling (outside the area mentioned above) and gillnetting have not been allowed in the CAMLR Convention Area since 2006, and fishing for toothfish in waters shallower than 550 m in exploratory fisheries has been prohibited since 2009. In addition, there are a number of areas closed to bottom fishing, including areas closed to protect known or possible VMEs. Details of the bottom fisheries targeting toothfish in the Convention Area can be found at CCAMLR (2015a).

Other bottom fisheries have operated in the Southern Ocean at various times since the 1960s. Some were large and intensive, and occurred prior to the establishment of CCAMLR. They no longer exist, either because they ceased operating prior to the entry into force of CCAMLR, or because they were closed by the Commission in

the 1990s, mainly in Subareas 48.1, 48.2, and 48.3, due to insufficient information for the exploited stocks to be assessed and managed with confidence. In addition, the Commission has closed a number of fisheries for toothfish due to concerns about the adverse impacts of IUU fishing.

Vulnerable marine ecosystems

CM 22-06 requires that encounters with evidence of VMEs in certain parts of the Convention Area, including high seas areas (CM 22-06, Paragraphs 1 and 2), be notified to the CCAMLR Secretariat. Notifications are reviewed by the Scientific Committee and WG-EMM, and agreed instances of VMEs are recorded in the CCAMLR VME Registry (CCAMLR, 2015b). So far, most of the known VMEs occur in Subareas 48.1 and 48.2 (South Atlantic Ocean), which are closed to bottom fishing, and those VMEs are afforded general protection under CM 32-02. VMEs which occur in areas where bottom fishing is permitted are afforded special protection under CM 22-09.

Encounters with potential VMEs during the course of bottom fishing in the Convention Area are notified under CM 22-07, which establishes a protocol for monitoring and reporting the incidental take of VME indicator taxa. Fishing vessels are required to monitor and report such incidental takes of those taxa, both through routine catch reporting and through random samples collected by scientific observers. The incidental take of VME-indicator taxa in the course of bottom fishing provides information which can be used for mapping the distribution of VMEs and associated areas. CCAMLR has also recognised that longlines and pots are not designed to sample benthic organisms, and therefore the absence of such taxa in the catch does not necessarily mean that the area being fished is not a VME. Managing the potential impact of bottom fishing on VMEs is further complicated by the difficulty of defining the point at which adverse impacts become 'significant', either as one-off events or as cumulative effects. CCAMLR's approach has therefore been to balance the acquisition of information on VMEs with the need to implement precautionary measures aimed at avoiding significant adverse impacts on VMEs.

In essence, the presence of a VME that is detected as part of a scientific research programme using appropriate sampling methods is reported to CCAMLR through the mechanism in CM 22-06. Evidence of the presence of VMEs encountered during fishing is reported through the requirements of CM 22-07, but noting the limitations of fishing gear for sampling VME taxa. The use by CCAMLR of these different sources of information in the protection of VMEs is described in the following section.

REGULATIONS AND MEASURES

Bottom fishing areas

CCAMLR fisheries, including those in high seas areas, are managed using a suite of Conservation Measures that regulate the extent of fishing, and include requirements for research fishing (including a tag and release program for toothfish), precautionary catch limits for target and bycatch species, mitigation of incidental mortality, data collection and scientific observation, and spatial and temporal closures. In addition, measures have been introduced to specifically protect benthic communities, including VMEs and potential VMEs on the high seas.

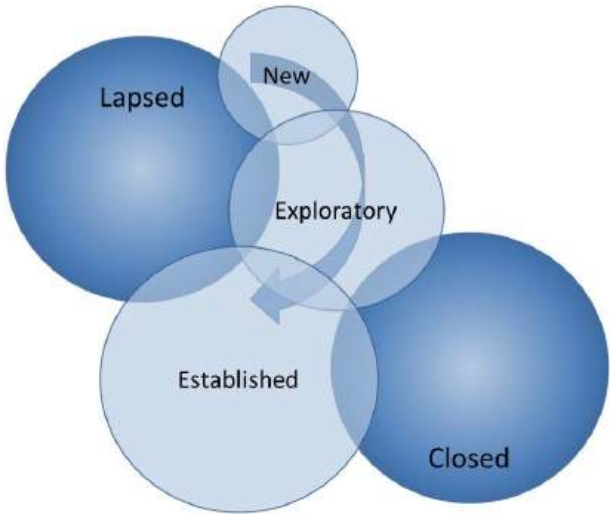
CCAMLR's regulatory framework classifies its fisheries into five types: new, exploratory, established, lapsed, and closed (CCAMLR, 2015c; Figure 57). The current bottom fisheries are classified as either exploratory or established. The exploratory toothfish fisheries are all within specific high seas areas of the Convention Area, and are managed by separate conservation measures (currently CM 41-01 to 41-11). Exploratory fisheries require notification and permission prior to fishing (CM 21-02). The established toothfish fisheries are within national EEZs, where different management approaches and regulations may apply.

Other bottom fisheries have operated in the Southern Ocean at various times since the 1960s. Some were large and intensive, and occurred prior to the establishment of CCAMLR. They no longer exist, either because they ceased operating prior to the entry into force of CCAMLR, or because they were closed by the Commission in the 1990s, mainly in Subareas 48.1, 48.2, and 48.3, due to insufficient information for the exploited stocks to be assessed and managed with confidence. In addition, the Commission has closed a number of fisheries for toothfish due to concerns about the adverse impacts of IUU fishing.

CCAMLR has adopted the following Conservation Measures (CMs) that restrict bottom fishing by closing areas to directed fishing, some of them specifically to protect benthic communities, including VMEs and potential VMEs in areas beyond national jurisdiction (listed in chronological order):

- CM 32-02 (since 1985): Prohibition of directed fishing in various areas
- CM 41-01 to 41-11 (since 1996): Various measures relating to bottom fisheries for toothfish, including spatial and temporal closures
- CM 22-04 (since 2006): Interim prohibition of deep-sea gillnetting
- CM 22-05 (since 2006): Restrictions on the use of bottom trawling gear in the Convention Area
- CM 22-06 (since 2007): Protocols for bottom fishing in the Convention Area
- CM 22-07 (since 2008): Interim measure for bottom fishing activities subject to Conservation Measure 2206 encountering potential vulnerable marine ecosystems in the Convention Area
- CM 22-08 (since 2009): Prohibition on fishing for *Dissostichus* spp. in depths shallower than 550 m in exploratory fisheries
- CM 22-09 (since 2011): Protection of registered vulnerable marine ecosystems in subareas, divisions, small-scale research units, or management areas open to bottom fishing.

FIGURE 57
CCAMLR regulatory framework for managing its fisheries



Source: CCAMLR, 2015c. www.ccamlr.org/en/fisheries/regulatory-framework.

Exploratory fishing protocols

CCAMLR's work on the development of management measures for deep-sea high seas fisheries dates back to 1985, when directed fishing on bottom finfish was prohibited in large-scale areas (CM 32-02). In 1993, the Commission introduced a notification system for exploratory fisheries, whereby Members were required to give prior notification

of their intention to participate in an exploratory fishery (CM 21-02). A similar notification system applies for new fisheries (CM 21-01). In 1996, the Commission introduced a range of operational requirements and precautionary catch limits for the exploratory fisheries for toothfish (CM 41-01 and associated CMs), including requirements for research fishing, deployment of scientific observers, mitigation measures for the incidental catch of seabirds, and detailed data collection. In 2006, the Commission introduced an interim prohibition of deep-sea gillnetting (CM 22-04) and restrictions on the use of bottom-trawling gear in high seas areas (CM 22-05).

In 2007, in confirmation and support of UNGA Resolution 61/105, the Commission introduced CM 22-06 on bottom fishing. which recognized the commitment made by Members to implement the CCAMLR precautionary and ecosystem approaches to fisheries management, and the need to protect VMEs from bottom fishing activities that have significant adverse impacts on such ecosystems. CM 22-06 outlined the procedures to be followed by a Member wishing to undertake bottom fishing activities in specified parts of the Convention Area, including high seas areas. Members must, each year, submit information on the potential significant adverse impacts on VMEs from the proposed bottom fishing. This is assessed by the Scientific Committee, which makes recommendations to the Commission, which then decides whether the fishery can proceed and the conditions under which it may operate.

In 2008, the Commission implemented an interim measure for bottom fishing activities subject to CM 22-06 encountering potential VMEs in the high seas areas of the Convention Area (CM 22-07). In 2009, the Commission introduced a general prohibition on fishing for toothfish in depths shallower than 550 m in exploratory fisheries (CM 22-08), in order to protect benthic communities. Also in 2009, the Commission introduced specific protection of registered VMEs in management areas open to bottom fishing (CM 22-09).

All of these measures are subject to annual review and further development by the Commission, based largely on the advice provided by the Scientific Committee and its Working Groups.

Vulnerable marine ecosystems

The Scientific Committee reviews the status of areas that have, or are likely to have, VMEs, and records these in the VME Registry, as VMEs, VME Risk areas, and VME fine-scale rectangles (defined as an area of 0.5° latitude by 1° longitude). The designation of a VME normally requires detailed investigations of the area by a scientific research vessel.

Encounter protocols

Since 2008, fishing vessels using bottom fishing gears have been required to take certain actions when they encounter evidence of a VME (CM 22-07). An encounter is defined as catching VME indicator taxa above a certain threshold value (see next section), and the action depends upon whether a high or low threshold is exceeded.

If the higher threshold is exceeded, the vessel must inform its Flag State and the Secretariat of the position and the number of VME indicator units caught. An area of 1 nm radius around the reported mid-point of the encounter is closed to fishing, and is designated a “Risk Area”.

Similarly, if the lower threshold is exceeded, the vessel must inform its Flag State and the Secretariat of the position and the number of VME indicator units caught. Upon receipt of a fifth such notification within a single fine-scale rectangle, the Secretariat notifies all relevant fishing vessels that a VME may be present in the rectangle, but vessels may continue to fish within this area subject to further notifications.

The Scientific Committee reviews all potential encounters, and advises the Commission if further management actions are necessary.

Vulnerable marine ecosystem indicators

CCAMLR's working definition of VMEs, as set out in CM 22-06, includes "seamounts, hydrothermal vents, cold water corals and sponge fields" (CM 22-06, Paragraph 3). The presence of VME indicator organisms above a certain threshold level is also taken as evidence of a VME. VME indicators are organisms which, when observed or caught as bycatch, indicate that fishing may potentially be in an area where VMEs occur. CCAMLR specifically defines "VME indicator organisms" as those listed in the "2009 VME Taxa Classification Guide" or, prior to this (in 2008, when CM 22-06 first entered into force), the "Benthic Invertebrate Classification Guide". The guides cover nine orders of Cnidaria (corals, sea pens, etc.), two classes of Porifera (sponges), as well as ascidians, bryozoans, brachiopods, pterobranchs, serpulid tube worms, xenophyophores, barnacles, scallops, some orders of Echinodermata, and various groups representative of chemosynthetic communities (Table 20).

TABLE 20
VME indicator taxa and their corresponding FAO codes

Phylum	Code	Level	Taxon
Brachiopoda	BRQ	Brachiopoda (Phylum)	Lamp shells
Bryozoa	BZN	Bryozoa (Phylum)	Lace corals
Xenophyophora	XEN	Xenophyophora (Phylum)	Xenophyophores
Porifera (PFR)	HXY	Hexactinellida (Class)	Glass sponges
	SPO	Demospongiae (Class)	Siliceous sponges
Hemichordata	PYZ	Pterobranchia (Class)	Acorn worms
Chordata (CZR)	SSX	Ascidiacea (Class)	Sea squirts
Echinodermata (ECH)	CXX	Stalked crinoid (Orders)	Stalked crinoids/sea lilies
	OOY	Ophiurida (Order)	Basket & snake stars
	CCH	Cidaroida (Order)	Pencil spine urchins
Cnidaria (CNI)	ATX	Actiniaria (Order)	Anemones
	AJZ	Alcyonacea (Order)	Soft corals
	NTW	Pennatulacea (Order)	Sea pens
	HQZ	Hydroidolina (Order)	Hydroids
	CSS	Scleractinia (Order)	Stony corals
	AQZ	Antipatharia (Order)	Black corals
	ZOT	Zoantharia (Order)	Zoanthids
	GGW	Gorgonacea (Order)	
		Isididae	Bamboo coral
		Coralliidae	Red/precious coral
		Primnoidae	Bottle brush & sea fans
		Chrysogorgiidae	Golden coral
	AXT	Anthoathecatae (Family)	Sylasterids/hydrocorals
Annelida (ANH)	SSY	Serpulidae (Family)	Serpulid tube worms
Arthropoda (AXX)	BCD	Bathylasmatidae (Family)	Goose & acorn barnacles
Mollusca (MOL)	DMK	*Adamussium colbecki* (Species)	Antarctic scallop
Chemosynthetic	CXX	Various groups	Chemosynthetic communities

Thresholds

CCAMLR has threshold values, established by CM 22-07 in 2008, that apply to bottom-set longlines and lines of pots, defined in terms of the number of VME indicator units recovered per line segment. 'VME indicator unit' is defined as either one litre of VME indicator organisms that can be placed in a 10-litre container or, 1 kg of VME indicator organisms that do not fit into a 10-litre container. For longlines, a 'line segment' means a 1 000-hook section of line or a 1 200 m section of line, whichever is shorter, and for pot lines a 1 200 m section. The higher threshold is 10 or more units

within a single line segment, and the lower threshold is 5–9 units within a single line segment.

The Scientific Committee has discussed the appropriateness of the threshold values in providing evidence of the presence of VMEs, and some have recognised that further work is required to address concerns that these values may not be exceeded even when video transects show ample evidence of VMEs. The WGEMM has also expressed concern about the relative captures of "heavy" and "light" indicator taxa by commercial gears (see e.g. CCAMLR, 2009a).

Impact assessments

CCAMLR, in line with the requirements of UNGA Resolution 61/105, has undertaken preliminary assessments of bottom fishing activities (impact assessment) in exploratory fisheries in the high seas areas of the Convention Area. CCAMLR achieves this by requiring that all Members intending to carry out exploratory bottom fisheries submit details of their intentions prior to fishing, together with any mitigation measures they plan to take to avoid significant adverse impacts on VMEs. This information is reviewed by the Scientific Committee to assess potential short- and long-term impacts on VMEs.

The impact assessments include: descriptions of the fishing gear, fishing activity, estimated fishing footprint per unit effort for a typical fishing gear deployment event, a description of non-standard gear deployment scenarios, estimation of associated frequencies and fishing footprints per unit effort, a characterisation of fragility for VME taxa within each spatial footprint, a calculation of footprint index and impact index for the fishing method, a spatial summary of historical fishing effort, and a calculation of spatially-resolved cumulative footprint and impact (see CCAMLR, 2012).

Observers

CCAMLR requires fishing vessels in the Convention Area to carry CCAMLR-designated scientific observers in accordance with the CCAMLR Scheme of International Scientific Observation. In exploratory bottom fisheries, all vessels are required to carry one scientific observer appointed in accordance with CCAMLR's Scheme of International Scientific Observation, and where possible, one additional scientific observer. In those fisheries, scientific observers must collect information in accordance with a "Data collection plan" (CMs 21-02 and 41-01) developed by the Scientific Committee. Vessels in exploratory toothfish fisheries are also required to make sufficient samples available to the on-board observers to enable collection of all data required by the Observer Sampling Requirements for the current fishing season and as described in the CCAMLR Scientific Observers Manual for finfish fisheries (CM 41-01), and to conduct research fishing in accordance with agreed Research Plans (CM 21-02).

Scientific research

Fishery-related research activities within the CAMLR Convention Area require prior notification, and in some cases prior approval by the Scientific Committee (CM 24-01). Vessels undertaking such research are required to report their research catch, effort, and biological data, and in some cases must carry scientific observers appointed under the CCAMLR Scheme for International Scientific Observation. Research catches are included in the annual catch limits in areas where such limits apply, and summary and full reports of the research activities must be provided to the Scientific Committee.

Research expeditions may present evidence of VMEs in a variety of forms to the WG-EMM for assessment. Evidence can be direct (e.g. photography) or indirect (e.g. biomass of VME indicator taxa).

Review procedures

CCAMLR Conservation Measures are reviewed each year by the Commission and the Scientific Committee, and modified as necessary. This review includes the evaluation of notifications by Members to participate in exploratory bottom fisheries. Current and historical measures are available on the CCAMLR website (CCAMLR, 2015d).

Other regulations that also protect benthic areas

Gear restrictions

Since 2006 CCAMLR has banned the use of gillnets in the Convention Area (CM 22-04). There are further restrictions on the use of bottom trawling gears in high seas areas of the Convention Area (CM 22-05).

Other spatial management measures

Since 2009, CCAMLR has imposed a general prohibition on fishing for *Dissostichus* spp. in depths shallower than 550 m in exploratory fisheries in order to protect benthic communities (CM 22-08).

VULNERABLE MARINE ECOSYSTEM CLOSURES AND OTHER REGULATED AREAS

Closed areas

A total of 46 registered VMEs have been identified, based on data collected since 2003 (Table 21; Figure 58). Of these, 42 VMEs are in areas where bottom fishing is currently prohibited (CM 32-02), and no additional measures are required to protect the VMEs in these areas at this time. The remaining four VMEs are in Subarea 88.1 and Division 58.4.1, where toothfish fisheries are permitted, and are afforded specific protection under CM 22-09. The closed areas are circular in shape; the two in Subarea 88.1 have a radius of 2.33 km (1.3 nm), and the two in Division 58.4.1 have a radius of 18.53 km (10 nm). Identification of VMEs typically requires confirmation by research-vessel surveys, and therefore their locations are within the areas covered by those expeditions. At present, if there is no evidence of a VME, it cannot be classified as either a registered VME or a VME Risk Area. All currently-identified registered VMEs occur in relatively shallow waters within a depth range of 42 to 695 m, with an average depth of 213 m (Figure 59). The VMEs that are without specific measures (i.e. protected under more general measures on prohibited fishing areas) are concentrated around the Antarctic Peninsula and southern Scotia Arc (Subareas 48.1 and 48.2), and around Terra Nova Bay in the western Ross Sea (Subarea 88.1).

A total of 76 VME Risk Areas have been declared since 2009 (Table 22; Figure 58). They are determined by encounters by fishing vessels, and hence occur in areas that are open to fishing. Protecting the VMEs that Risk Areas may contain therefore requires closing a circular area, with a radius of 1 nm, around the point where the encounter occurred. The depth of the water in the Risk Areas varies from 715 to 1 882 m, with an average depth of 1 176 m, which reflects the typical depth range at which the toothfish longline fisheries operate (Figure 59).

TABLE 21
VMEs currently registered in the CAMLR Convention Area

Year	Subarea/Division	# VMEs	Depth range (m)	Program/Member	# Taxa	Area (km^2)
2003	48.1	4	86-198	US AMLR		-
2006	48.1	13	96-235	US AMLR	4-10	-
2008	88.1	2	578-695	New Zealand	1	17 each
2008	58.4.1	2	578-695	CEAMARC-CASO	4-4	1 079 each
2009	48.1	4	149-638	US AMLR	8-18	-
2009	48.2	11	99-226	US AMLR	7-10	-
2009	48.2	2	336-350	US AMLR	2	-

TABLE 21 (CONTINUED)

2012	48.1	1	63	Germany		-
2012	88.1	7	42-50	Italy	2	-

- : no surface area currently defined. The VMEs occur in areas where bottom fishing is currently prohibited, and are defined by the start and end points of research transects.

FIGURE 58
CCAMLR VME and Risk areas as of 2015

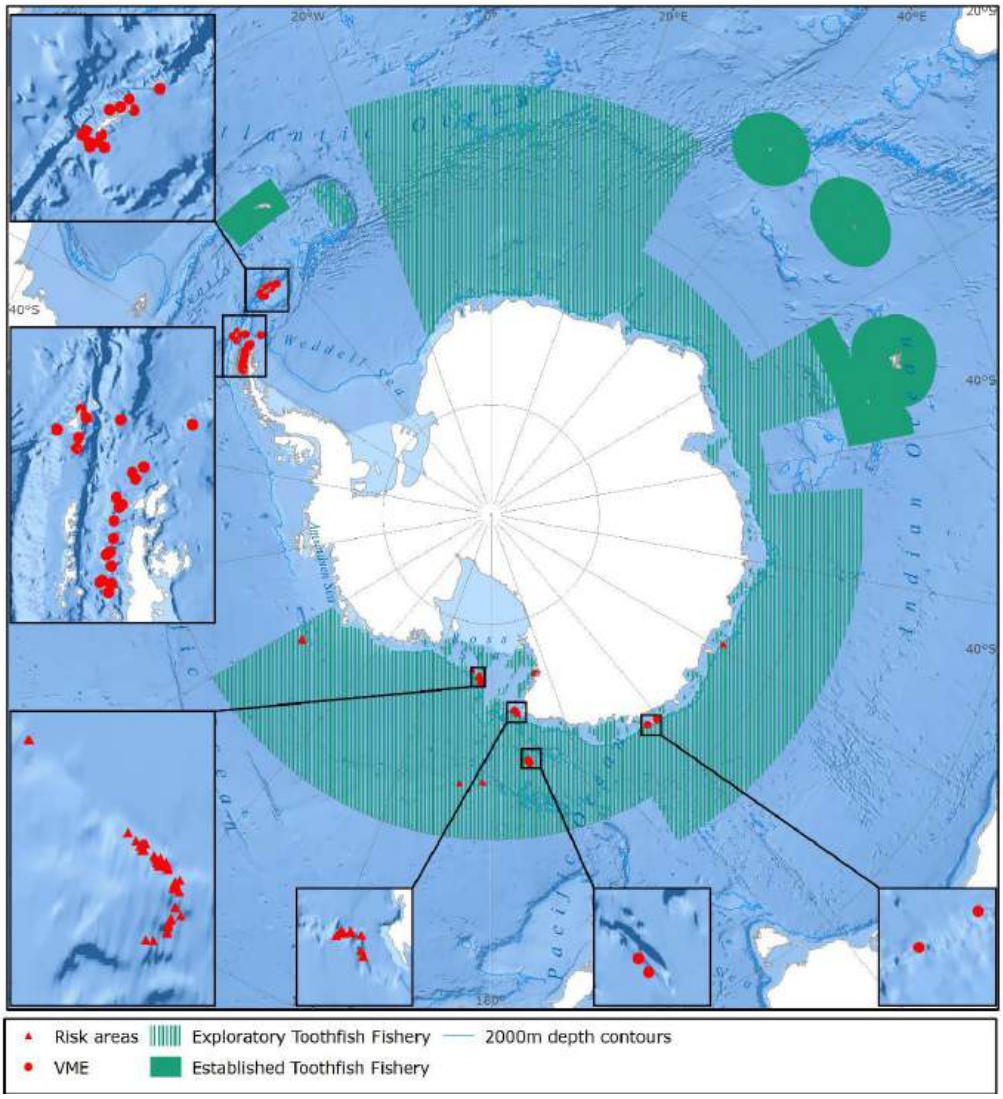
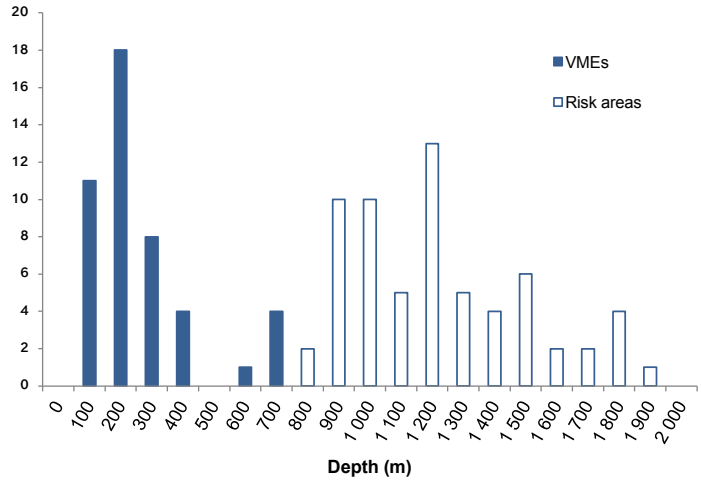


TABLE 22
VME Risk Areas in the CAMLR Convention Area

Year	Subarea/Division	# VME Risk Areas	Depth range (m)	# Taxa	# VME indicator units
2009	88.1	5	1 131-1 296	2-3	11-68
2009	88.2	2	1 323-1 438	2-2	10-10
2010	88.1	30	715-1 182	1-5	11-38
2010	88.2	2	1 452-1 712	2-3	13-15
2011	88.1	8	1 127-1 526	1-4	11-14
2012	88.1	5	826-1 767	1-7	11-42
2012	88.2	12	1 112-1 882	1-5	10-100
2015	58.4.1	1	1 417	1	12
2015	88.1	11	852-1 456	1-3	11-47

FIGURE 59
Depth of VMEs and risk areas in the CCAMLR Convention area in 100 m intervals



Bottom fishing areas

Established and exploratory bottom fishing activities for toothfish are currently undertaken within relatively small areas within the Statistical Areas where the fishery is permitted. These smaller areas are not specifically delineated in the regulations, and the regulations applying to the Statistical Area as a whole apply. However, CCAMLR produces detailed maps of longline fishing effort for toothfish fisheries (see e.g. CCAMLR, 2008), which identify the areas that are at greatest risk of impact by illustrating both the individual and cumulative effects of each fishery. The areas where toothfish fisheries were permitted during the 2014 season (1 December 2013 to 30 November 2014) are shown in Figure 60.

Other access-regulated areas

CCAMLR's regulations regarding the conduct of bottom fishing (CM 22-06) apply to the CAMLR Convention Area. Areas which are exempt from CM 22-06 are those where there was an established bottom fishery in 2006–2007 with a catch limit greater than zero (in statistical Subareas 48.3, 48.4, 58.6, 58.7, and Divisions 58.5.1 and 58.5.2). In addition, CCAMLR prohibits bottom fishing for toothfish in waters shallower than 550 m in exploratory fishing areas, which includes most of the Antarctic coastline except for Subareas 48.1, 48.5 and 88.3, where exploratory toothfish fisheries are not permitted (CM 22-08; Figure 61).

SURVEYS

Fishery-dependent

All fishery-dependent research surveys must be undertaken in accordance with all applicable Conservation Measures in force, including those that pertain to minimizing adverse impacts on VMEs (CMs 22-06 and 22-07).

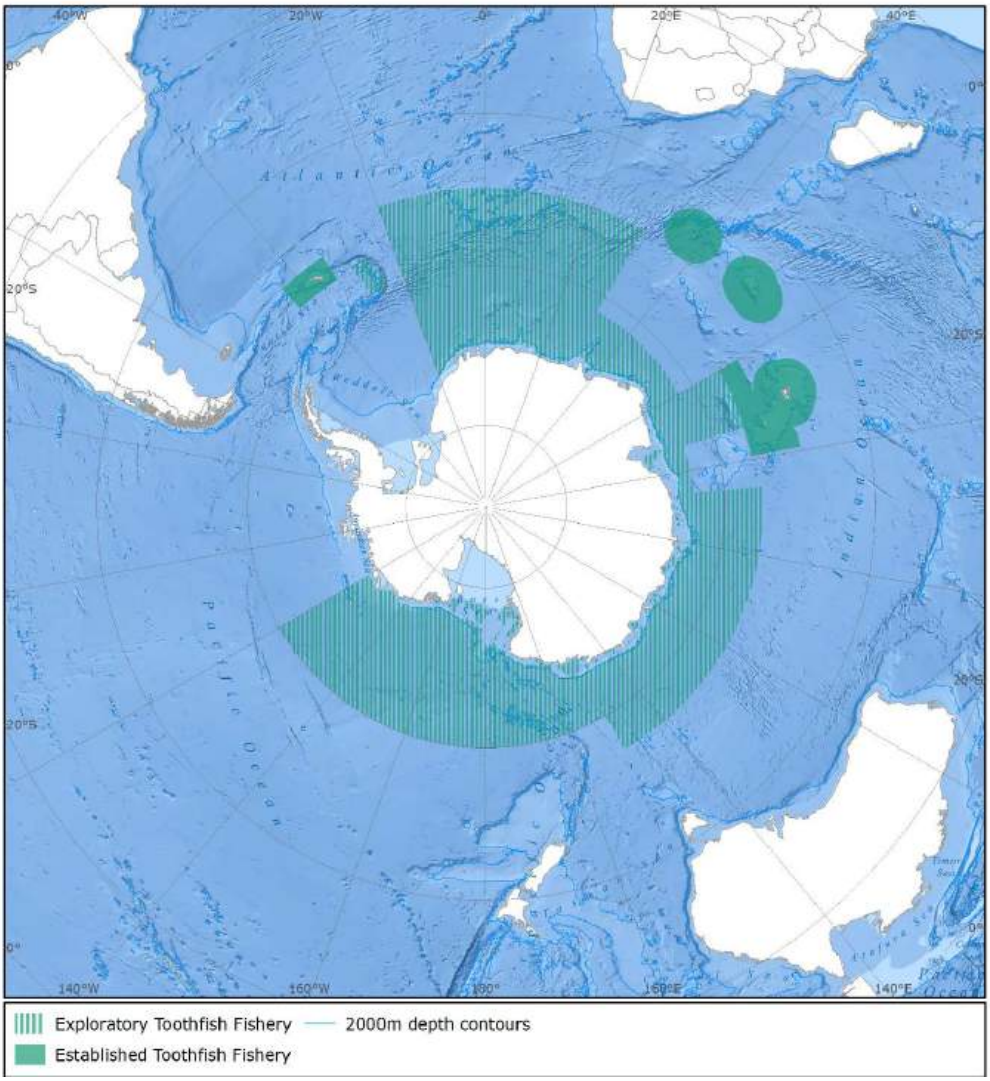
Fishery-independent

Fishery-independent research surveys are undertaken periodically by Members, as well as scientific surveys undertaken in the CAMLR Convention Area in which VMEs have been detected and registered.

Analysis

Analysis of information relative to research or detection of VMEs is undertaken annually by the Scientific Committee's Working Groups.

FIGURE 60
Established and exploratory toothfish fishing areas in 2014



OTHER INFORMATION

Exploratory fisheries

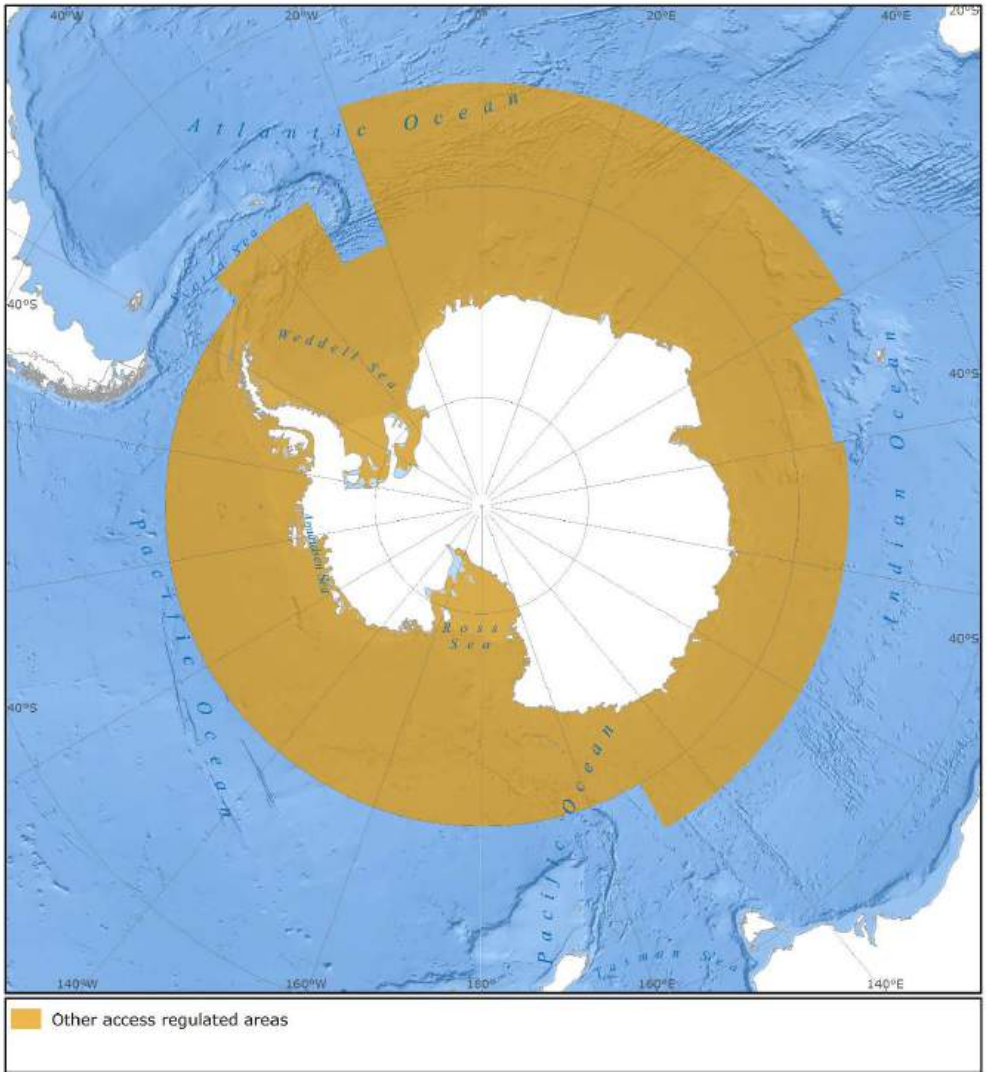
CCAMLR receives notifications each year from Members wishing to participate in exploratory fisheries for toothfish. These notifications are reviewed by the Commission and Scientific Committee, as well as various subsidiary bodies, and limits on the number of vessels which may participate in these fisheries each season are agreed and reported in the relevant CMs (CM 41-04 to 41-07, CM 41-09 to 41-11).

Identification guides

CCAMLR has published a four-page identification guide for VME indicator taxa, referenced in CM 22-07. The guide is designed for use by on-board scientific observers (CCAMLR, 2009b).

Individual Members have also produced various taxonomic guides, such as the *Field Identification Guide to Heard Island and McDonald Islands Benthic Invertebrates,* published by the Australian Antarctic Division. This regional guide aims to improve the reliability of bycatch reporting on fishing vessels operating in the Heard Island region (Hibberd and Moore, 2009).

FIGURE 61
Areas where CCAMLR has other measures regulating the conduct of bottom fisheries



Data sharing protocols

Data-sharing operates at many levels, from the initial notifications by Members of their intention of undertaking fishing within the CAMLR Convention Area, through the reporting of catch and effort by the vessel or its Flag State, the collection of biological data and associated information by scientific observers and their analysis by the Scientific Committee and Working Groups, and the review of catch limits and Conservation Measures by the Commission.

CCAMLR publishes all Conservation Measures, meeting reports, and abstracts of documents for those meetings. In addition, catch and effort data and detailed information relating to each fishery is also provided in the CCAMLR Statistical Bulletin and Fishery Reports. Members have access to more detailed information on the secure section of the CCAMLR Web site.

With respect to new and exploratory bottom fisheries, since 2002 Members have been required to notify their intent to fish to the Commission by 1 June (CM 21-02), or three months (CMs 21-01 and 22-06) before their meeting, which is generally held during the third week of October. There are independent requirements for fishing vessels to submit 'real-time' catch and effort reports to the CCAMLR Secretariat.

For exploratory fisheries, these reports must be made daily (CM 23-07), while in other fisheries this reporting is required every 5 or 10 days, and in some cases every month. The Secretariat's Data Centre is the custodian of the data which underpin the Commission's decisions and support the implementation and monitoring of those decisions. These data, collectively known as 'CCAMLR data', are used principally by the Scientific Committee, specialised groups, and the community of scientists, resource managers, fishery officers, and policy makers. The *Rules for Access and Use of CCAMLR Data* (CCAMLR, 2015e) generally govern the administration and use of data held by the Secretariat. Additional rules apply to the release of data from the Catch Documentation Scheme (CM 10-05) and data from the VMS (CM 10-04).

CCAMLR's VME glossary

For the purposes of discussions related to VMEs, CCAMLR, developed a glossary and a flow diagram to explain the relationships among the terms (CCAMLR, 2013).

Other activities that may have impacts on VMEs

The Southern Ocean and Antarctica, through the Antarctic Treaty, are protected from any forms of commercial mineral extraction. Activities related to oil, gas and deep sea mining, are thus forbidden and therefore cannot impact on VMEs. CCAMLR, though its role in managing biodiversity as well as fisheries, have been discussing the establishment of MPAs which may have some impact on fisheries and hence afford greater protection to any VMEs that may be within the MPA.

ACKNOWLEDGEMENTS

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GLOBAL SUMMARY

Global summary

THE VME CHALLENGE

The preceding chapters provide an overview of the achievements made by States and RFMO/As in the last ten years to sustainably manage deep-sea fisheries and protect VMEs in different regions of the world. This chapter aims to summarize actions taken by States and RFMO/As to address the provisions of Paragraph 83 of the UNGA Resolution 61/105 (2006), which called upon RFMO/As to adopt and implement measures to protect VMEs from any significant adverse impacts resulting from bottom fisheries (Box 4). Specifically, the chapter summarizes actions taken by regional organizations in relation to four elements called for in the resolution: (1) impact assessments, (2) VME identification, (3) VME closures, and (4) encounters and encounter protocols.

BOX 4

Resolution 61/105, Paragraph 83, adopted by the UNGA in 2006

83. *Calls upon* regional fisheries management organizations or arrangements with the competence to regulate bottom fisheries to adopt and implement measures, in accordance with the precautionary approach, ecosystem approaches and international law, for their respective regulatory areas as a matter of priority, but not later than 31 December 2008:

a) To assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on vulnerable marine ecosystems, and to ensure that if it is assessed that these activities would have significant adverse impacts, they are managed to prevent such impacts, or not authorized to proceed;

b) To identify vulnerable marine ecosystems and determine whether bottom fishing activities would cause significant adverse impacts to such ecosystems and the long-term sustainability of deep sea fish stocks, inter alia, by improving scientific research and data collection and sharing, and through new and exploratory fisheries;

c) In respect of areas where vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, are known to occur or are likely to occur based on the best available scientific information, to close such areas to bottom fishing and ensure that such activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems;

d) To require members of the regional fisheries management organizations or arrangements to require vessels flying their flag to cease bottom-fishing activities in areas where, in the course of fishing operations, vulnerable marine ecosystems are encountered, and to report the encounter so that appropriate measures can be adopted in respect of the relevant site.

Resolution 61/105 required States and RFMO/As to take relevant actions by 31 December 2008, only two years after the adoption of the resolution. While previous UNGA resolutions also called for action by RFMO/As and States, Resolution 61/105 was the first to utilize a deadline, and this started a process that has altered the management of high seas bottom fisheries and the way in which stakeholders view

these fisheries. Thus, the adoption of this resolution triggered a range of rapid actions at the global and regional levels aimed at addressing the concerns expressed. This included the development of the FAO Deep-sea Fisheries Guidelines and associated technical advice on scientific matters, the adoption of the necessary management measures, and process related matters. The international community also worked to ensure that the institutional mechanisms were in place to address these new elements (which, at the time, were largely outside the scope of the work traditionally covered by RFMO/As). The broader scope, procedures, and measures of the RFMO/As also set new requirements for data collection, collation and analysis, as well as for reporting, monitoring, control and surveillance.

INSTITUTIONAL STRENGTHENING

As of September 2016, eight regional management bodies exist with the competence to manage bottom fisheries in the high seas (including those for the Mediterranean and Southern Ocean regions), covering approximately 77 percent of the total area of the ABNJ. Three of these bodies (in the Indian Ocean, North Pacific, and South Pacific) were established after the adoption of UNGA Resolution 61/105, indicating the important efforts made by States to ensure that the appropriate institutional arrangements were put in place for the sustainable management of deep-sea fisheries including the conservation of deep-sea ecosystems. There are also two regional advisory bodies that assist States to manage fishery resources in the ABNJ. In the regions where there were or are no existing regional fishery management body, or where the full suite of conservation measures has not yet been adopted (for example, in the three newer RFMO/As and the two advisory bodies), some flag States have developed and implemented domestic measures to address the requirements of the UNGA resolutions. Domestic measures for relevant flag States are currently in place for relevant fishing vessels in the Pacific Ocean, and in the southern Indian Ocean.

The main gap in coverage is the southwestern Atlantic Ocean where there is no regional fisheries body addressing deep-sea fishing, even though bottom fishing occurs in the high seas of this region. There are also other regions of the world's ocean that are not covered by an RFMO/A or regional fishery body, however there is no known commercial bottom fisheries in these areas and no known measures have been implemented related to those regions. Flag States are also responsible for their fishing vessels when exploiting fishery resources in the high seas, and many have regulations to minimize or eliminate the long term impacts on targeted stocks and VMEs. These are particularly important in areas where there are no regional management bodies.

There have also been organizational changes within the regional fisheries bodies to accommodate the additional work necessary to identify and manage VMEs. In 2006, fisheries scientists formed the bulk of the participants at the regional meetings providing the advice. There was little expertise present to cover questions relating to benthic habitats, and there were no appropriate working groups to cover this important topic. It was, in many cases, difficult to find the expertise, but with time most regions now have developed the appropriate internal functions to address this topic (e.g. through dedicated agenda discussions at Scientific Committees, VME working groups, dedicated workshops, special studies, etc.) building on a larger set of expertise including experts on benthic habitats and impacts.

REGIONAL ACTIONS

Impact assessments

The assessment of impacts from bottom fisheries by RFMO/As on VMEs has been, in general, similar. The spatial extent of the bottom fisheries within each region was mapped and considered in relation to where VMEs were known or likely to occur. It was generally considered that VMEs within fished areas were either known, not

present, or had been removed by previous bottom fishing activities. Most RFMO/As allowed bottom fishing activities to continue inside the existing bottom fishing areas using the agreed management measures dealing with catch, effort and gear restrictions and various reporting requirements. Whereas bottom fishing in areas outside of the footprint were generally prohibited, or only allowed to proceed following stringent rules for impact assessments, commonly outlined in exploratory fishing protocols. Most RFMO/As address the risk of encountering VMEs within and outside of existing fishing footprints, the result of which would be the triggering of specific management measures.

It is generally assumed that mobile bottom-contact gear, especially bottom trawls, have a greater impact than fixed gears such as longlines, pots, and gillnets. The impact on VMEs from mid-water trawls, even if fished close to the seabed, is considered minimal unless they accidentally contact the seafloor. The increased emphasis on the need to minimize risk has also led to the development of fishing gear modifications, and the development of fishing technology to increase selectivity for targeted catch as well as adaptive fishing practices (e.g. aimed trawling).

The assessment of what constitutes significant adverse impacts on VMEs caused by bottom fishing is considered a challenge by many of those involved in advising on or in setting management measures. While general guidance exists in the FAO Deep-sea Fisheries Guidelines on factors that should be taken into account when considering the scale and significance of impacts (Paragraph 18), complete scientific knowledge is rarely available for these deep-sea ecosystems, and decisions have therefore been taken based on best available knowledge.

Recovery time following an impact has often been referred to as useful metric to consider and the FAO Deep-sea Fisheries Guidelines note that it can take 5-20 years for an ecosystem to recover from impacts, although some species and habitats may have longer recovery times.

The prior assessment of impacts caused by bottom contact gears is not usually required by RFMO/As when fishing within the existing fishing areas. These areas are generally well known and if any VMEs did exist in the precise fishing area in the past, is it unlikely they remain. However, as mentioned above, management measures do exist in some RFMO/As that require the closure of areas to bottom fishing if a VME is encountered in these existing fishing areas. Bottom fishing outside of the designated existing fishing areas is, in most regions, subject to exploratory fishing protocols that require impact assessments on both the target stock and on bycatch and incidental species. Exploratory fishing protocols monitor for impacts on VMEs by way of any VME indicator presence in catches, or by absence of observed VMEs using underwater camera systems. Such exploratory fishing is assessed on a casebycase basis and is reviewed before, during, and after the fishing operations by both the relevant scientific body and management body of the RFMO/A. These proposed fisheries are only allowed to proceed if it is determined that they are sustainable and if there is no significant impact on VMEs in the proposed fishing area.

VME identification

The FAO Deep-sea Fisheries Guidelines provides criteria for identifying VMEs based on the characteristics of the biota they contain:

i. Uniqueness or rarity
ii. Functional significance of the habitat
iii. Fragility
iv. Life-history traits of component species that make recovery difficult
v. Structural complexity

These criteria have mostly been assessed collectively and in combination with available information on the relevant habitats, species, groups and communities,

and VMEs subsequently delineated for the purposes of fisheries management. The provisions in the FAO Deep-sea Fisheries Guidelines are to be applied based on the precautionary approach. Therefore, assessments must be made, and appropriate measures adopted, even when there is a lack of detailed information.

In general, VMEs are determined for areas that contain dense aggregations of sedentary organisms that have the characteristics described in the FAO Deep-sea Fisheries Guidelines and that form distinct ecosystems upon certain underwater features (the feature itself is not usually considered a VME, but sometimes features have been used as a proxy). While other species may have similar characteristics described in the VME criteria, many are commonly protected under other measures (for example, deepwater sharks, marine reptiles, seabirds, and marine mammals). Upon integrating VME criteria to their regions, most RFMOs/As have expanded their data collection regimes to include reporting on agreed VME indicator species. This information, together with other fishery and research information, is used when applicable to refine the designation of VMEs.

In 2006, and still relevant in some regions, RFMO/As applied a precautionary approach and closed underwater features such as seamounts which were regarded as areas where VMEs are likely to occur. Other approaches, such as predictive modelling, were used to help decide where VMEs are most likely to occur. This approach combines information on bathymetric features with environmental and biological variables to predict the distribution of species that match the VME criteria. The use of such models has received some criticism with respect to their accuracy at the fine-scales required for predicting VMEs, and additional steps are normally needed to validate the models (e.g. groundtruthing).

Dedicated scientific surveys are considered by many to be the best way to identify VMEs, often using sophisticated underwater camera system either on a towed body or on a remotely operated underwater vehicle (ROV). However, this is expensive and time-consuming work that can be difficult to achieve given other priorities. Even when surveys are undertaken and images show the presence of VME indicator species, there are many factors to consider prior to declaring an area a VME. The criteria need to be satisfied, especially that the area has a high enough density of indicator species to be considered an ecosystem and not an isolated occurrence, that the area is susceptible to significant impacts from current or future bottom fishing activities, and that the extent of the area is identified and delineated. Since 2006, there has also been increased effort by commercial fishing vessels, in particular in the Indian Ocean, to gather information on the fished areas and other features, such as steep slopes and hard substrates, using multi-beam sonar and underwater camera systems to photograph and map the sea floor. Such initiatives have the potential to provide information to the competent authorities for identifying VMEs in a less costly way than through dedicated research cruises.

VME closures

RFMO/As are the only competent authorities that can declare VMEs for fisheries management purposes in the ABNJ. The response by RFMO/As to date is to delineate and close designated VME areas to all bottom-contact fishing gears. This precautionary approach ensures that there is no impact from bottom fishing in these areas. An exception is one recently designated VME on Valdivia Bank in the southeast Atlantic Ocean which was closed by SEAFO to all gears except pots and longlines.

These closures may, or may not, have a sunset clause and a review date. This allows for new information to be assessed and the VME protection measure to be amended if needed. In most cases, the measure is simply rolled over and the closure continues, but there have been cases where the VME boundary has been changed (e.g. in the northeast Atlantic Ocean) or the area re-opened to bottom fishing (e.g. in the southeast Atlantic

Ocean). The latter occurring when further surveys fail to identify any VME in the closed area. In all regions, the VME review processes have resulted, through time, in the identification and closures of additional VMEs as they become identified.

In the southern Ocean, areas within fishing grounds have been closed to fishing on a temporary basis when encounters above thresholds have been reported. These "VME Risk" areas remain closed until a scientific assessment confirms the existence of a VME, thereby supporting the closure, or reveals that there is no VME in the area. The same process applies in most other regions, except that encounters above thresholds have not been recorded from fishing grounds to date.

Management considerations require that delineated VMEs should be of an appropriate size. Whereas there is no lower or upper size limit for a VME, the smaller VMEs are currently around 10 km^2; for example, the VME Risk areas in the Southern Ocean are each 11 km^2. The three largest VMEs declared to date, the New England Seamounts (northwest Atlantic Ocean), the middle Mid-Atlantic Ridge (northeast Atlantic Ocean), and the Wüst Seamount (southeast Atlantic Ocean), are all over 200 000 km^2, but these include areas of abyssal plain that are far too deep for commercial fisheries.

Encounters with VMEs and Encounter protocols

It is recognized that there is a need to account for the existence of unknown VMEs inside and outside of the existing fishing areas. Most RFMO/As have developed an encounter protocol to identify and protect these areas. To mitigate for this risk in new fishing areas, these encounter protocols are often embedded in the exploratory fishing protocols. Encounter protocols are triggered by VME indicators being caught by (or entangled with) the fishing gear above a certain threshold level. The taxonomic level of the VME indicators is not the same in all regions; the VME indicators can be "corals and/or sponges", or they can be classified to a lower taxonomic level (including to the species level).

Encounters should be above a certain threshold value to trigger an action and to be taken as evidence that the vessel may be fishing in a VME. The thresholds vary among regions and sometimes also among fishing gears. The threshold value may be in terms of kilograms caught, or "units" that act as a proxy for weight or numbers, or for longlines it may be the presence on a certain percentage of hooks. Threshold values are normally higher for sponges than corals. An example of a current (2016) threshold from the northwest Atlantic Ocean is a catch per set (e.g. trawl tow, longline set, or gillnet set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges.

Encounters above threshold levels must be formally reported to the RFMO/A. While the details of the response to an encounter vary among regions, an immediate temporary closure is normally applied and the vessel must cease fishing and move away some specified distance from where the VME is believed to be. This has become known as the move on rule. To date, the southern Ocean is the only area where encounters above threshold have been reported.

CONCLUSIONS

The management of bottom fisheries in the ocean regions has evolved in the past decade, however, 2006 and the adoption of UNGA Resolution 61/105 has emerged as the baseline against which later development of measures taken to ensure sustainable management of deep-sea fisheries and protection of VMEs can be compared. The first year of implementation of this resolution by States and RFMO/As provides useful guidance on how the regions have met the UNGA 2008 deadline (Table 23).

The northwest Atlantic, northeast Atlantic, southeast Atlantic and Southern Ocean regions, all with well-established management bodies, had implemented most of the measures necessary to meet the 2008 deadline. The management in the Mediterranean

has not followed the same pathway as most of the other regions, but in many respects has achieved similar results. The two management bodies in the Pacific were in an interim phase from 2006-2012, but adopted voluntary measures that were supported by many of their members. Appropriate binding measures have now been adopted in the Pacific Ocean. The RFMA in the Indian Ocean also entered into force in 2012 and is making progress to develop their conservation and management measures.

The identification and development of areas known or likely to contain VMEs is ongoing. Early closures were more precautionary in nature as there was little information available of the distribution of VMEs throughout the regions. More recently, and as scientific surveys has allowed for the mapping of VMEs, the measures have targeted the specific sites where VMEs are known to occur. With some exceptions, this is most developed in regions having the more substantial bottom fisheries. There is a need for more work in some regions where regional management bodies are new or absent, e.g., in the north and south Pacific Ocean, Indian Ocean, and southwest Atlantic Ocean. Progress has been made in the western and eastern central Atlantic Ocean, where advisory bodies exist, and requires continued coordination with flag States having fishing interests.

The work on VMEs by the fisheries bodies managing the deep-sea high seas bottom fisheries has, to a large extent, changed the way in which these fisheries operate. At the same time the work load and associated costs accrued on the RFMO/As has significantly increased. Newly established RFMO/As, and those with many developing State members, would need to reflect on how priorities are set within the context of their programme of work and budget to address both objectives of sustainable use and conservation.

There is a need to place the VME work within the context of sustainable deep-sea high seas fisheries, where there are other considerations that also need to be developed. The scientific assessment and management of the targeted fish stocks has progressed since 2006, but perhaps not at the same rate as the management of VMEs has progressed. Further, there are other impacts from deep-seas fisheries, for example on deep-sea sharks, seabirds, turtles, etc., though perhaps these are more significant in fisheries closer to land. It is clear that these deep-sea fisheries are being progressively managed according to an ecosystem approach to fisheries and it is expected that this will continue in the future. At the same time, as the demands on the various marine resources increases, other sectoral activities and external factors (such as climate change) may increase in the ABNJ, which may have an impact on fisheries, and call for broader multi-sectoral cooperation between the relevant agencies.

Further it is clear that deep-sea fisheries in the high seas are simply part of a continuum of efforts made to sustainably harvest from the sea in order to provide nutritious food for an ever growing global population. This occurs throughout the sea from the coast, through the continental shelf, and into the deeper waters. All fisheries contribute to this, and it is important to keep and manage the diversity of these fisheries to ensure that they continue to provide these services in a sustainable manner, while maintaining the health of the environment upon which these fisheries depend.

TABLE 23

Ocean regions and year of first implementation of various management measures. See regional chapters for details

Region	Body		Management measure					
	Name	Established	Exploratory fishing protocols	Encounter protocols	Indicator species	Thresholds	Existing fishing area	VMEs (first, current)
Northeast Atlantic Ocean	NEAFC	1959	2008	2008	2009	2009	2009	2005 (5) 2016 (19)
Northwest Atlantic Ocean	NAFO	1979	2009	2008	2009	2009	2010	2007 (4) 2016 (20)
Eastern central Atlantic Ocean	CECAF	1967	-	-	-	-	-	2016 (1)*
Western central Atlantic Ocean	WECAFC*	1973	-	-	-	-	-	2016 (5)*
Southeast Atlantic Ocean	SEAFO	2003	2008	2008	2008	2009	2011	2007 (8) 2016 (9)
Southwest Atlantic Ocean	-	-	-	-	-	-	-	-
Mediterranean and Black Seas	GFCM	1949	-	-	-	-	-	2006 (3) 2016 (4)
North Pacific Ocean	NPFC iNPFC*	2015 2006	2016 2009	2016 2009	2016 2009	2016 -	2016 2008	2016 2009 (1)**
South Pacific Ocean	SPRFMO iSPRFMO*	2012 2006	2014 -	2014 -	-	-	2011** 2011**	-
Indian Ocean	SIOFA	2012	2016	2016	-	2016**	-	-
Southern Oceans	CCAMLR	1982		2008	2008	2008	1985***	2003 (4) 2016 (46+76)****

* advisory

** State measure

*** CCAMLR does not define a generalized existing fishing area. The only currently permitted high seas bottom fishery is for toothfish using longlines in specific areas, other areas are closed to all bottom fishing

**** 46 registered VMEs and 76 VME risk areas

This publication, Vulnerable Marine Ecosystems: processes and practices in the high seas, provides regional fisheries management bodies, States, and other interested parties with a summary of existing regional measures to protect vulnerable marine ecosystems from significant adverse impacts caused by deep-sea fisheries using bottom contact gears in the high seas. This publication compiles and summarizes information on the processes and practices of the regional fishery management bodies, with mandates to manage deep-sea fisheries in the high seas, to protect vulnerable marine ecosystems.

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