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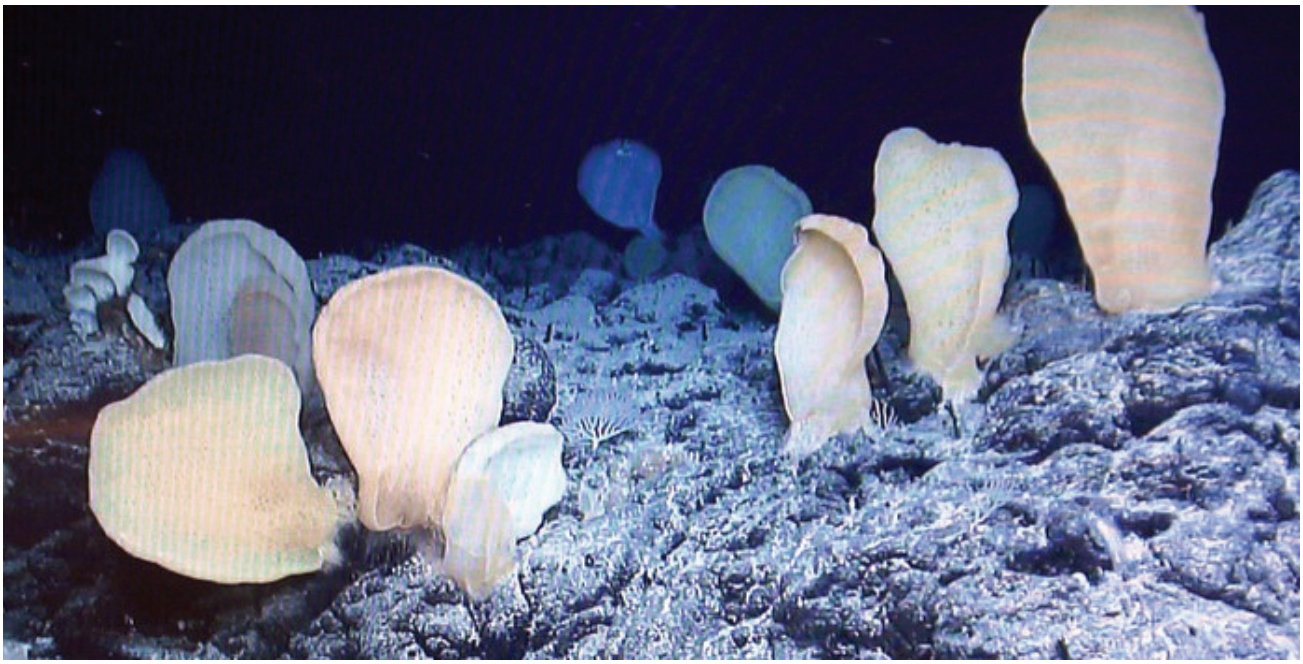
Report of the

WORKSHOP ON DEEP-SEA SPECIES IDENTIFICATION

Rome, Italy, 2–4 December 2009



Cover photo: An aggregation of the hexactinellid sponge *Poliopogon amadou* at the Great Meteor seamount, Northeast Atlantic. Courtesy of the Task Group for Maritime Affairs, Estrutura de Missão para os Assuntos do Mar – Portugal.

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PREPARATION OF THIS DOCUMENT

This FAO Fisheries and Aquaculture Report is the report of the Workshop on Deep-sea Species Identification held in Rome, Italy, from 2 to 4 December 2009. The objective of the Workshop was to identify and review the key issues for vulnerable deep-sea species that should be addressed when developing user-friendly identification tools for corals, sponges and chondrichthyes and, thus, assist in the implementation of the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas and enhance fisheries management tools in general. Part 1 of the report contains an overview of the presentations and discussions held during the Workshop and presents the conclusions and recommendations agreed upon by participants. Part 2 of the report contains the main elements of three background documents drafted for the Workshop. The background documents were harmonized for the purpose of this report and represent the consultants' knowledge on current information available on the different species groups.

FAO is grateful to the Workshop participants for their contributions to this report.

FAO.
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ABSTRACT

A Workshop on Deep-sea Species Identification was organized by FAO in Rome, Italy, from 2 to 4 December 2009. The meeting was organized in response to the need for a strategy for the development of appropriate deep-sea species identification tools for fishery purposes, in particular, to address the broadened requirements for reporting on not only target species, but also associated species following recent international developments with respect to fisheries management guidance and biodiversity conservation. The Workshop included an overview of relevant FAO programmes. The overview was followed by presentations and discussions on current knowledge and key issues to be addressed to improve knowledge of vulnerable deep-sea species groups such as chondrichthyes, corals, sponges and other selected deep-sea groups through the development of a database and appropriate identification tools to facilitate reporting on these species groups by fishery operators. Part 1 of the report includes these discussions as well as the conclusions and recommendations agreed upon by participants. Harmonized versions of the three background documents drafted for the Workshop are included in Part 2 of the report.

ABBREVIATIONS AND ACRONYMS

ABNJ	area beyond national jurisdiction
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
COFI	FAO Committee on Fisheries
EAF	ecosystem approach to fisheries
EBSA	ecologically or biologically significant area
EEZ	exclusive economic zone
GIS	geographic information system
GOBI	Global Ocean Biodiversity Initiative
IUCN	International Union for Conservation of Nature
IEO	Instituto Español de Oceanografía
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
RFMA	regional fisheries management arrangement
RFMO	regional fisheries management organization
ROV	remotely operated vehicle
SEAFO	South East Atlantic Fisheries Organisation
SIODFA	Southern Indian Ocean Deepwater Fishers' Association
SPRFMO	South Pacific Regional Fisheries Management Organisation
UNGA	United Nations General Assembly
VME	vulnerable marine ecosystem

CONTENTS

PART 1: REPORT OF THE EXPERT WORKSHOP

Background

The international community has responded to increased concern regarding sustainable use of marine resources and marine conservation in areas beyond national jurisdiction (ABNJs) through a number of recently developed international instruments. The International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO Deep-sea Guidelines [2009]) were one such instrument developed through FAO. The United Nations General Assembly (UNGA) has also addressed this issue in various resolutions (e.g. 61/105). In 2008, the Conference of Parties to the Convention on Biological Diversity (CBD), at its ninth meeting, adopted criteria for Ecologically or Biologically Significant Areas (EBSAs; Decision IX/20 Annex 1). Coordinated by the International Union for Conservation of Nature (IUCN), the Global Ocean Biodiversity Initiative (GOBI), an international partnership of marine institutions, has been working on developing both technical guidance and training materials concerning implementation of the CBD EBSA criteria.

The ecosystem approach to fisheries (EAF) is now widely advocated and applied in deep-sea fisheries. However, the inherent restrictions on obtaining sufficient information for stock assessment or benthic habitat data (compared with nearshore shelf/slope fisheries) mean that management regimes typically operate at a low level of knowledge, and management action must occur in a highly precautionary manner. In many deep-sea fisheries, there is a lack of the most basic underlying catch data to support adequate fisheries management and conservation efforts, but also, most of the stock are "poor data stock", i.e. with sporadic or intermittent fishing activity, that do not allow traditional assessments.

The main commercial fish species are often well recorded in fishery logbooks, but many of the bycatch species are not because they are unable to be easily identified at sea. Detailed taxonomic literature is of little help at sea to fishers, observers or even trained scientists, because much of the information is provided as detailed keys to entire taxa, which are practically impossible to use on a ship without a lot of time and specialized equipment such as microscopes. However, many of the common species can be readily identified with the aid of pictoral guides that highlight the main physical characteristics, and are annotated with comments to avoid confusion with similar species. Hence, the development of identification guides specifically for use of non-specialist technical staff at sea will enable better information on bycatch composition and stock status, as well impacts on, and location of, vulnerable marine ecosystems (VMEs) that have been recognized as major gaps in knowledge.

The development of species identification guides is specifically recommended in the FAO Deep-sea Guidelines in paragraph 36 (below):

> "36. National and international training programmes for fishers and scientific observers should be used to improve catch identification and biological data collection, including the use of existing FAO material for the identification of commercial species, and the development of field manuals for the identification of non-commercial species, particularly for benthic invertebrates. FAO should provide support to the development and coordination of such programmes."

Introduction

1. The Workshop on Deep-sea Species Identification was held in Rome, Italy, from 2 to 4 December 2009 and was attended by six participants from a wide range of experiences and geographic areas (see Appendix 1). The meeting was opened by Merete Tandstad, FAO Marine and Inland Fisheries Service, who welcomed the participants and asked participants to introduce themselves.

2. The agenda was presented and participants were given the opportunity to comment on the agenda, after which the agenda was adopted (see Appendix 2).

3. The Workshop was tasked with developing a strategy for the production of appropriate deep-sea species identification tools that can be used in fisheries operations. Johanne Fischer, FAO Marine and Inland Fisheries Service, introduced the workshop objectives and explained that the envisaged identification tools for vulnerable deep-sea species are meant to: (a) assist in the implementation of fisheries management measures (e.g. bycatch requirements, recording of catches, and inspection); (b) enhance scientific assessment; (c) be used by practitioners and by scientists; and (d) create public awareness. For the purpose of the Workshop, participants were requested to discuss a number of issues, such as the selection of species (e.g. pelagics yes or no; depth considerations, taxonomic levels for identification, and definition of vulnerability), as well as the types of products required (e.g. ID cards for on-the-spot identification, more comprehensive guides, and electronic databases). Other important topic consisted in the geographic resolution for different types of products, the information basis available so far for selected species (e.g. scientific drawings, and photographs), availability of cooperating experts for different species groups and the general logistic approach for each species group.

4. Malcolm Clark, National Institute of Water and Atmospheric Research (NIWA), New Zealand, was nominated chair of the meeting.

Relevant FAO Programmes

5. Two FAO Programmes are of particular relevance to the work discussed at the meeting: the FAO Programme on Deep-sea Fisheries in the High Seas; and the FAO FishFinder Programme.

FAO Programme on Deep-sea Fisheries in the High Seas

6. Jessica Sanders, FAO Policy, Economics and Institutions Service, presented the FAO Programme on Deep-sea Fisheries in the High Seas. Through the adoption of the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas, FAO was requested by the Committee on Fisheries (COFI) to carry out a number of supporting activities to create awareness and facilitate the implementation of the FAO Deep-sea Guidelines. Building on these requests, FAO has initiated a programme with the aim of assisting States, institutions, the fishing industry and the regional fisheries management organization and arrangements (RFMO/As) in the implementation of the FAO Deep-sea Guidelines. The objective is to improve the current management systems through more and better information and tools, as well as to better engagement and communication among stakeholders, and capacity building. The four-year programme seeks to establish a knowledge baseline in relation to these fisheries and related ecosystems. It contains four major components: (i) support tools for the implementation of the FAO Deep-sea Guidelines; (ii) a VME information system; (iii) pilot implementation activities for enhanced management of deep-sea resources; and (iv) global coordination, monitoring and evaluation, and dissemination of information. The Programme is seen as a multidonor programme, where components or elements of components can be supported through a modular approach.

FAO FishFinder Programme

7. Johanne Fischer, FAO Fisheries Management and Conservation Service, introduced the FAO FishFinder Programme. The Programme's objective is to improve the identification of marine organisms of actual and potential interest to fisheries by providing and disseminating tools to facilitate species identification in fisheries and by providing a global and coherent system of scientific and common nomenclature. Priority is assigned to resources of major commercial importance or threatened species and to developing countries/regions facing difficulties in species identification. The main activities of the Programme are: to secure the best up-to-date information (calling upon knowledgeable specialists in taxonomy); to compile information on species distribution in order to

produce distribution maps; to draw reliable and accurate illustrations of marine organisms and their anatomical details; and to produce and distribute, through different media, species identification information for fishery purposes. The outputs are publications on species identification such as regional and field guides, catalogues, CD–ROMs, synopses, fact sheets available on the Web, species distribution maps and scientific illustrations.

Discussion on chondrichthyes and corals and sponges

8. As a basis for the technical discussions, the Workshop was presented with the following three comprehensive background documents:

- Information to assist preparation of a deep-sea species identification guide – sharks, batoids and chimaeras (class Chondrichthyes), by Peter M. Kyne and Colin A. Simpfendorfer;
- Global list of cold-water corals (order Scleractinia; sub-order Filifera; sub-class Octocorallia, order Antipatharia) from waters deeper than 200 m, vulnerable species, and draft recommendations for the production of identification guides, by Marcelo Visentini Kitahara;
- Towards the development of an identification guide of vulnerable deep-sea sponges, by Joana R. Xavier and Rob W.M. van Soest.

In addition, two presentations were made: one by José Luis López Abellán, Instituto Español de Oceanografía (IEO), Spain, on work on deep-sea species in the Southeast Atlantic; and one by Malcolm Clark on NIWA's experience on developing species identification guides for fish and invertebrates.

The Workshop participants commended the authors of the background documents on their work and provided guidance on improvements to be made to these documents. A summary of the background documents as well as the discussions resulting from them is provided below, whereas the comprehensive background documents can be found in Part 2 of this report.

Chondrichthyes

9. Peter M. Kyne, Charles Darwin University, Research Institute for the Environment and Livelihoods, Australia, provided an extensive account on the immense information already available on these groups, noting that almost half of the total number of species occurs in deep-sea. An important note is that almost all of the deep-sea species have their bathymetric limit of distribution at around above 2 000 m and, therefore, cannot seek refuge (from fisheries) in deeper water. Mr Kyne further showed that there is a correlation between depth and species productivity (with deeper species generally producing fewer offspring or having later maturation age).

10. The class Chondrichthyes (cartilaginous fishes) comprises the sharks, batoids (together forming the subclass Elasmobranchii) and the chimaeras (subclass Holocephali). There has been considerable recent focus on the status of species and populations within this class given their inherent vulnerability resulting from life-history characteristics and well-documented and publicized cases of population declines and depletions. Particularly high levels of endemism are found in lanternsharks (Etmopteridae), catsharks (Scyliorhinidae) and batoids (Rajiformes), and this endemism is often associated with seamounts and mid-oceanic ridges.

11. Almost half of the known cartilaginous fishes (532 of 1 144 species) can be considered "deep-sea", although many other primarily shelf species have also been recorded at depths of more than 200 m. The deep-sea fauna comprises 254 sharks (~53 percent of known species; 23 families), 237 batoids (~35 percent of known species; 11 families) and 41 chimaeras (~91 percent of known species; 2 families). All 10 orders of chondrichthyans are represented in the deep-sea, however, the bulk of the fauna is attributable to four main groups: (i) squaloid dogfishes (order Squaliformes; 46.1 percent of the deep-sea shark fauna); (ii) scyliorhinid catsharks (order Carcharhiniformes, family

Scyliorhinidae; 40.2 percent of the deep-sea shark fauna); (iii) skates (order Rajiformes; families Arhynchobatidae, Rajidae and Anacanthobatidae; 89.7 percent of the deep-sea batoid fauna); and (iv) chimaeras (order Chimaeriformes, families Rhinochimaeridae and Chimaeridae).

12. A checklist of all known described extant deep-sea chondrichthyans (see Part 2, Appendix 1) was provided in phylogenetic order including species (with authority) and common names, a brief account of geographic distribution (including an overview of the respective FAO Areas for each species, allowing construction of species lists for any FAO Area), habitat preferences, depth range, and any relevant taxonomic issues. All deep-sea chondrichthyes are considered to be vulnerable to capture in fishing gear given their morphology, behaviour and habitat associations.

13. Lists were also provided of species known to be targeted (including historically) in fisheries (including those landed as byproduct or bycatch in multispecies fisheries) (17 sharks, 17 batoids, 3 chimaeras) and species known to be caught as bycatch (147 sharks, 146 batoids, 23 chimaeras; total of 316 species, although more have probably gone unrecorded). Approaches to assessing the "vulnerability" of species were discussed and the author suggested that these could include a combination of information on life history and productivity (the decreasing relationship between productivity and depth should be considered), extent of occurrence, rarity, target/bycatch species and conservation status (if any).

14. Reference lists were compiled of existing regional and global identification guides, general deep-sea chondrichthyan papers, general fisheries-related papers, and papers relating to species groups (the bulk of references): (i) squaloid dogfishes (divided by family); (ii) scyliorhinid catsharks; (iii) skates; (iv) chimaeras; and (v) other deep-sea groups. For these species groups, references related to taxonomy, distribution and occurrence, habitat, biology, ecology, fisheries and conservation were provided. While there are a considerable number of references available for some shark families (dogfishes and catsharks), the bulk in fact relate to a handful of species, mostly from the Northeast Atlantic. In addition, an overview of currents experts was provided.

15. The skate literature is diverse but much of it comes from shallower water species or from studies on the shelf for species with wide depth ranges, and chimaera literature is mostly limited to species descriptions.

16. As regards the development of new identification guides to deep-sea chondrichthyans, it was recommended that these should be undertaken at the species level, given the current status of knowledge on the group available information and the number of experts active in this field. Higher-level keys to families and genera should be provided. Keys to species are essential. Guides could include keys to all species (globally and regionally for regional guides), but then the species accounts could focus on the selected "vulnerable" species only. The selection of species should include those recorded as bycatch (including common species; not only "vulnerable" species). For individual accounts, the following components are considered critical: diagnostic characteristics, a list of similar species (referring the user to these species accounts), distribution maps and line drawings.

17. In the subsequent discussions, it was noted that a deep-sea chondrichthyan identification guide could be produced relatively quickly as there is considerable information available from existing FAO guides and publications. For the sharks, the bulk of species have detailed accounts prepared or in preparation from the Catalogue of Sharks of the World.[1] Material on batoids and chimaeras is more limited, but there is still a considerable amount available (e.g. 40 percent of deep-sea batoids have existing FAO line drawings).

[1] Compagno, L.J.V. 2001. *Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes).* FAO Species Catalogue for Fishery Purposes No. 1, Vol. 2. Rome, FAO. 269 pp. Note that Vol. 1 and Vol. 3 are still in preparation.

18. For this group, it was recommended that a global guide be prepared first, followed by regional guides as appropriate or required (it would be possible to prepare species lists for each FAO Area, or larger ocean regions from checklists provided). This would imply preparation of all information in the first instance, from which information could then be extracted for regional guides. It was, however, stressed that the taxonomy remains unresolved for several groups (*Apristurus*, *Centrophorus*, *Squalus*, and some skate groups) and there are at least 65 undescribed chondrichthyan species presently known (with numbers continuing to increase). Development of a guide will need to monitor developments in taxonomy and systematics, but selected experts will have a good understanding of this.

19. The Workshop participants agreed that chondrichthyans constitute the group for which more existing information and illustrations for a guide would be available, recognizing that there would still be gaps to address.

Corals

20. Marcelo Visentini Kitahara, James Cook University, Australia, introduced this topic, providing an overview of current knowledge and information available on this group, including a comprehensive list of all scleractinian (Anthozoa, Hexacorallia, Scleractinia) and calcified hydrozoans (Hydrozoa, Filifera, Stylsteridae) species, and all potential habitat-forming cold-water octocorallians (Anthozoa, Octocorallia) and antipatharians (Anthozoa, Hexacorallia, Antipatharia). An important note was that more than half of the total number of species occur in deep-sea, and provide habitat for a large variety of organisms. These organisms rely on corals as a source of food and shelter. In addition, it was noted that all species are vulnerable to many human activities, including deep-sea fisheries and that, to date, there are no data on the resilience of the habitats formed by deep-sea corals.

21. The term coral has been defined by Cairns[2] as: “animals in the cnidarian classes Anthozoa and Hydrozoa that produce either calcium carbonate (aragonitic or calcitic) secretions resulting in a continuous skeleton or as numerous microscopic, individualized sclerites, or that have a black, horn-like, proteinaceous axis”. From this definition, there are four orders belonging to two cnidarian classes: (i) class Anthozoa, subclass Hexacorallia – order Scleractinia, order Zoanthidea, order Antipatharia, subclass Octocorallia; and (ii) class Hydrozoa, subclass Hydroidolina – order Anthoathecata.

22. Known since the eighteenth century, cold-water corals are involved in the formation of large seabed structures such as reefs and giant carbonate mounds. These structures sustain some of the most species-rich marine ecosystems. Unlike tropical and subtropical coral reefs that grow in relatively shallow waters, cold-water corals do not rely on symbiosis with photosynthetic dinoflagellates (*Symbiodinium* species); instead, they capture microscopic animals and plant matter that drift past in the water column in waters deeper than 50 m.

23. A compilation was made for global distribution (in relation to the 19 FAO Major Fishing Areas) of all cold-water species of scleractinians (797 spp., including undescribed species), filiferians (246 spp.), all potential habitat-forming cold-water octocoralians (225 spp.), and antipatharians (33 spp.) known to occur in waters deeper than 200 m. Despite their important role in deep-sea environments, other cnidarians such as Corallimorpharia, Ceriantharia, Zoanthidea and Actiniaria are not part of the present report because they do not form large three-dimensional structures. All these groups, and many other taxa besides, can be important benthic invertebrate bycatch in commercial fisheries, yet, overall, can be considered less vulnerable to fishing gear. The species groups compiled in this report were proposed by the Workshop to be used as a starting point for any identification guides (but not excluding other, potentially interesting, groups).

[2] Cairns, S.D. 2007. Deep-water corals: an overview with special reference to diversity and distribution of deep-water scleractinian corals. *Bulletin of Marine Science*, 81(3): 311–322.

24. From each of the four groups, there is a brief discussion of species known to be: (i) vulnerable to fishing gear or other factors; or/and (ii) of commercial importance; or/and (iii) bycatch species. In addition, draft recommendations for the production of identification guides are suggested.

25. For some species of corals, it is complicated to compile knowledge owing to the difficulty in obtaining samples. One recognized problem is the difficulties related to exchanging materials between countries for research owing to restrictions under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), especially in those countries that do not have institutions with permanent CITES permissions. With regard to illustrations, photographs of corals are available for approximately 70 percent of the known species, and it is possible to acquire photos for many species from coral collections in museums.

26. To date, the possible level of identification is as follows: (i) scleractinian species (all colonials and key solitary species); (ii) order Antipatharia; (iii) subclass Octocoralia and key genera; and (iv) suborder Filifera and key genera. It was recognized that identifying some of the Scleractinia genera down to species level is problematic.

27. It was noted that the ecological role of solitary species is unknown and, thus, it was recommended to include these species owing to their potential vulnerability. Moreover, reliable distribution maps for solitary species are not readily available, and an effort should be made to see if such maps could be developed.

28. Many coral species are widespread, leading to considerable overlaps between FAO statistical areas. Nevertheless, the suggestion was made to start developing guides for individual regions instead of a global guide, noting that information compiled for one region could be applicable also to other regions. The guides should contain information on multiple species and particular attention should be paid to differences between similar species to help the users avoid confusion.

29. Participants discussed the difficulties in assessing vulnerability of different species for inclusion in the guides. It was also mentioned that climate change impacts needed to be considered as part of longer-term projects.

Sponges

30. Joana R. Xavier, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, the Netherlands, introduced this topic, providing an overview of current knowledge and information available on this group. She noted that sponge taxonomy and systematics is mainly based on internal morphological features such as the type, shape, size and arrangement of the skeletal structures (spicules, collagen fibrils and spongin fibres) that require microscopic examination. Additional characteristics such as external features (colour, shape, consistency, and distribution of the aquiferous system's openings) can be informative but alone are unreliable for taxonomic assignment.

31. The phylum Porifera (from Latin *porus* + *ferō* = pore bearer) constitutes a group of aquatic animals that is widely distributed geographically and bathymetrically in both marine and freshwater ecosystems. Regarded among the most primitive extant animal groups (635 mya[3]), they are a dominant invertebrate group in hard-bottom benthic communities throughout the temperate, tropical, and polar zones from intertidal to abyssal depths. Sponges play important ecological roles in bioerosion, reef formation, substrate consolidation, bentho-pelagic coupling, and habitat provision that have major implications for ecosystem functioning. In addition, as sessile organisms, sponges have developed a range of chemical defence strategies against predators, spatial competitors, or as antifouling. These secondary metabolites with antimicrobial, analgesic, antiviral and anticancer activities have placed sponges among the most prolific and promising producers of medical compounds and increasingly attract the interest of pharmaceutical companies.

[3] Dating is from the International Commission on Stratigraphy (www.stratigraphy.org); mya = million years ago.

32. The phylum comprises three extant (Demospongiae, Calcarea and Hexactinellida) and one extinct (Archaeocyatha) classes, 25 orders, 127 families, and 682 genera. Approximately 8 300 species are currently recognized (World Porifera Database[4]) but the true diversity of this group is estimated to comprise probably twice this number. It is estimated that there are approximately 4 000 sponge species occurring in deep-seas.

33. In some areas, deep-sea sponges form structurally complex habitats, e.g. sponge grounds and reefs, that support a diversity of associated fauna. There are three main types of sponge aggregations: (i) demosponge grounds, known as "ostur or cheese bottoms", composed by multispecific assemblages of large-sized and very abundant astrophorid species of the genera *Geodia*, *Stelletta*, *Isops* and *Stryphnus*; (ii) "monospecific" aggregations of glass sponges such as *Pheronema carpenteri*, *Asconema setubalense*, *Rossella nodastrella* and *Poliopogon amadou*; and (iii) sponge reefs, thus far only known from the western Canadian continental shelf, formed by several hexactinellid species such as *Chonelasma* sp., *Heterochone calyx*, *Aphrocallistes vastus* and *Farrea occa*. In other deep-sea habitats, such as in cold-water coral reefs, sponges do not constitute the primary structural organisms although their diversity surpasses by far that of the structural taxa (e.g. up to 122 sponge species associated to bathyal *Madrepora oculata* and *Lophelia pertusa* reefs of the Rockall Bank).

34. The distribution of all deep-sea species within the class Hexactinellida (glass sponges – 5 orders; 20 families; 121 genera; 645 species); and the orders Lithistida (stony sponges – 14 families; 45 genera; 197 species), Astrophorida (5 families; 42 genera; 691 species) and family Cladorhizidae (carnivorous sponges – 6 genera; 105 species) within the class Demospongiae by FAO Major Fishing Areas was compiled.

35. A list of bibliographic references was compiled. This list provides the main references containing information on: general sponge taxonomy; historical campaigns that yielded extensive sponge reports; sponge aggregations; trawl-induced damage to sponge populations; general deep-sea sponge diversity; and recent group-specific taxonomy. In addition, an overview of current experts was provided.

36. The main recommendations in regard to strategy and limitations on the production of a deep-sea sponge guide were provided. The main limitations highlighted were: (i) the need for microscopic examination for accurate species and/or genera assignment; (ii) the lack of information on species distribution and abundance; and (iii) a general shortage of sponge taxonomists especially for some regions/FAO Areas.

37. To date, despite the scarce knowledge on deep-water sponges, their distribution at species level seems to be very restricted, and usually each species is reported for only one FAO area. Yet, largely in contrast to shallow-water species, most of the deep-sea records are associated with detailed collection data (geographic coordinates, depth ranges, substrate and habitat characteristics).

38. It was broadly accepted that, although difficult, the FAO deep-water vulnerable species guide must include a representative number of deep-sea sponges to increase awareness on the group and, in addition, it will probably increase knowledge once more specimens are collected. In this respect, it was suggested that the specimens, species pictures and/or data collected through the initiative could be forward to the group expert.

Discussion on vulnerable deep-sea or bycatch fish species

39. Luis José López Abellán, IEO, presented a summary of the procedure adopted by the RFMO (South East Atlantic Fisheries Organisation [SEAFO]) in the region to address UNGA Resolution 61/105 and other impacts of bottom fishing on elasmobranchs and potentially other

[4] World Porifera Database can be accessed at: www.marinespecies.org/porifera

deep-sea fishes. For the latter topic, different views in relation to the definition of vulnerability were introduced for discussion and some examples of the practical application of resilience/productivity and intrinsic vulnerability concepts were given.

40. The joint Namibian–Spanish multidisciplinary research activities conducted on the Walvis Ridge seamounts (Ewing and Valdivia Bank) in 2008 and 2009 were described. They focused on mapping and characterizing seamounts, and on identifying potential VME areas or locations. In addition, an analysis of specific composition of samplings was made.

41. A general overview of fisheries carried out in the area was provided and the species composition of catches, including bycatch, in commercial fishing was analysed by type of gear. Data from research cruises and commercial activity were compared, showing the loss of information in relation to species identification in the commercial fishing.

42. A general descriptive account of fisheries in the South Atlantic was also presented. The SEAFO region was described, which is divided into four reporting areas (A–D). This covers two oceanographically different sections, south of 40 °S with Antarctic waters and north of 40 °S, which is more temperate. It was noted that SEAFO has started the process of describing the intrinsic vulnerability or vulnerability to fishing gear of most commercially important species in relation to the levels of aggregations, life history and distributions.

43. Discussion focused on the work done assessing the relative vulnerability of fish species. It was suggested that doing this for a wider range of bycatch species could be useful. For example, elasmobranchs had not yet been analysed, but it would be of interest to see how their intrinsic vulnerability compared with some of the less-productive teleosts.

44. It was stated that Cheung's method,[5] a fuzzy expert system to estimate vulnerability to fishing, based on life-history and ecological characteristics of species is available through FishBase,[6] and has been included in the SEAFO species profiles developed by this organization, but this would have to be checked as the information might not be available for non-commercial species. The reference to the resilience (productivity) of species is also included in the species profiles using Musick's method.[7] This could feed into a general discussion of relative vulnerability if that aspect were included in the species identification guides.

45. The possibility of a looking at the vulnerability of mixed species aggregations to fishing gear, the vulnerability of essential habitat and the productivity of species combined as an "ecosystem vulnerability" were also discussed.

Deep-sea species identification guides for vulnerable species

46. An overview of work on deep-sea species guides in the Southern Pacific was presented as an example of what guides for vulnerable deep-sea species could contain, including suggestions of elements for the development of deep-sea species guides for vulnerable species under the FAO Deep-sea Programme. This was followed by discussions on next steps in the preparation process, including a discussion on possible elements for a future project proposal in support of the development of such guides and on general information for a database on vulnerable deep-sea species that would feed into these guides.

[5] Cheung W.W.L., Pitcher, T.J. and Pauly, D. 2005. A fuzzy logic expert system to estimate intrinsic extinction vulnerability of marine fishes to fishing. *Biological Conservation* 124: 97–111.
Cheung W.W.L., Watson, R., Morato, T., Pitcher, T.J. and Pauly, D. 2007. Intrinsic vulnerability in the global fish catch. *Marine Ecology Progress Series*, 333: 1–12.
[6] FishBase can be accessed at: www.fishbase.org
[7] Musick, J.A. 1999. Criteria to define extinction risk in marine fishes. *Fisheries*, 24(12): 6–14.

Overview of work on deep-sea species in the Southern Pacific

47. Malcolm Clark gave a presentation entitled "Development of guides for VME species experience with identification of fish and invertebrate bycatch". This described the context and progressive development of identification guides by NIWA since the 1990s, which include a wide range of fish and benthic invertebrate species from New Zealand waters. They have also been modified for use on fishing vessels that operate in the southern Indian ocean (through the Southern Indian Ocean Deepwater Fishers' Association [SIODFA]). Separate guides have been developed for the Antarctic (Commission for the Conservation of Antarctic Marine Living Resources [CCAMLR]) and South Pacific (South Pacific Regional Fisheries Management Organisation [SPRFMO]).

48. Example pages were shown for both fish and benthic invertebrate guides. The structure and content were based on presenting information on several hundred species in a form appropriate for use by research scientists, as well as scientific observers on commercial vessels. The guides include sets of instructions for handling and preserving the samples. Photographic "keys" were provided for higher family or order levels, so that identification could occur at the appropriate taxonomic level depending on the condition of material and confidence of the user. Each species page included scientific and common names, recording codes (generally a three-letter code), a distribution map (for fishes), an annotated photograph and/or line drawing, and notes on distinguishing features, colour, size, distribution, depth, similar species, and references.

49. The guides prepared by NIWA were not initially "identification-at-a-glance". However, this approach was applied for the first drafts of working observer identification sheets prepared for the SPRFMO and recently the CCAMLR in response to developing VME criteria.

Discussion on ways forward for the development of guides for vulnerable deep-sea species

50. Following the different presentations, there was discussion focusing on how to ensure continued development of deep-sea species guides for fisheries purposes, including possible elements for a project proposal. Information on each species should be stored in a relational database format. The underlying concept of a database is that it would enable a variety of products to be output, and to evolve with new information and data. In addition, if species data or pages were available electronically, and searchable and selectable online, that would enable interested users to compile their own identification guide for a specific geographical area or group of species. General information and information requirements that should be included in that database can be found in Table 1.

Furthermore, the following was noted with regard to what guides for vulnerable species should include and how these should be structured:

51. The structure of the guide should be hierarchical, so that identification of all specimens can occur, even if taxonomic resolution varies. A balance is needed between identifications being too general to be informative (e.g. simply coral), and too specific (or including too many species) to be usable.

52. Identification needs to be based on external and macro-size features (so species included do not require identification with microscopes or technical equipment) to facilitate onboard identification.

53. Rare and unusual species need to be retained, so the guide should include notes on preservation of specimens. Similarly, other species that cannot be easily identified using macro-size features might need to be retained.

54. Guides need to have general introductory notes on the species and groups, and identification drawings to show the anatomical features used or referred to in the guide.

Table 1. General information for database on vulnerable deep-sea species

This is a summary table of desirable information for a database (repository) on deep-sea species. Depending on the species, more or less information will be available to create either sheets or any type of documentation needed by the users.

Key pieces of information	Description (if available)
Nomenclature	• Species name, including species authority • Common name • Junior synonyms, if regularly used
Codes	Existing codes: • FAO codes (chondrichthyes, bony fish) • Other codes (e.g. RFMOs, etc.) • New codes • Create codes for sponges and corals (refer to CCAMLR, and others)[1]
Taxonomic systematics	• Phylum • Class • Order • Family
Line drawings and/or colour photography (both live and on deck)	• Annotated to highlight features • Details in line drawing
Distinguishing features	• Description of main characteristics, including diagnostic descriptions (key points to look for)
Formatting	• Colour attribution • Size (to be consistent)
Distribution	• Description or map: it is better if it is an expert map of distribution, but record points (type of locality and others) should also be included
Depth range	• If it is known to be more common at a certain depth range, e.g. 300–1 200 m, commonly 500 –700 m
Habitat and biology (optional, when the space is available)	• To be discussed according to the region • Information that is useful or interesting to heighten interest/awareness, e.g. usually found on hydrothermal vents, seamounts, etc. / reproduction / life-history characteristics including age, growth, etc. • Follow a consistent format and layout • Habitat preferences, e.g. at broad scale –- slope, seamounts • Key biological features, e.g. size, age/growth, reproduction, maturity • Elements to report, e.g. if elasmobranch pups expelled when on deck • Assessing maturity
Similar species	Description of similar species to differentiate them from others: • list names and page numbers if a key, or other species, are included; or • list what to look at for distinguishing features
Remarks	Covers any other comments (e.g. general taxonomic confidence, distribution, poisonous): • Symbol to signify category if it is listed on the IUCN Red List (if it is already described in the introduction) • Regional guides to signify if it is already listed by an RFMO

[1] To be evaluated based on different codes in use.

55. It is important to annotate with notes about similar species or taxa in order to minimize confusion with similar species and aid confidence in identifications.

56. Photographs showing fresh coloration have proved very useful, making a combination of annotated line drawing and good colour photographs the preferred option.

57. If the guide is in a book format, it will need multiple indexes (species, common name, family).

58. Observer guides are generally for higher taxa, for which sheet/poster-type formats can also work well.

59. There is a need for consistency in guide form, species covered, codes between FAO, RFMOs and national bodies.

60. Training with actual material is useful (essential for some groups such as stony corals).

Conclusions and recommendations

61. The Workshop recognized the widespread distribution of deep-sea fisheries, the vulnerability of certain taxa taken as bycatch in these bottom contact fisheries and the lack of means to identify these species. The Workshop also recognized the immediate need for identification tools to inform fisheries management.

62. The Workshop recommended that a series of identification guides be developed for certain vulnerable groups of species affected by bottom gear, with an initial focus on three of the most affected groups: chondrichthyes, corals and sponges.

63. The Workshop agreed that the compilation of information should be on a global scale and be as comprehensive as possible, using existing information as well as encouraging the collection of new data.

64. The Workshop agreed that this information can be used as the basis for the development of a variety of guides that target different geographic areas and user groups at varying levels of detail.

65. The Workshop agreed on a number of details including the content and structure of such guides as outlined in Table 1, as well as an overall strategy for the development of a work plan. This included the development of a project proposal for the development of deep-sea species identification material that will be presented to potential donors for their consideration.

APPENDIX 1

List of participants

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APPENDIX 2

Agenda

WEDNESDAY 2 DECEMBER 2009

09:00	**Arrival in FAO**	
09:00–10:30	Introduction • Opening and administrative arrangements • Election of chair and designation of note takers for the different sessions • Agenda • Objectives of the meeting	Merete Tandstad/ Johanne Fischer
10:30–11:00	**Coffee break**	
11:00–13:00	Relevant FAO Programmes • Introduction to the FAO Programme on Deep-sea Fisheries in the High Seas • Preparation of species identification material under the FAO FishFinder Programme • Discussion	Merete Tandstad/ Jessica Sander/ Johanne Fischer
13:00–14:00	**Lunch**	
14:00–15:30	Corals • Global list of known corals (by region), vulnerable species, relevant references and list of experts • Draft recommendations for the production of identification guides • Discussion	Marcelo Visentini Kitahara
15:30–16.00	**Coffee break**	
16:00–17:00	Sponges • Global list of known sponges (by region), vulnerable species, relevant references and list of experts • Draft recommendations for the production of identification guides • Discussion	Joana R. Bogalho Teixeira Xavier

THURSDAY 3 DECEMBER 2009

09:00–10:30	Elasmobranchs and chimaeras • Global list of known (a) sharks/rays and (b) chimeras (by region), vulnerable species, relevant references and list of experts • Draft recommendations for the production of identification guides • Discussion	Peter Kyne
10:30–11:00	**Coffee break**	
11:00–13:00	Vulnerable deep-sea or bycatch fish species • Overview of work on deep-sea species at IEO • Overview of work on deep-sea species in the Southern Pacific • Discussion	Luis José López Abellán/ Malcolm Clark
13:00–14:00	**Lunch**	
14:00–15:30	Next steps • Elements for project proposal • Way forward	Johanne Fischer/ Merete Tandstad/ Jessica Sanders
15:30–16:00	**Coffee break**	
16:00–17:00	• Discussion	Malcolm Clark

FRIDAY, 4 DECEMBER 2009

09:00–10:30	• Report writing	All
10:30–11:00	**Coffee break**	
11:00–13:00	• Report writing	All
14:00–14:00	**Lunch**	
14:00–15:30	• Discussion and adoption of report and main recommendations • Closure	Malcolm Clark
15:30–16.00	**Coffee break**	

PART 2: EXPERT WORKSHOP BACKGROUND DOCUMENTS

Information to assist preparation of a deep-sea species identification guide – sharks, batoids and chimaeras (class Chondrichthyes)

by Peter M. Kyne and Colin A. Simpfendorfer
Charles Darwin University and James Cook University

Overview

Following the FAO terms of reference, a global list (in relation to the 19 FAO major fishing areas) of known chondrichthyes: sharks, batoids and chimaeras (by region and at species level) that occur in the deep seas in depths from about 200 down to about 2 000 m, was compiled. From this, extract lists of those species (or species groups) that are known to be (a) vulnerable to fishing gear or other factors or/and (b) of commercial importance or/and (c) by-catch species, were also compiled. A relevant bibliography for regional and global identification guides, general deep-sea chondrichthyes and for each species group was assembled. Finally, draft recommendations for the production of identification guides are suggested.

1. List of relevant chondrichthyans

The deep-sea chondrichthyans are those whose distribution is confined to (or predominantly at) depths below 200 m, or those that spend a considerable part of their lifecycle below this depth. The maximum depth considered in this list is 2 000 m. Excluded from the list are many chondrichthyans, which have been recorded at depths of more than 200 m but which are predominantly shelf species. These species are recorded far less commonly or irregularly in the deep-sea.

The total number of extant, formally described chondrichthyan species currently stands at 1 144; this comprises 482 sharks, 671 batoids and 45 holocephalans (W.T, *personal communications*). Of the global fauna, 532 chondrichthyans can be considered to be deep-sea species (according to our definition; 200–2 000 m), representing 46.5 percent of the global total. The deep-sea fauna is divided between 254 sharks (52.7 percent of global), 237 batoids (35.3 percent of global) and 41 holocephalans (91.1 percent of global). All nine orders of elasmobranchs and the single holocephalan order are represented in the deep-sea (Table 1).

The bulk of the deep-sea chondrichthyan fauna is attributable to four main groups: (i) squaloid dogfishes (order Squaliformes), which represent 46.1 percent of the deep-sea shark fauna; (ii) scyliorhinid catsharks (order Carcharhiniformes, family Scyliorhinidae) (40.2 percent of the deep-sea shark fauna); (iii) skates (order Rajiformes, families Arhynchobatidae, Rajidae and Anacanthobatidae) (89.7 percent of the deep-sea batoid fauna); and (iv) holocephalans (order Chimaeriformes, families Rhinochimaeridae and Chimaeridae).

2. Annotated global checklist of extant deep-sea chondrichthyans

Within the checklist, where a ? follows a generic name, the placement of this species in that particular genera is questionable and thus tentative. Further research may result in placement in another genus, evaluation of a subgenera to generic level or designation of an altogether new genus. Where a ? follows a specific name, the validity of this species is questionable or the use of that specific name may be invalid. Distribution, habitat and depth information was collated from Compagno and Duffy (2003), global and regional field guides, specifically Last and Stevens (2009), Carpenter and Niem (1998, 1999), Carpenter (2002), Ebert (2003), Compagno *et al.* (2005) and White *et al.* (2006), as well as the primary literature, grey literature sources and consultation with experts. Habitat zones broadly follow Compagno *et al*. (2005).

The checklist covers the depth range 200–2 000 m. Few chondrichthyans are restricted to waters more than 2 000 m. In fact, only three skates have a minimum depth of ~2 000 m. These are: abyssal skate *Bathyraja ishiharai* Stehmann, 2005 (abyssal plains at ~2 300 m), fine-spined skate *Bathyraja*

microtrachys (Osburn and Nichols, 1916) (deep slopes and abyssal plains at 1 995–2 900 m) and pallid skate *Bathyraja pallida* (Forster, 1967) (deep slopes and abyssal plains at 2 200–3 280 m). These species are not treated here. No chondrichthyans have ever been observed or recorded in the hadal or hadopelagic zones (Compagno *et al.*, 2005; Priede *et al.*, 2006). Priede *et al.* (2006) hypothesized that the high-energy demands of chondrichthyans exclude them from the deepest habitat zones.

Table 1
Diversity of deep-sea chondrichthyan fishes by order and family

Order	Family	Common Name	Number of Species
Sharks			
Hexanchiformes	Chlamydoselachidae	Frilled Sharks	2
	Hexanchidae	Sixgill and Sevengill Sharks	3
Squaliformes	Echinorhinidae	Bramble Sharks	2
	Squalidae	Dogfish Sharks	25
	Centrophoridae	Gulper Sharks	17
	Etmopteridae	Lanternsharks	42
	Somniosidae	Sleeper Sharks	16
	Oxynotidae	Roughsharks	5
	Dalatiidae	Kitefin Sharks	9
Squatiniformes	Squatinidae	Angelsharks	7
Pristiophoriformes	Pristiophoridae	Sawsharks	3
Heterodontiformes	Heterodontidae	Bullhead Sharks	1
Orectolobiformes	Parascylliidae	Collared Carpetsharks	2
Lamniformes	Odontaspididae	Sand Tiger Sharks	2
	Pseudocarchariidae	Crocodile Sharks	1
	Mitsukurinidae	Goblin Sharks	1
	Alopiidae	Thresher Sharks	1
	Cetorhinidae	Basking Sharks	1
Carcharhiniformes	Scyliorhinidae	Catsharks	102
	Proscylliidae	Finback Catsharks	3
	Pseudotriakidae	False Catsharks	2
	Triakidae	Houndsharks	6
	Carcharhinidae	Requiem Sharks	1
		Subtotal - sharks	**254**
Batoids			
Rajiformes	Rhinobatidae	Guitarfishes	1
	Narcinidae	Numbfishes	7
	Narkidae	Sleeper Rays	4
	Torpedinidae	Torpedo Rays	8
	Arhynchobatidae	Softnose Skates	75
	Rajidae	Hardnose Skates	116
	Anacanthobatidae	Legskates	21
	Plesiobatidae	Giant Stingarees	1
	Urolophidae	Stingarees	2
	Hexatrygonidae	Sixgill Stingrays	1
	Dasyatidae	Whiptail Stingrays	1
		Subtotal - batoids	**237**
Holocephalans			
Chimaeriformes	Rhinochimaeridae	Longnose Chimaeras	8
	Chimaeridae	Shortnose Chimaeras	33
		Subtotal - holocephalans	**41**
		Total	**532**

A detailed list of species found for FAO major fishing areas is presented in Appendix 2.

3. Species vulnerable to fishing gear or other factors

All deep-sea chondrichthyans are vulnerable to fishing gear to some extent. However, despite being susceptible to gear they may not currently encounter it. This may occur for species that only occur at great depths (more than 1 000 m) where fishing occurs infrequently in most regions, or that occur in habitats that are rarely fished. Although great depths may currently provide protection from fishing to some species, there is a general trend towards fishing deeper as resources in shallower seas become more difficult to catch (Morato *et al*., 2006). Thus, over time it would be expected that many deep-sea species will encounter increasing fishing pressure. This trend may be of concern for fisheries managers as recent work has shown that there is an inverse relationship between depth and population productivity in chondrichthyans (Simpfendorfer and Kyne, 2009). In general, deep-sea species have intrinsic rebound potentials approximately half of those from continental slope and epipelagic habitats. As a result deep-sea species will have relatively limited scope to provide sustainable catches by targeted fisheries or be very slow to recover if overfished. In addition, unlike teleost fishes, few shark species occur below 3 000 m (Priede *et al*., 2006) so they do not have a deepwater refuge where fishing does not currently occur.

4. Species of commercial importance and those taken as bycatch

While all deep-sea chondrichthyans are vulnerable to fishing gear, few are targeted by fisheries (Appendix 3). There are two main groups of species that are targeted in deep-sea fishing operations:

- Squalene yielding deep-sea sharks. Many species of deep-sea sharks contain large quantities of squalene in their livers. In particular members of the families Centrophoridae (e.g. *Centrophorus granulosus* [Bloch and Schneider, 1801], *C. harrissoni* [McCulloch, 1915], *C. isodon* [Chu, Meng and Liu, 1981], *C. squamosus* [Bonnaterre, 1788], *C. zeehani* [White, Ebert and Compagno, 2008], *Deania calcea* [Lowe, 1839]), Etmopteridae (e.g. *Etmpoterus virens* [Bigelow, Schroeder and Springer, 1953]), Dalatiidae (e.g. *Dalatias licha* [Bonnaterre, 1788]) and Somniosidae (e.g. *Centrosymnus coelolepis* [Bocage and Capello, 1864], *Centroselachus crepidater* [Bocage and Capello, 1864], *Proscymnodon plunketi* [Waite, 1909]). Squalene is a high value product and demand has driven the retention of bycatch and in some instances targeting of these species where significant catches are made. Locations where this has occurred include the Northeast Atlantic, Southeast Australia, Southeast Asia, Maldives, and Southern Africa. In many locations where these species have been targeted or regularly taken as bycatch significant declines in abundance have been observed after relatively short periods of fishing (Graham *et al*., 2001; Jones *et al*., 2005).

- Skates. Skate flesh (often sold as “wings”) is considered of high quality and a range of species are taken as both target and bycatch in fisheries. Most are caught by deepwater trawl fisheries, but some are targeted by longlines. Significant catches are mostly taken in temperate areas, including in the Northeast, Northwest and Southwest Atlantic, Alaska, and Chile. The most commonly utilized groups include members of the families Rajidae (e.g. *Amblyraja radiate* [Donovan, 1808], *Dipturus* spp., *Raja* spp.) and Arhynchobatidae (e.g. *Bathyraja* spp.). In the Northeast Atlantic where skates have been a common target and bycatch species over many decades, populations of less productive species have declined significantly, and have been extirpated from substantial parts of their ranges (Brander, 1981; Dulvy and Reynolds, 2002), suggesting that intensive fisheries may not be sustainable for all species. Declines have been documented in other regions also, including Southeast Australia (Graham *et al*., 2001) and the Northwest Atlantic (Devine *et al*., 2006).

While these two groups represent the majority of catch of deep-sea chondrichthyans, many species from other groups are also captured as bycatch in fisheries (Appendix 3). For some species or groups the vast majority of individuals are discarded because of the lack of commercial value due to their small size, low quality products, lack of markets, difficulty in processing or high levels of mercury. This includes groups within the dogfish sharks (Squaliformes) and the catsharks (Scyliorhinidae) such

as some species of the genera *Etmopterus* and *Apristurus*, respectively. For many other species markets exist for flesh and livers and they are retained when they are taken as bycatch in other deep-sea fisheries. It should also be recognised that, although at present unrecorded, additional species of deep-sea chondrichthyan may also be taken as bycatch.

5. Recommendation for the production of the identification guide

The guide should be comprehensive in its coverage of species. For the chondrichthyans, this includes 532 deep-sea species across the three major groups (sharks, batoids and chimaeras).

There would need to be some consideration however, of dealing with other species not considered by definition to be deep-sea species, but which have been recorded in depths more than 200 m. This includes many chondrichthyans which have been recorded at depths of more than 200 m but which are predominantly species of the shelf. These species are recorded far less commonly or irregularly in the deep-sea and include such examples as spiny dogfish *Squalus acanthias* Linnaeus, 1758 (a shelf species which has been recorded exceptionally to 1 446 m) and many shelf skates whose bathymetrical distribution extends to the upper slope, including sandy skate *Leucoraja circularis* (Couch, 1838), blonde skate *Raja brachyura* (Lafont, 1873), thornback skate *R. clavata* Linnaeus, 1758, clearnose skate *R. eglanteria* Bosc, 1802, brown skate *R. miraletus* Linnaeus, 1758 and rough skate *R. radula* Delaroche, 1809.

Some particular species which may require justification as to their absence from this report are the broadnose sevengill shark *Notorynchus cepedianus* (Péron, 1807), which although recorded to 570 m is primarily a coastal inshore shark of temperate waters; the sparsetooth dogfish *Scymnodalatias oligodon* (Kukuyev and Konovalenko, 1988) and the largetooth cookiecutter shark *Isistius plutodus* (Garrick and Springer, 1964), although both occur over very deep water (to 4 000 m), they have both only ever been recorded in the epipelagic zone (–200 m depth in the water column) (it should be noted though that these species are potential vertical migrators and may also occur in the mesopelagic and bathypelagic zones); the megamouth shark *Megachasma pelagios* (Taylor, Compagno and Struhsaker, 1983), a coastal, shelf and epipelagic species recorded from the pelagic zone to depths of 166 m over water to 4 600 m depth, but never recorded from the deep-sea. One last notable species is the great white shark *Carcharodon carcharias* (Linnaeus, 1758), a coastal, inshore, shelf and epipelagic offshore species known to undertake considerable migrations. Great whites have rarely been recorded from the continental slope (Compagno, 2001), and thus in the deep-sea, and a reported capture at 1 280 m (Bigelow and Schroeder, 1948; Compagno, 2001) is doubtful (Bonfil *et al*., 2005). However, more recent research of a shark tagged off South Africa has shown that during transoceanic migration great whites undertake periodic deep dives to depths of up to 980 m (Bonfil *et al*., 2005). It should be noted that this depth is the sensor limit for the tag employed and so it is possible that the tagged shark dived to depths in excess of 980 m. While deep dives were regular in occurrence during its migration, with the shark spending 18 percent of the time at depths of 500–750 m, a far greater amount of time (61 percent) was spent at the surface in water – 0.5 m deep (Bonfil *et al*., 2005). Thus, given the species' primarily coastal and epipelagic occurrence, it is not considered a deep-sea species.

- The guide should be strong on field identification. This should include accurate keys to species for each family (tested in the field and using museum collections). Keys are very valuable in the field identification of species.
- An introduction to each family should be included. These could follow the style of the FAO species identification guides of fishery purposes (e.g. the living marine resources of the Western Central Pacific: Carpenter and Niem, 1998; Carpenter and Niem, 1999).
- Each species account should include key field identification features. This should be different from any taxonomic description, and should highlight those characters which can be used to accurately identify a species, and separate it from all other species.
- The inclusion in each species account of a note on 'Similar Species' would prove valuable. This will allow the user to cross check their specimen with those species with which it is most likely to be misidentified.

- Each species account should include a distribution map, and a brief note on distribution, habitat and depth range. This is essential information to determine if a species' occurrence overlaps, or potentially overlaps with known fishing operations. Worthwhile would be an estimation (as accurate as possible using geographic information system [GIS]) of a species' extent of occurrence and/or area of occupancy. This information is vital in conservation planning.
- Each species account should include information on maximum size, size at maturity and size at birth, if known. A comment should be made if this, the most basic of information, is unknown for a species. This assists in highlighting knowledge gaps.
- Each species should include available biological information. However, there is no need to go into great detail, although summaries can be provided (fecundity, reproductive cycle, age and growth are particularly important). Information on diet and feeding ecology is not so vital for an identification guide. The above mentioned biological information is lacking for the vast majority of species (it has largely been summarised for all species in Kyne and Simpfendorfer (2007) and Kyne and Simpfendorfer (2010).
- Each species account of targeted species (Appendix 3) should include information on fisheries they are captured in and any trend data, where available. For bycatch species, information on at least the type of fishery (trawl, longline etc.) should be provided. More general fishery information can be provided in the introduction to families.
- Each species account should include its conservation status according to the IUCN Red List of Threatened Species. The vast majority of chondrichthyans have now been assessed against the IUCN Red List Categories and Criteria and so this data is readily available (IUCN, 2009). It serves to highlight not only those threatened species, but also the large proportion of Data Deficient species, drawing attention to the poorly-known status of taxa, knowledge gaps, and information required to accurately assess conservation status.
- Each species account, or at least the family introduction should include information on taxonomic uncertainty. This can encourage the provision of material required for taxonomic resolution. This section should also include the results of molecular taxonomy studies that are helping to resolve the placement and relationships between many taxa.
- The guide should contain preliminary sections discussing issues relating to chondrichthyans and the deep-sea, management considerations, vulnerabilities, general fishery trends, habitat considerations, etc. (for example, the limited area of available habitat for species occurring only on the continental slope).
- The guide could be undertaken in two editions, a global guide which encompasses all regions and is comprehensive, and regional guides specific to ocean regions. These regional guides are more practical for users working in the field.

6. Potential difficulties/technical considerations

There has been a recent resurgence in chondrichthyan taxonomy and more than a third of known species have been described in the last 30 years (Last, 2007), while in the last five years there has been considerable effort placed into describing new fauna and resolving taxonomic issues. However, there is still considerable taxonomic work required for the three major faunal groups. The total number of known species is ever increasing as exploratory and taxonomic work ensues and there is considerable material still awaiting description (at the time of writing, at least 37 sharks, 23 batoids and 5 chimaeras are known to represent new species). These numbers of species illustrate two important points. Firstly, the overall lack of knowledge of the deep-sea fauna at even the most basic (i.e. taxonomic) level. Secondly, that the deep-sea chondrichthyan fauna is far from fully documented. For example, a recent joint Australian/Indonesian project monitoring the landings of chondrichthyans at various fish markets in Indonesia has revealed several previously unknown deep-sea taxa amongst a larger number of new species (White *et al.*, 2006). The majority of fishing in Indonesia is still focused on coastal and pelagic resources, with relatively little deep-sea fishing activity. With continuing exploitation of traditional resources, fishing activities will likely move to deeper water around Indonesia, and the discovery of new fauna will likely continue. The checklist of known species will

also continue to grow as material is gathered and examined from exploratory research cruises to previously poorly surveyed ocean regions. The 2003 NORFANZ voyage[1], surveying the seamounts and abyssal plains around the Lord Howe and Norfolk Ridges in the Western Pacific is one such example (Last, 2007). Priede *et al.* (2006) note, however, that the discovery of new species of chondrichthyans at considerable depth (more than 3 000 m) is unlikely given present bathymetrical distributions and the apparent inability of chondrichthyans to exploit the deepest habitat zones.

The systematics and inter-relationships of several groups of deep-sea chondrichthyans remains unresolved and as these groups are reviewed by taxonomists, the total number of species will ultimately change. One of the more taxonomically complex groups is the gulper sharks of the genus *Centrophorus*. A review of some of the Indo-West Pacific gulper shark fauna highlighted that many species traditionally considered to be wide-ranging with global distributions are likely species-complexes of regional endemics (White *et al*., 2008; W.T. White, personal communications). Forms in the Atlantic likely represent distinct species to those in the Indo-West Pacific, for example, the lowfin gulper shark *Centrophorus lusitanicus* Bocage and Capello, 1864. At even a more localised scale, the Indo-West Pacific longnose gulper shark *C. harrissoni* McCulloch, 1915 was found to be distinct between the east and west coast of Australia, representing separate species (White *et al*., 2008). Resolution of such issues will have a profound effect on conservation and management of gulper sharks, amongst the most exploited and vulnerable of the deep-sea sharks.

Another deep-sea group that has undergone recent taxonomic revision are the catsharks of the genus *Apristurus*. This large group has a complex and confused taxonomic history in part due to poor descriptions, lack of comparative material, poorly-defined morphometric characters and the large number of synonyms and undescribed species (Nakaya *et al*., 2005; Sato, 2005). Resolution of the genus relied on an international collaboration of experts. These studies incorporated new fauna, some which proved to be limited range endemics (see papers in Last *et al*., 2008).

Finally, the softnose and hardnose skates of the families Arhynchobatidae and Rajidae are considered to be a morphologically conservative, yet highly diverse group (McEachran and Dunn, 1998). Indeed, they are two of the largest families of chondrichthyans, yet the phylogeny and inter-relationships of the skates remain unresolved.

The resolution of taxonomic issues, and the description of known new species is a priority, and a push to complete this work is required. Keeping abreast of the description of new species and taxonomic changes is paramount to ensuring that a deep-sea species identification guide be comprehensive and up to date.

For the sharks, the Sharks of the World catalogues (FAO Species Catalogue for Fisheries Purposes), in particular Volume 1 (Hexanchiformes, Squaliformes, Squatiniformes and Pristiophoriformes) presently in preparation by David A. Ebert will serve as a valuable compilation of information on all deep-sea sharks. A new deep-sea identification guide should align closely to these catalogues. For the batoids and the holocephalans, such global catalogues do not exist and thus there is no baseline to measure against. The preparation of information on deep-sea batoids and holocephalans will likely prove more time consuming than the sharks.

The status of the FAO Batoid Catalogue needs to be considered. This guide is a priority and it may be difficult to convince some batoid taxonomists to work on a new guide for the deep-sea fauna, while the batoid catalogue remains unfinished.

Expertise is limited in some deep-sea groups, with a relatively small pool of taxonomist experts, many of which have been involved, or are being involved in the development of other guides and catalogues. This may limit their ability to be able to commit to a new guide, if other commitments are ongoing.

[1] www.environment.gov.au/coasts/discovery/voyages/norfanz/index.html

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APPENDIX 1

Annotated global checklist of extant deep-sea chondrichthyans

Class Chondrichthyes.

Subclass Holocephali.

Order Chimaeriformes. Modern Chimaeras.

Family Rhinochimaeridae. Longnose Chimaeras.

***Harriotta haeckeli* (Karrer, 1972).** Smallspine spookfish.
Patchy in the Southern Ocean and Atlantic. Abyssal plains and deep-sea troughs. 1 114-2 603 m.

***Harriotta raleighana* (Goode and Bean, 1895).** Narrownose or longnose chimaera, bentnose rabbitfish or bigspine spookfish.
Wide-ranging but patchy in the Indian, Pacific and Atlantic. Upper to deep slope, abyssal plains and seamounts. 380-2 600 m.

***Neoharriotta carri* (Bullis and Carpenter, 1966).** Dwarf sicklefin chimaera.
Western Central Pacific: southern Caribbean. Upper slope. 240-600 m.

***Neoharriotta pinnata* (Schnakenbeck, 1931).** Sicklefin chimaera.
Eastern Central and Southeast Atlantic: West Africa. Outermost shelf and upper slope. 200-470 m.

***Neoharriotta pumila* (Didier and Stehmann, 1996).** Arabian sicklefin chimaera.
Western Indian: Arabian Sea and Gulf of Aden. Outer shelf and upper to mid slope. 100-1 120 m.

***Rhinochimaera africana* (Compagno, Stehmann and Ebert, 1990).** Paddlenose chimaera or spookfish.
Patchy in the Indo-West Pacific and Southeast Atlantic. Upper to mid slope and seamounts. 550-1 450 m.

***Rhinochimaera atlantica* (Holt and Byrne, 1909).** Spearnose chimaera or straightnose rabbitfish.
Wide-ranging in the Atlantic. Upper to mid slope. 500-1 500 m.

***Rhinochimaera pacifica* (Mitsukuri, 1895).** Pacific spookfish or knifenose chimaera.
Patchy in the Indo-West Pacific and the Southeast Pacific. Outermost shelf, upper to mid slope, deep-sea troughs, deep-sea plateaus and seamounts. 191-1 290 m (mostly >700 m).

Family Chimaeridae. Shortnose Chimaeras.

***Chimaera argiloba* (Last, White and Pogonoski, 2008).** Whitefin chimaera.
Eastern Indian: western Australia. Upper slope. 370-520 m.

***Chimaera cubana* (Howell-Rivero, 1936).** Cuban chimaera.
Western Central Atlantic: Caribbean. Upper slope. 234-450 m.

***Chimaera fulva* (Didier, Last and White, 2008).** Southern chimaera.
Eastern Indian and Southwest Pacific: southern Australia. Mid slope. 780-1 095 m.

***Chimaera jordani* (Tanaka, 1905).** Jordan's chimaera.
Confirmed from the Northwest Pacific (Japan) and Western Indian, but probably more wide-ranging. Upper to deep slope. 383-1 600 m.

***Chimaera lignaria* (Didier, 2002).** Giant, purple or carpenter's chimaera.
Primarily Southwest Pacific: southern Australia and New Zealand. Upper to deep slope, deep-sea plateaus and seamounts. 400-1 800 m (mostly >800 m).

***Chimaera macrospina* (Didier, Last and White, 2008).** Longspine chimaera.
Eastern Indian and Western Pacific: Australia. Upper to mid slope. 435–1 300 m (mostly >800 m).

***Chimaera monstrosa* (Linnaeus, 1758).** Rabbitfish.

Wide-ranging in the Northeast Atlantic including the Mediterranean. Shelf and upper to mid slope. 50-1 000 m (mostly 300-500 m).

***Chimaera obscura* (Didier, Last and White, 2008).** Shortspine chimaera.

Western Central and Southwest Pacific: eastern Australia. Upper to mid slope. 450-1 000 m.

***Chimaera owstoni* (Tanaka, 1905).** Owston's chimaera.

Northwest Pacific: Japan. Upper to mid slope. 500-1 200 m.

***Chimaera panthera* (Didier, 1998).** Leopard or roundfin chimaera.

Southwest Pacific: New Zealand. Upper to mid slope, deep-sea rises, submarine ridges and seamounts. 327-1 020 m.

***Chimaera phantasma* (Jordan and Snyder, 1900).** Silver chimaera

Northwest Pacific: Japan and Taiwan. Shelf and upper to mid slope. 20-962 m. Includes the junior synonym *Chimaera pseudomonstrosa* Fang and Wang, 1932.

***Hydrolagus affinis* (Capello, 1867).** Atlantic chimaera or smalleyed rabbitfish.

Wide-ranging in the North Atlantic. Upper to deep slope, abyssal plains and seamounts. 300-2 909 m (mostly >1 000 m).

***Hydrolagus africanus* (Gilchrist, 1922).** African chimaera.

Western Indian and probably Southeast Atlantic: southern Africa. Upper to mid slope. 300-1 300 m (mostly 421–750 m).

***Hydrolagus alberti* (Bigelow and Schroeder, 1951).** Gulf chimaera.

Western Central Atlantic: Caribbean and the Gulf of Mexico. Upper to mid slope. 348-1 100 m.

***Hydrolagus alphus* (Quaranta, Didier, Long and Ebert, 2006).** Whitespot ghostshark.

Southeast Pacific: Galapagos Islands. Upper to mid slope. 600-900 m.

***Hydrolagus barbouri* (Garman, 1908).** Ninespot chimaera.

Northwest Pacific: Japan. Upper to mid slope. 250-1 100 m (most common 600-800 m).

***Hydrolagus bemisi* (Didier, 2002).** Pale ghostshark.

Southwest Pacific: New Zealand. Upper to mid slope, deep-sea plateaus and rises. 400-1 100 m (mostly 500-700 m).

***Hydrolagus colliei* (Lay and Bennett, 1839).** Spotted ratfish.

Northeast and Eastern Central Pacific: Alaska to Mexico. Shelf and upper to mid slope. 0-971 m.

***Hydrolagus homonycteris* (Didier, 2008).** Black ghostshark.

Primarily Southwest Pacific: southern Australia and New Zealand. Mid slope and seamounts. 866-1 447 m.

***Hydrolagus lemures* (Whitley, 1939).** Blackfin ghostshark.

Eastern Indian and Western Central and Southwest Pacific: Australia. Outer shelf and upper slope. 146-700 m.

***Hydrolagus lusitanicus* (Moura, Figueiredo, Machado, Almeida and Gordo, 2005).**

Northeast Atlantic: Portugal. Deep slope. 1 600 m.

***Hydrolagus macrophthalmus* (de Buen, 1959).** Bigeye chimaera.

Southeast Pacific: Chile. Habitat data not available.

***Hydrolagus marmoratus* (Didier, 2008).** Marbled ghostshark.

Western Central and Southwest Pacific: eastern Australia. Upper to mid slope. 548–995 m.

***Hydrolagus matallanasi* (Soto and Vooren, 2004).** Striped Rabbitfish.

Southwest Atlantic: southern Brazil. Upper slope. 416-736 m.

***Hydrolagus mccoskeri* (Barnett, Didier, Long and Ebert, 2006).** Galapagos ghostshark.

Southeast Pacific: Galapagos Islands. Upper slope. 396-506 m.

***Hydrolagus melanophasma* (James, Ebert, Long and Didier, 2009).** Eastern Pacific black ghostshark

Eastern Central Pacific: California (United States) to Gulf of California (Mexico). Shelf and upper to deep slope. 31-1 667 m.

***Hydrolagus mirabilis* (Collett, 1904).** Large-eyed rabbitfish or spectral chimaera.

Wide-ranging in the Eastern Atlantic and also in the Western Central Atlantic. Upper to deep slope. 450–1 933 m (mostly >800 m).

***Hydrolagus mitsukurii* (Dean, 1904).** Mitsukurii's chimaera.
Northwest and Western Central Pacific: Japan to the Philippines. Upper to mid slope. 325-770 m. Includes the junior synonym *Hydrolagus deani* (Smith and Radcliffe, 1912).

***Hydrolagus novaezealandiae* (Fowler, 1910).** Dark or New Zealand ghostshark.
Southwest Pacific: New Zealand. Shelf and upper to mid slope. 25-950 m (most common 150-500 m).

***Hydrolagus ogilbyi* (Waite, 1898).** Ogilby's ghostshark.
Eastern Indian and Southwest Pacific: southeastern Australia. Outer shelf and upper slope. 120-350 m.

***Hydrolagus pallidus* (Hardy and Stehmann, 1990).** Pale chimaera.
Scattered records in the Northeast Atlantic. Mid to deep slope and deep-sea troughs. 1 200-2 650 m.

***Hydrolagus purpurescens* (Gilbert, 1905).** Purple chimaera.
Northwest Pacific (Japan) and Eastern Central Pacific (Hawaii). Mid to deep slope, deep-sea troughs and seamounts. 920-1 130 m (Japan), 1 750-1 951 m (Hawaii). Includes the probable junior synonym *Hydrolagus eidolon* (Jordan and Hubbs, 1925).

***Hydrolagus trolli* (Didier and Séret, 2002).** Pointy-nosed blue chimaera.
Patchy in the Southwest and Western Central Pacific. Upper to mid slope and seamounts. 610-2 000 m (mostly >1 000 m).

Subclass Elasmobranchii.

Superorder Squalomorphii. Squalomorph Sharks.

Order Hexanchiformes. Cow and Frilled Sharks.

Family Chlamydoselachidae. Frilled Sharks.

***Chlamydoselachus africana* (Ebert and Compagno, 2009).** Southern African frilled shark.
Southeast Atlantic and Western Indian: southern Africa. Upper to mid slope. 300-1 400 m.

***Chlamydoselachus anguineus* (Garman, 1884).** Frilled shark.
Wide-ranging but patchy in temperate and tropical waters of the Atlantic and Indo-Pacific. Shelf and upper to mid slope. 50-1 500 m.

Family Hexanchidae. Sixgill and Sevengill Sharks.

***Heptranchias perlo* (Bonnaterre, 1788).** Sharpnose sevengill shark or perlon.
Wide-ranging but patchy in temperate and tropical waters of the Atlantic and Indo-Pacific. Shelf (occasional) and upper to mid slope. 27–1 000 m.

***Hexanchus griseus* (Bonnaterre, 1788).** Bluntnose sixgill shark.
Wide-ranging but patchy in temperate and tropical waters of the Atlantic and Indo-Pacific. Shelf, upper to deep slope, submarine ridges and seamounts. Mainly deepwater, young inshore in cold water. 0-2 490 m (500-1 100 m usual).

***Hexanchus nakamurai* (Teng, 1962).** Bigeye sixgill shark.
Wide-ranging but patchy in warm-temperate and tropical waters of the Atlantic and Indo-Pacific. Shelf (occassional) and upper slope. 90-621 m.

Order Squaliformes. Dogfish Sharks.

Family Echinorhinidae. Bramble Sharks.

***Echinorhinus brucus* (Bonnaterre, 1788).** Bramble shark.
Wide-ranging but patchy in the Atlantic and Indo-Pacific. Shelf (occassional) and upper to mid slope. 18-900 m.

***Echinorhinus cookei* (Pietschmann, 1928).** Prickly shark.
Patchy in the Eastern, Central and Western Pacific. Shelf and upper to mid slope and seamounts. 11-1 100 m.

Family Squalidae. Dogfish Sharks.

***Cirrhigaleus asper* (Merrett, 1973).** Roughskin spurdog.
Wide-ranging but patchy in warm-temperate and tropical waters of the Atlantic and Indo-Pacific. Shelf and upper slope. 73-600 m.

***Cirrhigaleus australis* (White, Last and Stevens, 2007).** Southern mandarin dogfish.
Eastern Indian and Southwest Pacific: southern Australia and New Zealand. Upper slope. 360-640 m.

***Cirrhigaleus barbifer* (Tanaka, 1912).** Mandarin dogfish.
Patchy in the Western Pacific. Outer shelf and upper slope. 146-640 m. May represent a species complex.

***Squalus albifrons* (Last, White and Stevens, 2007).** Eastern highfin spurdog.
Western Central and Southwest Pacific: eastern Australia. Outer shelf and upper slope. 131-450 m.

***Squalus altipinnis* (Last, White and Stevens, 2007).** Western highfin spurdog.
Eastern Indian: western Australia. Upper slope. ~300 m.

***Squalus blainville* (Risso, 1826).** Longnose spurdog.
Nominally from the Eastern Atlantic and the Mediterranean, but not well defined due to confusion with other species and taxonomic issues. Shelf and upper slope. 16–>440 m. Considerable taxonomic issues (records from elsewhere in the Atlantic and the Indo-Pacific based in part on *S. mitsukurii* or close relatives).

***Squalus brevirostris* (Tanaka, 1917).** Japanese shortnose spurdog.
Northwest Pacific: Japan and Taiwan. Habitat information not available. Tentatively placed on checklist as distinct from *S. megalops*.

***Squalus bucephalus* (Last, Séret and Pogonoski, 2007).** Bighead spurdog.
Western Pacific: Norfolk Ridge and New Caledonia. Upper to mid slope and submarine ridges. 448-880 m.

***Squalus chloroculus* (Last, White and Motomura, 2007).** Greeneye spurdog.
Southwest Pacific and Eastern Indian: southern Australia. Upper to mid slope. 216-1 360 m.

***Squalus crassispinus* (Last, Edmunds and Yearsley, 2007).** Fatspine spurdog.
Eastern Indian: northwestern Australia. Outermost shelf and upper slope. 187-262 m.

***Squalus cubensis* (Howell-Rivero, 1936).** Cuban dogfish.
Warm-temperate waters of the Western Atlantic. Shelf and upper slope. 60-380 m.

***Squalus edmundsi* (White, Last and Stevens, 2007).** Edmund's spurdog.
Eastern Indian: western Australia and Indonesia. Upper to mid slope. 204-850 m (mostly 300-500 m).

***Squalus grahami* (White, Last and Stevens, 2007).** Eastern longnose spurdog.
Western Central and Southwest Pacific: eastern Australia. Outer shelf and upper slope. 148-504 m (mainly 220-450 m).

***Squalus griffini* (Phillipps, 1931).** Northern spiny dogfish.
Southwest Pacific: New Zealand. Shelf and upper slope. 37-616 m.

***Squalus hemipinnis* (White, Last and Yearsley, 2007).** Indonesian shortsnout spurdog
Eastern Indian: Indonesia. Upper slope.

***Squalus japonicus* (Ishikawa, 1908).** Japanese spurdog.
Northwest and Western Central Pacific: East Asia. Outer shelf and upper slope. 120-340 m.

***Squalus lalannei* (Baranes, 2003)**. Seychelles spurdog.
Western Indian: Seychelles. Mid slope. 1 000 m.

***Squalus megalops* (Macleay, 1881).** Shortnose spurdog.
Widespread in temperate and warm-temperate waters of the Indo-West Pacific and Eastern Atlantic. Shelf and upper slope. 0-732 m. May represent a species complex.

***Squalus melanurus* (Fourmanoir, 1979).** Blacktail spurdog.
Western Central Pacific: New Caledonia. Shelf and upper slope. 34-480 m.

***Squalus mitsukurii* (Jordan and Snyder, in Jordan and Fowler, 1903).** Shortspine spurdog.
Wide-ranging, but patchy in temperate and tropical waters of the Atlantic and Indo-Pacific, but not well defined due to taxonomic issues. Shelf and upper to mid slope, submarine ridges and seamounts. 4-954 m (100-500 m usual). Resolution of considerable taxonomic issues is ongoing. Tentatively includes the junior synonym *Squalus probatovi* Myagkov and Kondyurin, 1986.

***Squalus montalbani* (Whitley, 1931).** Philippine spurdog.
Patchy in the Eastern Indian and Western Pacific. Upper slope. 295-670 m.

***Squalus nasutus* (Last, Marshall and White, 2007).** Western longnose spurdog.
Patchy in the Eastern Indian and Western Pacific. Upper to mid slope. 300-850 m (mainly 300-400 m).

***Squalus notocaudatus* (Last, White and Stevens, 2007).** Bartail spurdog.
Western Central Pacific: northeastern Australia. Upper slope. 225-454 m.

***Squalus rancureli* (Fourmanoir, 1978).** Cyrano spurdog.
Western Central Pacific: Vanuatu. Upper slope. 320-400 m.

***Squalus raoulensis* (Duffy and Last, 2007).** Kermadec spiny dogfish.
Southwest Pacific: Kermadec Ridge. Submarine ridges. 320 m.

Family Centrophoridae. Gulper Sharks.

***Centrophorus acus* (Garman, 1906).** Needle dogfish.
Patchy in the Eastern Indian and Western Pacific. Outer shelf and upper to mid slope. 150-950 m (mostly >200 m, possibly to 1 786 m).

***Centrophorus atromarginatus* (Garman, 1913).** Dwarf gulper shark.
Patchy in the Indo-West Pacific, but not well defined. Outer shelf and upper slope. 150-450 m.

***Centrophorus granulosus* (Bloch and Schneider, 1801).** Gulper shark.
Wide-ranging but patchy in the Atlantic and Indo-Pacific, but some records may represent additional species. Shelf and upper to mid slope. 50-1 440 m (mostly 200-600 m). Resolution of taxonomic issues ongoing and as such occurrence and distribution not well defined.

***Centrophorus harrissoni* (McCulloch, 1915).** Longnose gulper shark.
Patchy in the Western Central and Southwest Pacific. Upper to mid slope and submarine ridges. 220-1 050 m.

***Centrophorus isodon* (Chu, Meng and Liu, 1981).** Blackfin gulper shark.
Patchy in the Indo-West Pacific. Mid slope. 760-770 m.

***Centrophorus lusitanicus* (Bocage and Capello, 1864).** Lowfin gulper shark.
Patchy in the Eastern Atlantic and Indo-West Pacific. Upper to mid slope. 300-1 400 m (mostly 300-600 m). Indo-West Pacific form may represent a separate species (*Centrophorus* cf. *lusitanicus* in White *et al.* 2006).

***Centrophorus moluccensis* (Bleeker, 1860).** Smallfin gulper shark.
Patchy in the Indo-West Pacific. Outer shelf and upper to mid slope. 125-820 m. Resolution of taxonomic issues ongoing. May represent a species complex.

***Centrophorus niaukang* (Teng, 1959.)** Taiwan gulper shark.
Patchy in the Eastern Indian and Western Pacific. Outer shelf and upper to mid slope. 98-~1 000 m.

***Centrophorus seychellorum* (Baranes, 2003).** Seychelles gulper shark.
Western Indian: Seychelles. Mid slope. 1 000 m.

***Centrophorus squamosus* (Bonnaterre, 1788).** Leafscale gulper shark.
Wide-ranging, but patchy in the Eastern Atlantic and Indo-West Pacific. Upper to deep slope and abyssal plains. 230-3 280 m.

***Centrophorus tessellatus* (Garman, 1906).** Mosaic gulper shark.
Scattered locations in the Western Atlantic and Pacific, but some records provisional. Upper slope. 260-730 m. Taxonomic issues mean that occurrence and distribution are not well defined and as such many records are provisional.

***Centrophorus westraliensis* (White, Ebert and Compagno, 2008).** Western gulper shark.
Eastern Indian: western Australia. Upper to mid slope. 616-750 m.

***Centrophorus zeehaani* (White, Ebert and Compagno, 2008).** Southern dogfish.
Eastern Indian and Southwest Pacific: southern Australia. Upper slope. 208-701 m (usually >400 m).

***Deania calcea* (Lowe, 1839).** Birdbeak or shovelnose dogfish.
Wide-ranging in the Eastern Atlantic and Indo-West Pacific. Shelf and upper to mid slope. 70–1 470 m (usually 400–900 m). Indonesian form may represent a distinct species (*Deania* cf. *calcea* in White *et al*. 2006).

***Deania hystricosum* (Garman, 1906).** Rough longnose dogfish.
Scattered locations in the Eastern Atlantic and Western Pacific. Upper to mid slope. 470-1 300 m.

***Deania profundorum* (Smith and Radcliffe, 1912).** Arrowhead dogfish.
Scattered locations in the Atlantic and Indo-West Pacific. Upper to deep slope. 275–1 785 m.

***Deania quadrispinosum* (McCulloch, 1915).** Longsnout dogfish.
Southern regions of the Eastern Atlantic and Indo-West Pacific. Outer shelf and upper to mid slope. 150-1 360 m (usually <400 m).

Family Etmopteridae. Lanternsharks.

***Aculeola nigra* (de Buen, 1959).** Hooktooth dogfish.
Southeast Pacific: Peru to Chile. Outer shelf and upper slope. 110–735 m.

***Centroscyllium excelsum* (Shirai and Nakaya, 1990).** Highfin dogfish.
Northwest Pacific: Emperor Seamount Chain. Seamounts. 800–1 000 m.

***Centroscyllium fabricii* (Reinhardt, 1825).** Black dogfish.
Wide-ranging in temperate waters of the Atlantic. Outer shelf and upper to deep slope. 180-1 600 m (usually >275 m, probably to 2 250 m).

***Centroscyllium granulatum* (Günther, 1887).** Granular dogfish.
Southeast Pacific: Chile. Upper slope. 300–500 m.

***Centroscyllium kamoharai* (Abe, 1966).** Bareskin dogfish.
Indo-West Pacific: Japan, Australia and possibly the Philippines. Upper to mid slope. 500-1 200 m (mostly >900 m).

***Centroscyllium nigrum* (Garman, 1899).** Combtooth dogfish.
Patchy in the Central and Eastern Pacific. Upper to mid slope. 400–1 143 m.

***Centroscyllium ornatum* (Alcock, 1889).** Ornate dogfish.
Northern Indian: Arabian Sea and the Bay of Bengal. Upper to mid slope. 521–1 262 m.

***Centroscyllium ritteri* (Jordan and Fowler, 1903).** Whitefin dogfish.
Northwest Pacific: Japan. Upper to mid slope and seamounts. 320–1 100 m.

***Etmopterus baxteri* (Garrick, 1957).** New Zealand lanternshark.
Southern regions of the Eastern Atlantic and Indo-West Pacific. Upper to mid slope. 250-1 500 m. Occurrence and distribution not well defined in the Southeast Atlantic and Western Indian.

***Etmopterus bigelowi* (Shirai and Tachikawa, 1993).** Blurred smooth lanternshark.
Wide-ranging but patchy in the Atlantic and Indo-Pacific. Outer shelf, upper to mid slope, submarine ridges and seamounts. 163–1 000 m.

***Etmopterus brachyurus* (Smith and Radcliffe, 1912).** Shorttail lanternshark.
Scattered in the Indo-West Pacific: Japan, the Philippines and Australia. Upper slope. 400-610 m. References to the species off southern Africa refer to the as yet undescribed sculpted lanternshark.

***Etmopterus bullisi* (Bigelow and Schroeder, 1957).** Lined lanternshark.
Western Central Atlantic: Caribbean. Upper to mid slope. 275–824 m (mostly >350 m).

***Etmopterus burgessi* (Schaaf-da Silva and Ebert, 2006).** Broad-snout lanternshark.
Northwest Pacific: Taiwan. Slope. >300 m.

***Etmopterus carteri* (Springer and Burgess, 1985).** Cylindrical lanternshark.
Western Central Atlantic: Caribbean coast of Colombia. Upper slope. 283–356 m.

***Etmopterus caudistigmus* (Last, Burgess and Séret, 2002).** New Caledonia tailspot lanternshark
Western Central Pacific: New Caledonia. Upper to mid slope. 638–793 m.

***Etmopterus decacuspidatus* (Chan, 1966).** Combtooth lanternshark.
Northwest Pacific: South China Sea. Upper slope. 512–692 m.

***Etmopterus dianthus* (Last, Burgess and Séret, 2002).** Pink lanternshark.
Western Central Pacific: Australia and New Caledonia. Upper to mid slope. 700–880 m.

***Etmopterus dislineatus* (Last, Burgess and Séret, 2002).** Lined lanternshark.
Western Central Pacific: Australia. Upper slope. 590–700 m.

***Etmopterus evansi* (Last, Burgess and Séret, 2002).** Blackmouth lanternshark.
Eastern Indian: Australia and Arafura Sea. Shoals and reefs on the upper slope. 430–550 m.

***Etmopterus fusus* (Last, Burgess and Séret, 2002).** Pygmy lanternshark.
Eastern Indian: Australia. Upper slope. 430–550 m.

***Etmopterus gracilispinis* (Krefft, 1968).** Broadband lanternshark.
Wide-ranging but patchy in the Western Atlantic and off southern Africa. Outer shelf and upper to mid slope. 70–1 000 m.

***Etmopterus granulosus* (Günther, 1880).** Southern lanternshark.
Southwest Atlantic and Southeast Pacific: southern South America. Upper slope. 220–637 m.

***Etmopterus hillianus* (Poey, 1861).** Caribbean lanternshark.
Northwest and Western Central Atlantic including the Caribbean. Upper slope. 311–695 m.

***Etmopterus litvinovi* (Parin and Kotlyar, in Kotlyar, 1990).** Smalleye lanternshark.
Southeast Pacific: Nazca and Sala y Gomez Submarine Ridges. Submarine ridges. 630-1 100 m.

***Etmopterus lucifer* (Jordan and Snyder, 1902)**. Blackbelly lanternshark.
Patchy in the Western Pacific, but provisional records from elsewhere require confirmation. Outer shelf, upper to mid slope. 158–1 357 m.

***Etmopterus molleri* (Whitley, 1939).** Slendertail lanternshark.
Patchy in the Western Pacific and possibly also the Western Indian (Mozambique). Upper slope. 238-655 m. Includes the probable junior synonym *Etmopterus schmidti* Dolganov, 1986.

***Etmopterus perryi* (Springer and Burgess, 1985).** Dwarf lanternshark.
Western Central Atlantic: Caribbean off Colombia. Upper slope. 283–375 m.

***Etmopterus polli* (Bigelow, Schroeder and Springer, 1953).** African lanternshark.
Eastern Atlantic: West Africa. Possibly Caribbean off Venezuela. Upper to mid slope. 300-1 000 m.

***Etmopterus princeps* (Collett, 1904).** Great lanternshark.
Wide-ranging in the North and Central Atlantic. Upper to deep slope, deep-sea rises, deep-sea plateaus and abyssal plains. 567–4 500 m.

***Etmopterus pseudosqualiolus* (Last, Burgess and Séret, 2002).** False pygmy laternshark.
Western Central Pacific: Norfolk and Lord Howe Ridges. Submarine ridges. 1 043–1 102 m.

***Etmopterus pusillus* (Lowe, 1839).** Smooth lanternshark.
Wide-ranging in temperate and warm-temperate waters of the Atlantic and Indo-West and Central Pacific. Upper to mid (possibly to deep) slope. 274–1 000 m (possibly to 1 998 m).

***Etmopterus pycnolepis* (Kotlyar, 1990).** Densescale lanternshark.
Southeast Pacific: Nazca and Sala y Gomez Submarine Ridges. Submarine ridges. 330-763 m.

***Etmopterus robinsi* (Schofield and Burgess, 1997).** West Indian laternshark.
Western Central Atlantic: Caribbean. Upper to mid slope. 412–787 m.

***Etmopterus schultzi* (Bigelow, Schroeder and Springer, 1953).** Fringefin lanternshark.
Western Central Atlantic: Gulf of Mexico. Upper to mid slope. 220–915 m (mostly >350 m).

***Etmopterus sentosus* (Bass, D'Aubrey and Kistnasamy, 1976).** Thorny lanternshark.
Western Indian: East Africa. Upper slope. 200–500 m.

***Etmopterus spinax* (Linnaeus, 1758).** Velvet belly.
Widespread in the Eastern Atlantic and Mediterranean. Shelf, upper to deep slope and deep-sea rises. 70–2 490 m (mostly 200–500 m).

***Etmopterus splendidus* (Yano, 1988).** Splendid lanternshark.
Northwest Pacific: Japan and Taiwan. Uppermost slope. 210 m.

***Etmopterus unicolor* (Engelhardt, 1912).** Brown lanternshark.
Patchy in the Eastern Atlantic and Indo-West Pacific. Upper to mid slope and seamounts. 750–1 500 m.

***Etmopterus villosus* (Gilbert, 1905).** Hawaiian lanternshark.
Eastern Central Pacific: Hawaii. Upper to mid slope. 406–911 m.

***Etmopterus virens* (Bigelow, Schroeder and Springer, 1953).** Green lanternshark.
Western Central Atlantic: Gulf of Mexico and Caribbean. Upper to mid slope. 196–915 m (mostly >350 m).

***Miroscyllium sheikoi* (Dolganov, 1986).** Rasptooth dogfish.
Northwest Pacific: off Japan. Upper slope of submarine ridges. 340–370 m.

***Trigonognathus kabeyai* (Mochizuki and Ohe, 1990).** Viper dogfish.
North and Central Pacific: Japan and Hawaii. Upper slope and seamounts. 270–360 m.

Family Somniosidae. Sleeper Sharks.

***Centroscymnus coelolepis* (Bocage and Capello, 1864).** Portuguese dogfish.
Wide-ranging in the Atlantic and Indo-Pacific. Outer shelf, upper to deep slope and abyssal plains. 128–3 675 m (mostly >400 m).

***Centroscymnus owstoni* (Garman, 1906).** Roughskin dogfish.
Wide-ranging, but patchy in the Atlantic, Pacific and Eastern Indian. Upper to mid slope and submarine ridges. 426–1 459 m (mostly >600 m). Includes the junior synonym *Centroscymnus cryptacanthus* Regan, 1906.

***Centroselachus crepidater* (Bocage and Capello, 1864).** Longnose velvet dogfish.
Wide-ranging, but patchy in the Western Atlantic, Pacific and Western Indian. Upper to deep slope. 270–2 080 m (mostly >500 m).

***Proscymnodon macracanthus* (Regan, 1906).** Largespine velvet dogfish.
Southeast Pacific: Straits of Magellan (Chile). Habitat and depth unrecorded.

***Proscymnodon plunketi* (Waite, 1909).** Plunket shark.
Patchy in southern regions of the Indo-West Pacific. Upper to mid slope. 219–1 427 m (most common 550–732 m).

***Scymnodalatias albicauda* (Taniuchi and Garrick, 1986).** Whitetail dogfish.
Patchy in the Southern Ocean. Outer shelf, upper slope and submarine ridges. 150–500 m.

***Scymnodalatias garricki* (Kukuyev and Konovalenko, 1988).** Azores dogfish.
Northeast Atlantic: North Atlantic Ridge. Mesopelagic over seamounts. 300 m.

***Scymnodalatias sherwoodi* (Archey, 1921).** Sherwood's dogfish.
Patchy in the Southern Ocean. Upper slope. 400–500 m.

***Scymnodon ringens* (Bocage and Capello, 1864).** Knifetooth dogfish.
Northeast and Eastern Central Atlantic. Uncertain from New Zealand in the Southwest Pacific. Upper to deep slope. 200–1 600 m.

***Somniosus antarcticus* (Whitley, 1939).** Southern sleeper shark.
Patchy in the Southern Ocean. Outer shelf and upper to mid slope. 145–1 200 m.

***Somniosus longus* (Tanaka, 1912).** Frog shark.
Western Pacific: Japan and New Zealand. Upper to mid slope. 250–1 160 m.

***Somniosus microcephalus* (Bloch and Schneider, 1801).** Greenland shark.
Cool temperate and boreal waters of the North Atlantic. Shelf (inshore in Arctic winter) and upper to mid slope. 0–1 200 m.

***Somniosus pacificus* (Bigelow and Schroeder, 1944).** Pacific sleeper shark.
Wide-ranging in the North Pacific. Shelf and upper to deep slope (shallower in north, deeper in south of range). 0–2 000 m.

***Somniosus rostratus* (Risso, 1810).** Little sleeper shark.
Northeast Atlantic and the Mediterranean. Uncertain from Cuba in the Western Central Atlantic. Outermost shelf and upper to mid slope. 200–2 200 m.

***Zameus ichiharai* (Yano and Tanaka, 1984).** Japanese velvet dogfish.
Northwest Pacific: Japan. Upper to mid slope. 450–830 m.

***Zameus squamulosus* (Günther, 1877).** Velvet dogfish.
Wide-ranging but patchy in the Atlantic, Indian and Pacific. Upper to mid slope. Also epipelagic and mesopelagic. 550–1 450 m (when benthic); 0–580 m in water up to 6 000 m deep (when pelagic).

Family Oxynotidae. Roughsharks.

***Oxynotus bruniensis* (Ogilby, 1893).** Prickly dogfish.
Indo-West Pacific: New Zealand and Australia. Shelf and upper to mid slope. 45–1 067 m (most common 350–650 m).

***Oxynotus caribbaeus* (Cervigon, 1961).** Caribbean roughshark.
Western Central Atlantic: Gulf of Mexico and Caribbean (Venezuela). Upper slope. 402-457 m.

***Oxynotus centrina* (Linnaeus, 1758).** Angular roughshark.
Wide-ranging in the Eastern Atlantic and the Mediterranean. Shelf and upper slope. 50–660 m (mostly >100 m).

***Oxynotus japonicus* (Yano and Murofushi, 1985).** Japanese roughshark.
Northwest Pacific: Japan. Uppermost slope. 225–270 m.

***Oxynotus paradoxus* (Frade, 1929).** Sailfin roughshark.
Northeast and Eastern Central Atlantic: Scotland to West Africa. Upper slope. 265–720 m.

Family Dalatiidae. Kitefin Sharks.

***Dalatias licha* (Bonnaterre, 1788).** Kitefin shark.
Wide-ranging but patchy in the Atlantic, Indo-West and Central Pacific. Shelf and upper to deep slope. 37–1 800 m (mainly >200 m).

***Euprotomicroides zantedeschia* (Hulley and Penrith, 1966)**. Taillight shark.
Patchy in the South Atlantic: off Brazil and southern Africa. Upper slope. Also epipelagic. 458–641 m (when benthic), 0–25 m (when pelagic).

***Euprotomicrus bispinatus* (Quoy and Gaimard, 1824).** Pygmy shark.
Wide-ranging but scattered records in the Atlantic and Indo-Pacific. Epipelagic, mesopelagic and bathypelagic. 0–>1 500 m in water up to 9 938 m deep.

***Heteroscymnoides marleyi* (Fowler, 1934).** Longnose pygmy shark.
Scattered records in the southern Atlantic, Southeast Pacific and Southwest Indian. Epipelagic and mesopelagic. 0–502 m in water 830–>4 000 m deep.

***Isistius brasiliensis* (Quoy and Gaimard, 1824).** Cookiecutter or cigar shark.
Circumglobal in tropical and warm temperate waters. Epipelagic, mesopelagic and bathypelagic. 0-3 500 m.

***Isistius labialis* (Meng, Chu and Li, 1985).** South China cookiecutter shark.
Northwest Pacific: South China Sea. Mesopelagic over slope. 520 m.

***Mollisquama parini* (Dolganov, 1984).** Pocket shark.
Southeast Pacific: Nazca Submarine Ridge. Submarine ridges. 330 m.

***Squaliolus aliae* (Teng, 1959).** Smalleye pygmy shark.
Patchy in the Western Pacific and Eastern Indian. Epipelagic, mesopelagic and bathypelagic near land. 200–2 000 m.

***Squaliolus laticaudus* (Smith and Radcliffe, 1912).** Spined pygmy shark.
Wide-ranging but scattered records in the Atlantic, Western Pacific and Western Indian. Epipelagic and mesopelagic. 200–500 m.

Order Squatiniformes. Angelsharks.

Family Squatinidae. Angelsharks.

***Squatina aculeata* (Dumeril, in Cuvier, 1817).** Sawback angelshark.
Eastern Atlantic off West Africa, and the Western Mediterranean. Shelf and upper slope. 30-500 m.

***Squatina africana* (Regan, 1908).** African angelshark.
Western Indian: East Africa. Shelf and upper slope. 0–494 m (mainly 60–300 m).

***Squatina albipunctata* (Last and White, 2008).** Eastern angelshark.
Western Pacific and (marginally) Eastern Indian: eastern Australia. Shelf and upper slope. 37–415 m.

***Squatina argentina* (Marini, 1930).** Argentine angelshark.
Southwest Atlantic: Brazil to Argentina. Shelf and upper slope. 51–320 m (mostly 120-320 m).

***Squatina formosa* (Shen and Ting, 1972).** Taiwan angelshark.
Western Pacific: Taiwan and the Philippines. Outer shelf and upper slope. 183–385 m.

***Squatina pseudocellata* (Last and White, 2008).** Western angelshark.
Eastern Indian: western Australia. Outer shelf and upper slope. 150–312 m.

***Squatina tergocellata* (McCulloch, 1914).** Ornate angelshark.
Eastern Indian: Australia. Outer shelf and upper slope. 130–400 m (most common ~300 m).

Order Pristiophoriformes. Sawsharks.

Family Pristiophoridae. Sawsharks.

***Pliotrema warreni* (Regan, 1906).** Sixgill sawshark.
Southeast Atlantic and Western Indian: southern Africa. Shelf and upper slope. 37–500 m.

***Pristiophorus delicatus* (Yearsley, Last and White, 2008).** Tropical sawshark.
Western Central Pacific: northeastern Australia. Upper slope. 246–405 m.

***Pristiophorus schroederi* (Springer and Bullis, 1960).** Bahamas sawshark
Western Central Atlantic: between Cuba, Florida (United States) and Bahamas. Upper to mid slope. 438–952 m.

Order Rajiformes. Batoids.

Family Rhinobatidae. Guitarfishes.

***Rhinobatos variegatus* (Nair and Lal Mohan, 1973).** Stripenose guitarfish
Eastern Indian: Gulf of Mannar, India. Upper slope. 366 m.

Family Narcinidae. Numbfishes.

***Benthobatis kreffti* (Rincon, Stehmann and Vooren, 2001).** Brazilian blind torpedo.
Southwest Atlantic: Brazil. Upper slope. 400–600 m.

***Benthobatis marcida* (Bean and Weed, 1909).** Pale or blind torpedo.
Western Central Atlantic: South Carolina (United States) to northern Cuba. Upper to mid slope. 274-923 m.

***Benthobatis moresbyi* (Alcock, 1898).** Dark blindray.
Western Indian: Arabian Sea. Mid slope. 787–1 071 m.

***Benthobatis yangi* (Carvalho, Compagno and Ebert, 2003).** Narrow blindray.
Northwest and Western Central Pacific: Taiwan. Upper slope (possibly also outer shelf). <300 m.

***Narcine lasti* (Carvalho and Séret, 2002).** Western numbfish.
Eastern Indian: western Australia. Outermost shelf and upper slope. 180–320 m.

***Narcine nelsoni* (Carvalho, 2008).** Eastern numbfish.
Western Central Pacific: northeastern Australia. Outer shelf and upper slope. 140–540 m.

***Narcine tasmaniensis* (Richardson, 1840).** Tasmanian numbfish.
Eastern Indian and Southwest Pacific: southeastern Australia. Shelf (south of range) and upper slope (north of range). 5–640 m (in north of range mainly 200–640 m).

Family Narkidae. Sleeper Rays.

***Heteronarce garmani* (Regan, 1921).** Natal sleeper ray.
Western India: Mozambique and South Africa. Shelf and upper slope. 73–329 m.

***Heteronarce mollis* (Lloyd, 1907).** Soft sleeper ray.
Western Indian: Gulf of Aden. Shelf and upper slope. 73–346 m.

***Typhlonarke aysoni* (Hamilton, 1902).** Blind electric ray.
Southwest Pacific: New Zealand. Shelf and upper to mid slope. 46–900 m (most common 300–400 m).

***Typhlonarke tarakea* (Phillipps, 1929).** Oval electric ray.
Southwest Pacific: New Zealand. Shelf and upper to mid slope. 46–900 m (most common 300–400 m).

Family Torpedinidae. Torpedo Rays.

***Torpedo fairchildi* (Hutton, 1872).** New Zealand torpedo ray.
Southwest Pacific: New Zealand. Shelf and upper to mid slope. 5–1 135 m (most common 100–300 m).

***Torpedo fuscomaculata* (Peters, 1855).** Blackspotted torpedo.
Western Indian: Mozambique and South Africa. Reports from Western Indian Ocean islands likely refer to similar undescribed species. Shelf and upper slope. 0–439 m.

***Torpedo macneilli* (Whitley, 1932).** Short-tail torpedo ray.
Eastern Indian and Western Pacific: Australia. Outer shelf and upper slope. 90–825 m.

***Torpedo microdiscus* (Parin and Kotlyar, 1985).** Smalldisk torpedo.
Southeast Pacific: Nazca and Sala y Gomez Submarine Ridges. Submarine ridges.

***Torpedo nobiliana* (Bonaparte, 1835).** Great, Atlantic, or black torpedo.
Wide-ranging in the Eastern and Western Atlantic. Shelf and upper slope. 2–530 m.

***Torpedo puelcha* (Lahille, 1928).** Argentine torpedo.
Southwest Atlantic: Brazil to Argentina. Shelf and upper slope. Inshore–600 m.

***Torpedo tokionis* (Tanaka, 1908).** Longtail torpedo ray.
Patchy in the Eastern Indian and Western Pacific. Upper slope. 410–735 m.

***Torpedo tremens* (de Buen, 1959).** Chilean torpedo.
Patchy in the Eastern Central and Southeast Pacific. Shelf and upper slope. Inshore 0–700 m.

Family Arhynchobatidae. Softnose Skates.

***Arhynchobatis asperrimus* (Waite, 1909).** Longtailed skate.
Southwest Pacific: New Zealand. Outer shelf and upper to mid slope. 90–1 070 m.

***Bathyraja abyssicola* (Gilbert, 1896).** Deepsea skate.
Wide-ranging in the North Pacific. Upper to deep slope and abyssal plains. 362–2 906 m.

***Bathyraja aguja* (Kendall and Radcliffe, 1912).** Aguja skate.
Southeast Pacific: Peru. Mid slope. 980 m.

***Bathyraja albomaculata* (Norman, 1937).** White-dotted skate.
Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper to mid slope. 55-861 m.

***Bathyraja aleutica* (Gilbert, 1895).** Aleutian skate.
Wide-ranging in the North Pacific. Outer shelf and upper slope. 91–700 m.

***Bathyraja andriashevi* (Dolganov, 1985).** Little-eyed skate.
Northwest Pacific: Japan and Russia. Mid to deep slope. 1 400–2 000 m.

***Bathyraja bergi* (Dolganov, 1985).** Bottom skate.

Northwest Pacific: Japan and Russia. Outer shelf and upper to mid slope. 70–900 m. Includes the junior synonym *Bathyraja pseudoisotrachys* Ishihara and Ishiyama, 1985.

***Bathyraja brachyurops* (Fowler, 1910).** Broadnose skate.

Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper slope. 28–604 m.

***Bathyraja caeluronigricans* (Ishiyama and Ishihara, 1977).** Purpleblack skate.

Northwest Pacific: Japan and Russia. Upper slope. 200–400 m. Possible synonym of *Bathyraja matsubarai* (Ishiyama, 1952).

***Bathyraja cousseauae* (Diaz de Astarloa and Mabragaña, 2004).** Cousseau's skate.

Southwest Atlantic: Argentina and the Falkland/Malvinas Islands. Outer shelf and upper to mid slope. 119–1 011 m.

***Bathyraja diplotaenia* (Ishiyama, 1950).** Duskypink skate.

Northwest Pacific: Japan. Outer shelf and upper slope. 100–700 m.

***Bathyraja eatonii* (Günther, 1876).** Eaton's skate.

Circum-Antarctic. Shelf, upper to mid slope, deep-sea plateaus and submarine ridges. 15-800 m.

***Bathyraja fedorovi* (Dolganov, 1985).** Cinnamon skate.

Northwest Pacific: Japan and Russia. Upper to deep slope and abyssal plains. 447–2 025 m.

***Bathyraja griseocauda* (Norman, 1937).** Graytail skate.

Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper to mid slope. 82-941 m.

***Bathyraja hesperafricana* (Stehmann, 1995).** West African skate.

Eastern Central Atlantic: West Africa. Mid to deep slope. 750–2 000 m.

***Bathyraja interrupta* (Gill and Townsend, 1897).** Bering skate.

Wide-ranging in the North and Eastern Central Pacific, although not well defined due to possible misidentifications. Shelf and upper to mid slope. 23–1 500 m.

***Bathyraja irrasa* (Hureau and Ozouf-Costaz, 1980).** Kerguelen sandpaper skate.

Antarctic Indian: Kerguelen Islands. Upper to mid slope. 300–1 200 m.

***Bathyraja isotrachys* (Günther, 1877).** Raspback skate.

Northwest Pacific: Russia, Japan and Korea. Upper to deep slope. 370–2 000 m.

***Bathyraja kincaidii* (Garman, 1908).** Sandpaper skate.

Eastern Central and Northeast Pacific: Baja California north to Gulf of Alaska. Shelf and upper to mid slope. 55–1 372 m (most common 200–500 m).

***Bathyraja lindbergi* (Ishiyama and Ishihara, 1977).** Commander skate.

Northwest Pacific: Japan, Russia and the Bering Sea. Outer shelf and upper to mid slope. 120–950 m.

***Bathyraja longicauda* (de Buen, 1959).** Slimtail skate.

Southeast Pacific: Peru and Chile. Upper slope. 580–735 m.

***Bathyraja maccaini* (Springer, 1972).** McCain's skate.

Southeast Pacific and Antarctic Atlantic: Chile and Antarctica (Orkney and South Shetland islands to the Antarctic Peninsula). Shelf and upper slope. Inshore–500 m.

***Bathyraja macloviana* (Norman, 1937).** Patagonian skate.

Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper slope. 53–514 m.

***Bathyraja maculata* (Ishiyama and Ishihara, 1977).** Whiteblotched skate.

Northern Pacific: Aleutian Islands and Bering Sea westwards to Japan. Shelf and upper to mid slope. 73–1 110 m.

***Bathyraja magellanica* (Philippi, 1902 or Steindachner, 1903).** Magellan skate.

Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper slope. 51–600 m (mostly <70 m in Falklands).

***Bathyraja matsubarai* (Ishiyama, 1952)**. Duskypurple skate.

Northwest Pacific: Japan and Russia. Occurrence in the Northeast Pacific requires confirmation. Outer shelf and upper to deep slope. 120–2 000 m.

***Bathyraja meridionalis* (Stehmann, 1987).** Darkbelly skate.
Primarily Sub-Antarctic in the Atlantic, possibly circum-Antarctic. Upper to deep slope, abyssal plains and seamounts. 300–2 240 m.

***Bathyraja minispinosa* (Ishiyama and Ishihara, 1977).** Smallthorn skate.
Northern Pacific: Aleutian Islands and Bering Sea westwards to Japan. Outer shelf and upper to mid slope. 150–1 420 m.

***Bathyraja multispinis* (Norman, 1937).** Multispine skate.
Southwest Atlantic and Southeast Pacific: southern South America. Outer shelf and upper slope. 82-740 m. A record at 1 900 m off Uruguay requires confirmation.

***Bathyraja murrayi* (Günther, 1880).** Murray's skate.
Antarctic Indian: Kerguelen and Heard Islands, but possibly circum-Antarctic. Shelf and upper slope. 30–650 m.

***Bathyraja notoroensis* (Ishiyama and Ishihara, 1977).** Notoro skate.
Northwest Pacific: Japan. Upper slope. ~600 m. Possible synonym of *Bathyraja matsubarai* (Ishiyama, 1952).

***Bathyraja papilionifera* (Stehmann, 1985).** Butterfly skate.
Southwest Atlantic: Argentina and the Falkland/Malvinas Islands. Upper to deep slope and seamounts. 637–2 000 m.

***Bathyraja parmifera* (Bean, 1881).** Alaska or flathead skate.
Wide-ranging in the North Pacific: Gulf of Alaska to Japan. Shelf and upper to mid slope. 20-1 425 m. Includes the synonym *Bathyraja simoterus* (Ishiyama, 1967).

***Bathyraja peruana* (McEachran and Miyake, 1984).** Peruvian skate.
Southeast Pacific: Ecuador to Chile. Upper to mid slope. 600–1 060 m.

***Bathyraja richardsoni* (Garrick, 1961).** Richardson's skate.
Southwest Pacific: Australia and New Zealand (possibly also in the North Atlantic). Mid to deep slope, abyssal plains and seamounts. 1 370–2 909 m.

***Bathyraja scaphiops* (Norman, 1937).** Cuphead skate.
Southwest Atlantic: Argentina and the Falkland/Malvinas Islands. Outer shelf and upper slope. 104-509 m (most common 104–159 m).

***Bathyraja schroederi* (Krefft, 1968).** Whitemouth skate.
Southwest Atlantic and Southeast Pacific: southern South America. Mid to deep slope and abyssal plains. 800–2 380 m.

***Bathyraja shuntovi* (Dolganov, 1985).** Narrownose skate.
Southwest Pacific: New Zealand. Upper to mid slope. 300–1 470 m.

***Bathyraja smirnovi* (Soldatov and Lindberg, 1913).** Golden skate.
Northwest Pacific: Bering Sea to Japan. Outer shelf and upper to mid slope. 100–1 000 m.

***Bathyraja smithii* (Müller and Henle, 1841).** African softnose skate.
Southeast Atlantic: Namibia and South Africa. Upper to mid slope. 400–1 020 m.

***Bathyraja spinicauda* (Jensen, 1914).** Spinetail or spinytail skate.
Wide-ranging in the Northeast and Northwest Atlantic. Outer shelf and upper to mid slope. 140-1 209 m (mainly >400 m).

***Bathyraja spinosissima* (Beebe and Tee-Van, 1941).** White skate.
Eastern Central and Southeast Pacific. Records from the Northwest Pacific may be a separate species. Mid to deep slope and abyssal plains. 800–2 938 m.

***Bathyraja trachouros* (Ishiyama, 1958).** Eremo skate.
Northwest Pacific: Japan. Upper slope. 300–500 m.

***Bathyraja trachura* (Gilbert, 1892).** Roughtail skate.
Wide-ranging in the North Pacific. Upper to deep slope and abyssal plains. 213–2 550 m.

***Bathyraja tzinovskii* (Dolganov, 1985).** Creamback skate.
Northwest Pacific: Japan and Russia. Deep slope and abyssal plains. 1 776–2 500 m.

***Bathyraja violacea* (Suvorov, 1935).** Okhotsk skate.
North Pacific: Bering Sea to Japan. Shelf and upper to mid slope. 23–1 100 m.

***Brochiraja aenigma* (Last and McEachran, 2006).**
Southwest Pacific: New Zealand. Upper slope. 660–665 m.

***Brochiraja albilabiata* (Last and McEachran, 2006).**
Southwest Pacific: New Zealand. Mid slope. 785–1 180 m.

***Brochiraja asperula* (Garrick and Paul, 1974).** Prickly deepsea skate.
Southwest Pacific: New Zealand. Mid slope. 350–1 010 m.

***Brochiraja leviveneta* (Last and McEachran, 2006).**
Southwest Pacific: New Zealand. Mid slope. 960–1 015 m.

***Brochiraja microspinifera* (Last and McEachran, 2006).**
Southwest Pacific: New Zealand. Upper to mid slope. 510–900 m.

***Brochiraja spinifera* (Garrick and Paul, 1974).** Spiny deepsea skate.
Southwest Pacific: New Zealand. Upper slope. 500–750 m.

***Insentiraja laxipella* (Yearsley and Last, 1992).** Eastern looseskin skate.
Western Central Pacific: northeastern Australia. Mid slope. 800–880 m.

***Insentiraja subtilispinosa* (Stehmann, 1985).** Velvet or western looseskin skate.
Patchy in the Eastern Indian and Western Central Pacific. Upper to mid slope. 320–1 460 m.

***Notoraja azurea* (McEachran and Last, 2008).** Blue skate.
Eastern Indian: western and southern Australia. Mid slope. 765–1 440 m.

***Notoraja hirticauda* (Last and McEachran, 2006).** Ghost skate.
Eastern Indian: western Australia. Upper to mid slope. 500–760 m.

***Notoraja lira* (McEachran and Last, 2008).** Broken Ridge skate.
Eastern Indian: Broken Ridge. Submarine ridges. 1 050 m.

***Notoraja ochroderma* (McEachran and Last, 1994).** Pale skate.
Western Central Pacific: northeastern Australia. Upper slope. 400–455 m.

***Notoraja sapphira* (Séret and Last, 2009).** Sapphire skate.
Southwest and Western Central Pacific: Norfolk Ridge. Submarine Ridges. 1 195–1 313 m.

***Notoraja sticta* (McEachran and Last, 2008).** Blotched skate.
Eastern Indian: southern Australia. Mid slope. 820–1 200 m.

***Notoraja tobitukai* (Hiyama, 1940).** Leadhued skate.
Northwest Pacific: Japan and Taiwan. Shelf and upper to mid slope. 60–900 m.

***Pavoraja alleni* (McEachran and Fechhelm, 1982).** Allen's skate.
Eastern Indian: western Australia. Upper slope. 304–458 m.

***Pavoraja arenaria* (Last, Mallick and Yearsley, 2008).** Sandy peacock skate.
Eastern Indian: southern Australia. Outermost shelf and upper slope. 192–712 m (mainly 300–400 m).

***Pavoraja mosaica* (Last, Mallick and Yearsley, 2008).** Mosaic skate.
Western Central Pacific: northeastern Australia. Upper slope. 300–405 m.

***Pavoraja nitida* (Günther, 1880).** Peacock skate.
Eastern Indian and Southwest Pacific: southern Australia. Shelf and upper slope. 75–432 m.

***Pavoraja pseudonitida* (Last, Mallick and Yearsley, 2008).** False peacock skate.
Western Central Pacific: northeastern Australia. Upper slope. 212–512 m.

***Pavoraja umbrosa* (Last, Mallick and Yearsley, 2008).** Dusky skate.
Western Pacific: eastern Australia. Upper slope. 360–731 m.

***Psammobatis scobina* (Philippi, 1857).** Raspthorn sandskate.
Southeast Pacific: Chile. Shelf and upper slope. 40–450 m.

***Pseudoraja fischeri* (Bigelow and Schroeder, 1954).** Fanfin skate.
Scattered records in the Western Central Atlantic. Upper slope. 412–576 m.

***Rhinoraja kujiensis* (Tanaka, 1916).** Dapple-bellied softnose skate.
Northwest Pacific: Japan. Upper to mid slope. 450–~1 000 m.

***Rhinoraja longi* (Raschi and McEachran, 1991).** Aleutian dotted skate.
North Pacific: Aleutian Islands. Upper slope. 390–435 m.

***Rhinoraja longicauda* (Ishiyama, 1952).** White-bellied softnose skate.
Northwest Pacific: Japan and Russia. Upper to mid slope. 300–1 000 m.

***Rhinoraja obtusa* (Gill and Townsend, 1897).** Blunt skate.
North Pacific: Bering Sea. Habitat and depth information not available.

***Rhinoraja odai* (Ishiyama, 1952).** Oda's skate.
Northwest Pacific: Japan. Upper to mid slope. 300–870 m.

***Rhinoraja taranetzi* (Dolganov, 1985).** Mudskate.
Reasonably wide-ranging in the North Pacific. Shelf and upper to mid slope. 81–1 000 m. Includes the junior synonym *Bathyraja hubbsi* Ishihara and Ishiyama, 1985.

Family Rajidae. Hardnose Skates.

***Amblyraja badia* (Garman, 1899).** Broad skate.
Patchy in the North Pacific. Mid to deep slope and abyssal plains. 846–2 324 m.

***Amblyraja doellojuradoi* (Pozzi, 1935).** Southern thorny skate.
Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper slope. 51–642 m.

***Amblyraja frerichsi* (Krefft, 1968).** Thickbody skate.
Southwest Atlantic and Southeast Pacific: southern South America. Mid to deep slope and abyssal plains. 720–2 609 m.

***Amblyraja georgiana* (Norman, 1938).** Antarctic starry skate.
Circum-Antarctic, including off Chile and the Falkland/Malvinas Islands. Shelf and upper to mid slope. 20–800 m.

***Amblyraja hyperborea* (Collett, 1879).** Arctic or boreal skate.
Wide-ranging but patchy in deep temperate waters. Upper to deep slope and abyssal plains. 300-2 500 m. Taxonomic issues unresolved, may represent a species complex.

***Amblyraja jenseni* (Bigelow and Schroeder, 1950).** Jensen's skate.
North Atlantic: Nova Scotia (Canada) to southern New England (United States) and Iceland. Upper to deep slope. 366–2 196 m.

***Amblyraja radiata* (Donovan, 1808).** Thorny skate.
Wide-ranging in the North Atlantic and also off South Africa. Shelf and upper to mid slope. 18-1 400 m (most common 27–439 m).

***Amblyraja reversa* (Lloyd, 1906).** Reversed skate.
Western Indian: Arabian Sea. Deep slope. 1 500 m.

***Amblyraja robertsi* (Hulley, 1970).** Bigmouth skate.
Southeast Atlantic: South Africa. Mid slope. 1 350 m.

***Amblyraja taaf* (Meisner, 1987).** Whiteleg skate.
Antarctic Indian: Crozet Islands. Outer shelf and upper slope. 150–600 m.

***Breviraja claramaculata* (McEachran and Matheson, 1985).** Brightspot skate.
Western Central Atlantic: South Carolina to Florida (United States). Upper to mid slope. 293-896 m.

***Breviraja colesi* (Bigelow and Schroeder, 1948).** Lightnose skate.
Western Central Atlantic: Florida (United States), Bahamas and Cuba. Upper slope. 220-415 m.

***Breviraja marklei* (McEachran and Miyake, 1987).** Nova Scotia skate.
Northwest Atlantic: Canada. Upper to mid slope. 443–988 m.

***Breviraja mouldi* (McEachran and Matheson, 1995).** Blacknose skate.
Western Central Atlantic: Honduras to Panama. Upper to mid slope. 353–776 m.

***Breviraja nigriventralis* (McEachran and Matheson, 1985).** Blackbelly skate.
Western Central Atlantic: Panama and the northern coast of South America. Upper to mid slope. 549-776 m.

***Breviraja spinosa* (Bigelow and Schroeder, 1950).** Spinose skate.
Western Central Atlantic: North Carolina to Florida (United States). Upper slope. 366–671 m.

***Dactylobatus armatus* (Bean and Weed, 1909).** Skilletskate.
Patchy in the Western Central Atlantic. Upper slope. 338–685 m.

***Dactylobatus clarki* (Bigelow and Schroeder, 1958).** Hookskate.
Patchy in the Western Central Atlantic. Upper to mid slope. 366–915 m.

***Dipturus acrobelus* (Last, White and Pogonoski, 2008).** Deepwater skate.
Eastern Indian and Southwest Pacific: southern Australia. Upper to mid slope. 446–1 328 m (mainly 800–1 000 m).

***Dipturus apricus* (Last, White and Pogonoski, 2008).** Pale tropical skate.
Western Central Pacific: northeastern Australia. Outermost shelf and upper slope. 196–606 m (mainly 300–500 m).

***Dipturus batis* (Linnaeus, 1758).** Gray or blue skate.
Formerly wide-ranging in the Northeast and Eastern Central Atlantic, including the Mediterranean, but now extirpated from or reduced in much of its historical range. Outer shelf, upper to deep slope and deep-sea rises. 100–2 619 m.

***Dipturus bullisi* (Bigelow and Schroeder, 1962).** Tortugas skate.
Patchy in the Western Central Atlantic. Upper slope. 183–549 m.

***Dipturus campbelli* (Wallace, 1967).** Blackspot skate.
Western Indian: patchy off South Africa and Mozambique. Outer shelf and upper slope. 137-403 m.

***Dipturus canutus* (Last, 2008).** Grey skate.
Eastern Indian and Southwest Pacific: southeastern Australia. Upper slope. 330–730 m (mainly 400-600 m).

***Dipturus cerva* (Whitley, 1939).** White-spotted skate.
Eastern Indian and Southwest Pacific: southern Australia. Shelf and upper slope. 20–470 m.

***Dipturus crosnieri* (Séret, 1989).** Madagascar skate.
Western Indian: Madagascar. Upper to mid slope. 300–850 m.

***Dipturus doutrei* (Cadenat, 1960).** Violet or javelin skate.
Eastern Central and Southeast Atlantic: West Africa. Outer shelf and upper to mid slope. 163–800 m (mostly >400 m).

***Dipturus endeavouri* (Last, 2008).** Endeavour skate.
Western Central and Southwest Pacific: eastern Australia. Outer shelf and upper slope. 125-500 m.

***Dipturus garricki* (Bigelow and Schroeder, 1958).** San Blas skate.
Western Central Atlantic: northern Gulf of Mexico and Nicaragua. Upper slope. 275–476 m.

***Dipturus gigas* (Ishiyama, 1958).** Giant skate.
Northwest and Western Central Pacific: Japan to the Philippines. Upper to mid slope. 300-1 000 m.

***Dipturus grahami* (Last, 2008).** Graham's skate.
Western Central and Southwest Pacific: eastern Australia. Outer shelf and upper slope. 146-490 m (mainly 250–450 m).

***Dipturus gudgeri* (Whitley, 1940).** Bight skate.
Eastern Indian and Southwest Pacific: southern Australia. Outer shelf and upper slope. 160-765 m (most common 400–550 m).

***Dipturus healdi* (Last, White and Pogonoski, 2008).** Heald's skate.
Eastern Indian: western Australia. Upper slope. 304–520 m.

***Dipturus innominatus* (Garrick and Paul, 1974).** New Zealand smooth skate.
Southwest Pacific: New Zealand. Shelf and upper to mid slope. 15–1 310 m.

***Dipturus johannisdavesi* (Alcock, 1899).** Travancore skate.
Western Indian: Gulf of Aden and India. Upper slope. 457–549 m.

***Dipturus laevis* (Mitchell, 1817).** Barndoor skate.
Northwest Atlantic: Canada and United States. Shelf and upper slope. 0–430 m.

***Dipturus lanceorostratus* (Wallace, 1967).** Rattail skate.
Western Indian: Mozambique. Upper slope. 430–439 m.

***Dipturus leptocaudus* (Krefft and Stehmann, 1975).** Thintail skate.
Southwest Atlantic: Brazil. Upper slope. 400–550 m.

***Dipturus linteus* (Fries, 1838).** Sailskate.
North Atlantic, primarily in the Northeast Atlantic. Upper to mid slope. 150–1 200+ m.

***Dipturus macrocaudus* (Ishiyama, 1955).** Bigtail skate.
Northwest Pacific: Japan, Korea and Taiwan. Upper to mid slope. 300–800 m.

***Dipturus melanospilus (*Last, White and Pogonoski, 2008).** Blacktip skate.
Western Central and Southwest Pacific: eastern Australia. Upper slope. 239–695 m.

***Dipturus mennii* (Gomes and Paragó, 2001).** South Brazilian skate.
Southwest Atlantic: Brazil. Outer shelf and upper slope. 133–500 m. Includes the likely synonym *Dipturus diehli* Soto and Mincarone, 2001.

***Dipturus nidarosiensis* (Collett, 1880).** Norwegian skate.
Northeast Atlantic: Norway, Iceland and the Rockall Trough. Upper to mid slope and deep-sea rises. 200–1 000 m.

***Dipturus oculus* (Last, 2008).** Ocellate skate
Eastern Indian: western Australia. Upper slope. 200–389 m.

***Dipturus oregoni* (Bigelow and Schroeder, 1958).** Hooktail skate.
Western Central Atlantic: northern Gulf of Mexico. Upper to mid slope. 475–1 079 m.

***Dipturus oxyrhynchus* (Linnaeus, 1758).** Sharpnose skate.
Wide-ranging in the Northeast and Eastern Central Atlantic, including the Mediterranean. Shelf and upper to mid slope. 15–900 m.

***Dipturus polyommata* (Ogilby, 1910).** Argus skate.
Western Central Pacific: northeastern Australia. Outer shelf and upper slope. 135–320 m.

***Dipturus pullopunctata* (Smith, 1964).** Slime skate.
Southeast Atlantic: Namibia and South Africa. Shelf and upper slope. 15–457 m (most common 100-300 m).

***Dipturus queenslandicus* (Last, White and Pogonoski, 2008).** Queensland deepwater skate.
Western Central Pacific: northeastern Australia. Upper slope. 399–606 m.

***Dipturus springeri* (Wallace, 1967).** Roughbelly skate.
Southeast Atlantic and Western Indian: southern Africa. Upper slope. 400–740 m (mostly 400–500 m).

***Dipturus stenorhynchus* (Wallace, 1967).** Prownose skate.
Southeast Atlantic and Western Indian: South Africa and Mozambique. Upper to mid slope. 253-761 m.

***Dipturus teevani* (Bigelow and Schroeder, 1951).** Caribbean skate.
Patchy throughout the Western Central Atlantic. Upper slope. 311–732 m.

***Dipturus tengu* (Jordan and Fowler, 1903).** Acutenose or tengu skate.
Northwest and Western Central Pacific: Japan to the Philippines. Shelf and upper slope. 45-300 m.

***Dipturus trachydermus* (Krefft and Stehmann, 1974).** Roughskin skate.
Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper slope. 20–450 m.

***Dipturus wengi* (Séret and Last, 2008).** Weng's skate.
Eastern Indian and Western Pacific: Australia and Indonesia. Upper to mid slope. 486-1 165 m.

***Fenestraja atripinna* (Bigelow and Schroeder, 1950).** Blackfin pygmy skate.
Western Central Atlantic: North Carolina (United States) to Cuba. Upper to mid slope. 366-951 m.

***Fenestraja cubensis* (Bigelow and Schroeder, 1950).** Cuban pygmy skate.
Western Central Atlantic: Florida (United States), Bahamas and Cuba. Upper to mid slope. 440–869 m.

***Fenestraja ishiyamai* (Bigelow and Schroeder, 1962).** Plain pygmy skate.
Scattered records in the Western Central Atlantic. Upper to mid slope. 503–950 m.

***Fenestraja maceachrani* (Séret, 1989).** Madagascar pygmy skate.
Western Indian: Madagascar. Upper to mid slope. 600–765 m.

***Fenestraja mamillidens* (Alcock, 1889).** Prickly skate.
Eastern Indian: Bay of Bengal. Mid slope. 1 093 m.

***Fenestraja plutonia* (Garman, 1881).** Pluto skate.
Patchy in the Western Central Atlantic. Upper to mid slope. 293–1 024 m.

***Fenestraja sibogae* (Weber, 1913).** Siboga pygmy skate.
Western Central Pacific: Bali Sea, Indonesia. Upper slope. 290 m.

***Fenestraja sinusmexicanus* (Bigelow and Schroeder, 1950).** Gulf of Mexico pygmy skate.
Patchy in the Western Central Atlantic. Shelf and upper to mid slope. 56–1 096 m.

***Gurgesiella atlantica* (Bigelow and Schroeder, 1962).** Atlantic pygmy skate.
Western Atlantic: Central and South America. Upper to mid slope. 247–960 m.

***Gurgesiella dorsalifera* (McEachran and Compagno, 1980).** Onefin skate.
Southwest Atlantic: Brazil. Upper to mid slope. 400–800 m.

***Gurgesiella furvescens* (de Buen, 1959).** Dusky finless skate.
Southeast Pacific: Galapagos Islands and Peru to Chile. Upper to mid slope. 300–960 m.

***Leucoraja compagnoi* (Stehmann, 1995).** Tigertail skate.
Southeast Atlantic and Western Indian: South Africa. Upper slope. 497–625 m.

***Leucoraja fullonica* (Linnaeus, 1758).** Shagreen skate.
Northeast (and marginally into the Eastern Central) Atlantic, including the western Mediterranean. Shelf and upper to mid slope. 30–800 m.

***Leucoraja garmani* (Whitley, 1939).** Rosette skate.
Northwest and Western Central Atlantic: Cape Cod to Florida (United States). Shelf and upper slope. 37–530 m.

***Leucoraja lentiginosa* (Bigelow and Schroeder, 1951).** Freckled skate.
Western Central Atlantic: northern Gulf of Mexico. Shelf and upper slope. 53–588 m.

***Leucoraja leucosticta* (Stehmann, 1971).** Whitedappled skate.
Eastern Central and Southeast Atlantic: West Africa. Shelf and upper slope. 70–600 m.

***Leucoraja melitensis* (Clark, 1926).** Maltese skate.
Southwestern and south-central Mediterranean. Shelf and upper to mid slope. 60–800 m (more common 400–800 m).

***Leucoraja naevus* (Müller and Henle, 1841).** Cuckoo skate.
Reasonably wide-ranging in the Northeast and Eastern Central Atlantic, including the Mediterranean. Shelf and upper slope. 20–500 m.

***Leucoraja pristispina* (Last, Stehmann and Séret, 2008).** Sawback skate.
Eastern Indian: western Australia. Upper slope. 202–504 m.

***Leucoraja wallacei* (Hulley, 1970).** Yellowspot or blancmange skate.
Southeast Atlantic and Western Indian: southern Africa. Shelf and upper slope. 70–500 m (most common 150–300 m).

***Leucoraja yucatanensis* (Bigelow and Schroeder, 1950).** Yucatan skate.
Western Central Atlantic: Central America. Outermost shelf and upper slope. 192–457 m.

***Malacoraja kreffti* (Stehmann, 1978).** Krefft's skate.
Northeast Atlantic: Rockall Trough and Iceland. Mid slope and deep-sea rises. 1 200 m.

***Malacoraja obscura* (Carvalho, Gomes and Gadig, 2006).** Brazilian soft Skate.
Southwest Atlantic: Brazil. Mid slope. 808–1 105 m.

***Malacoraja senta* (Garman, 1885).** Smooth skate.
Northwest Atlantic: Canada and United States. Shelf and upper to mid slope. 46–914 m.

***Malacoraja spinacidermis* (Barnard, 1923).** Prickled or roughskin skate.
Wide-ranging but patchy in the Eastern Atlantic. Upper to deep slope. 450–1 568 m.

***Neoraja africana* (Stehmann and Séret, 1983).** West African pygmy skate.
Eastern Central Atlantic: Gabon and Western Sahara. Mid to deep slope. 900–1 550 m.

***Neoraja caerulea* (Stehmann, 1976).** Blue pygmy skate.
Northeast Atlantic: Rockall Trough. Upper to mid slope and deep-sea rises. 600–1 262 m.

***Neoraja carolinensis* (McEachran and Stehmann, 1984).** Carolina pygmy skate.
Western Central Atlantic: North Carolina to Florida (United States). Upper to mid slope. 695-1 010 m.

***Neoraja iberica* (Stehmann, Séret, Costa and Baro, 2008).** Iberian pygmy skate
Northeast Atlantic: Iberian Peninsula. Upper slope. 270–670 m.

***Neoraja stehmanni* (Hulley, 1972).** South African pygmy skate.
Southeast Atlantic: South Africa. Upper to mid slope. 292–1 025 m (most common > 600 m).

***Okamejei arafurensis* (Last and Gledhill, 2008).** Arafura skate.
Western Central Pacific and Eastern Indian: northern Australia. Outermost shelf and upper slope. 179-298 m.

***Okamejei heemstrai* (McEachran and Fechhelm, 1982).** Narrow or East African skate.
Western Indian: East Africa. Upper slope. 200–500 m.

***Okamejei leptoura* (Last and Gledhill, 2008).** Thintail skate.
Eastern Indian: western Australia. Upper slope. 202–735 m.

***Raja africana*? (Capapé, 1977).** African skate.
Disjunct range in the Mediterranean (Tunisia) and Eastern Central Atlantic (Mauritania). Shelf and upper slope. 50–400 m. Homonym, requires a replacement name.

***Raja bahamensis* (Bigelow and Schroeder, 1965).** Bahama skate.
Western Central Atlantic: Florida (United States) and Bahamas. Upper slope. 366–411 m.

***Raja binoculata* (Girard, 1854).** Big skate
Wide-ranging in the Northeast and Eastern Central Pacific (and marginally into the Northwest Pacific). Shelf and upper to mid slope. 3–800 m.

***Raja inornata* (Jordan and Gilbert, 1880).** California skate.
Eastern Central Pacific: western United States and Mexico. Shelf and upper to mid slope. 17-671 m.

***Raja maderensis* (Lowe, 1841).** Madeira skate.
Eastern Central Atlantic: Madeira. Shelf and upper slope. ?–500 m.

***Raja polystigma* (Regan, 1923).** Speckled skate.
Western Mediterranean. Outer shelf and upper slope. 100–400 m.

***Raja rhina* (Jordan and Gilbert, 1880).** Longnose skate.
Wide-ranging in the Northeast and Eastern Central Pacific. Shelf and upper to mid slope. 9-1 069 m.

***Raja stellulata* (Jordan and Gilbert, 1880).** Pacific starry skate.
Eastern Central Pacific: United States and Mexico. Shelf and upper slope. 18–732 m (usually <100 m). Records from Alaska and Bering Sea likely other species (i.e. *B. parmifera*).

***Raja straeleni* (Poll, 1951).** Biscuit skate.
Wide-ranging in the Eastern Central and Southeast Atlantic: West Africa; Western Indian: southern Africa. Shelf and upper slope. 80–690 m (mostly 200–300 m).

***Rajella annandalei* (Weber, 1913).** Indonesian round or Annandale's skate.
Western Central Pacific: eastern Indonesia. Upper to mid slope. 400–830 m.

***Rajella barnardi* (Norman, 1935).** Bigthorn skate.
Wide-ranging in the Eastern Atlantic: West Africa. Outer shelf and upper to deep slope. 102-1 700 m. Includes the junior synonym *Raja confundens* Hulley, 1970.

***Rajella bathyphila* (Holt and Byrne, 1908).** Deepwater skate.
Wide-ranging in the North Atlantic. Upper to deep slope and abyssal plains. 600–2 050 m (mostly >1 000 m).

***Rajella bigelowi* (Stehmann, 1978).** Bigelow's skate.
Wide-ranging but patchy in the North and Central Atlantic. Upper to deep slope, deep-sea rises and abyssal plains. 650–4 156 m (mostly >1 500 m).

***Rajella caudaspinosa* (von Bonde and Swart, 1923).** Munchkin skate.
Southeast Atlantic and Western Indian: Namibia and South Africa. Upper slope. 310–520 m.

***Rajella challengeri* (Last and Stehmann, 2008).** Challenger skate.
Eastern Indian and Southwest Pacific: southern Australia. Mid slope. 860–1 500 m.

***Rajella dissimilis* (Hulley, 1970).** Ghost skate.
Patchy in the Eastern Atlantic. Upper to deep slope. 400–1 570 m.

***Rajella eisenhardti* (Long and McCosker, 1999).** Galapagos gray skate.
Southeast Pacific: Galapagos Islands. Mid slope. 757–907 m.

***Rajella fuliginea* (Bigelow and Schroeder, 1954).** Sooty skate.
Patchy in the Western Central Atlantic. Upper to mid slope. 731–1 280 m.

***Rajella fyllae* (Luetken, 1888).** Round skate.
Wide-ranging in the Northeast and Northwest Atlantic. Outer shelf and upper to deep slope. 170-2 050 m (average depth range 400–800 m).

***Rajella kukujevi* (Dolganov, 1985).** Mid-Atlantic skate.
Patchy in the Northeast Atlantic. Mid slope. 750–1 341 m.

***Rajella leopardus* (von Bonde and Swart, 1923).** Leopard skate.
Patchy in the Eastern Central and Southeast Atlantic and possibly Western Indian (South Africa). Outer shelf and upper to deep slope. 130–1 920 m.

***Rajella nigerrima* (de Buen, 1960).** Blackish skate.
Southeast Pacific: Ecuador to Chile. Upper to mid slope. 590–1 000 m.

***Rajella purpuriventralis* (Bigelow and Schroeder, 1962).** Purplebelly skate.
Patchy in the Western Central Atlantic. Upper to deep slope. 732–2 010 m.

***Rajella ravidula* (Hulley, 1970).** Smoothback skate.
Eastern Central and Southeast Atlantic: Morocco and South Africa. Mid slope. 1 000-1 250 m.

***Rajella sadowskyii* (Krefft and Stehmann, 1974).** Brazilian skate.
Southwest Atlantic and Southeast Pacific: southern South America. Mid slope. 1 200 m.

***Rostroraja alba* (Lacepede, 1803).** White, bottlenose or spearnose skate.
Wide-ranging in the Eastern Atlantic, including the western Mediterranean, and the Western Indian (to Mozambique). Shelf and upper slope. 30–600 m.

***Zearaja chilensis* (Guichenot, 1848).** Yellownose skate.
Southwest Atlantic and Southeast Pacific: southern South America. Shelf and upper slope. 28–500 m. Includes the junior synonym *Dipturus flavirostris* (Philippi, 1892).

***Zearaja nasutus* (Banks, in Müller and Henle, 1841).** Rough skate.
Southwest Pacific: New Zealand. Shelf and upper to mid slope. 10–1 500 m.

Family Anacanthobatidae. Legskates.

***Anacanthobatis americanus* (Bigelow and Schroeder, 1962).** American legskate.
Western Atlantic: Caribbean and the northern coast of South America. Outermost shelf and upper to mid slope. 183–915 m.

***Anacanthobatis donghaiensis* (Deng, Xiong and Zhan, 1983).** East China legskate.
Northwest Pacific: East China Sea. Upper to mid slope. 200–1 000 m.

***Anacanthobatis folirostris* (Bigelow and Schroeder, 1951).** Leafnose legskate.
Western Central Atlantic: northern Gulf of Mexico. Upper slope. 300–512 m.

***Anacanthobatis longirostris* (Bigelow and Schroeder, 1962).** Longnose legskate.
Western Central Atlantic: northern Gulf of Mexico and Caribbean. Upper to mid slope. 520-1 052 m.

***Anacanthobatis marmoratus* (von Bonde and Swart, 1924).** Spotted legskate.
Western Indian: South Africa and Mozambique. Upper slope. 230–322 m.

***Anacanthobatis nanhaiensis* (Meng and Li, 1981).** South China legskate.
South China Sea. Validity uncertain.

***Anacanthobatis ori* (Wallace, 1967).** Black legskate.
Western Indian: Mozambique and Madagascar. Mid to deep slope. 1 000–1 725 m.

***Anacanthobatis stenosoma* (Li and Hu, 1982).** Narrow legskate.
South China Sea. Validity uncertain.

***Cruriraja andamanica* (Lloyd, 1909).** Andaman legskate.
Patchy in the Indian Ocean: Tanzania and the Andaman Sea. Upper slope. 274–511 m.

***Cruriraja atlantis* (Bigelow and Schroeder, 1948).** Atlantic legskate.
Western Central Atlantic: Florida (United States) to Cuba. Upper to mid slope. 512–778 m.

***Cruriraja cadenati* (Bigelow and Schroeder, 1962).** Broadfoot legskate.
Western Central Atlantic: Florida (United States) and Puerto Rico. Upper to mid slope. 457-896 m.

***Cruriraja durbanensis* (von Bonde and Swart, 1924).** Smoothnose legskate.
Southeast Atlantic: South Africa. Mid slope. 860 m. Note types collected off Northern Cape Province of South Africa, not off KwaZulu-Natal as suggested by the specific name.

***Cruriraja parcomaculata* (von Bonde and Swart, 1924).** Roughnose legskate
Southeast Atlantic and Western Indian: Namibia and South Africa. Outer shelf and upper slope. 150-620 m.

***Cruriraja poeyi* (Bigelow and Schroeder, 1948).** Cuban legskate.
Scattered records throughout the Western Central Atlantic. Upper to mid slope. 366–870 m.

***Cruriraja rugosa* (Bigelow and Schroeder, 1958).** Rough legskate.
Western Central Atlantic: Gulf of Mexico and Caribbean. Upper to mid slope. 366–1 007 m.

***Cruriraja triangularis* (Smith, 1964).** Triangular legskate.
Western Indian: South Africa and Mozambique. Upper slope. 220–675 m.

***Sinobatis borneensis* (Chan, 1965).** Borneo legskate.
Patchy in the Northwest and Western Central Pacific. Upper to mid slope. 475–835 m.

***Sinobatis bulbicauda* (Last and Séret, 2008).** Western Australian legskate.
Eastern Indian: western Australia; Western Central Pacific: Indonesia. Outer shelf and upper to mid slope. 150–1 125 m (mostly 400–800 m).

***Sinobatis caerulea* (Last and Séret, 2008).** Blue legskate.
Eastern Indian: western Australia. Upper to mid slope. 482–1 168 m.

***Sinobatis filicauda* (Last and Séret, 2008).** Eastern Australian legskate.
Western Central Pacific: northeastern Australia. Upper to mid slope. 606–880 m.

***Sinobatis melanosoma* (Chan, 1965).** Blackbodied legskate.
Northwest and Western Central Pacific: South China Sea. Mid slope. 900–1 100 m.

Family Plesiobatidae. Giant Stingarees.

***Plesiobatis daviesi* (Wallace, 1967).** Deepwater stingray or giant stingaree.
Patchy in the Indo-West and Central Pacific. Shelf (single record at 44 m off Mozambique) and upper slope. 44–680 m (mostly 275–680 m).

Family Urolophidae. Stingarees.

***Urolophus expansus* (McCulloch, 1916).** Wide stingaree.
Eastern Indian: southern Australia. Outer shelf and upper slope. 130–420 m (mainly 200-300 m).

***Urolophus piperatus* (Séret and Last, 2003).** Coral Sea stingaree.
Western Central Pacific: northeastern Australia. Upper slope and deep reefs. 170–370 m.

Family Hexatrygonidae. Sixgill Stingrays.

***Hexatrygon bickelli (*Heemstra and Smith, 1980).** Sixgill stingray.
Wide-ranging but patchy in the Indo-West and Central Pacific. Upper to mid slope (although some shallow water and beach stranding records). 362–1 120 m.

Family Dasyatidae. Whiptail Stingrays.

***Dasyatis brevicaudata* (Hutton, 1875).** Shorttail or smooth stingray.
Patchy in the Indo-West Pacific (New Zealand, Australia and southern Africa). Inshore and shelf in Australia and New Zealand, outermost shelf and upper slope off South Africa. Intertidal–160 m (New Zealand, Australia), 180–480 m (southern Africa).

Superorder Galeomorphii. Galeomorph Sharks.

Order Heterodontiformes. Bullhead Sharks.

Family Heterodontidae. Bullhead Sharks.

***Heterodontus ramalheira* (Smith, 1949).** Whitespotted bullhead shark.
Western Indian: East Africa and Arabian Sea. Outer shelf and uppermost slope. 40–275 m (mostly >100 m).

Order Orectolobiformes. Carpetsharks.

Family Parascylliidae. Collared Carpetsharks.

***Cirrhoscyllium japonicum* (Kamohara, 1943).** Saddled carpetshark.
Northwest Pacific: Japan. Uppermost slope. 250–290 m.

***Parascyllium sparsimaculatum* (Goto and Last, 2002).** Ginger carpetshark.
Eastern Indian: Australia. Upper slope. 245–435 m.

Order Lamniformes. Mackerel Sharks.

Family Odontaspididae. Sand Tiger Sharks.

***Odontaspis ferox* (Risso, 1810).** Smalltooth sand tiger or bumpytail raggedtooth.
Wide-ranging but patchy in the Atlantic, including the Mediterranean, and the Indo-Pacific. Possibly circumglobal in warm-temperate and tropical waters. Shelf and upper slope. 13-880 m.

***Odontaspis noronhai* (Maul, 1955).** Bigeye sand tiger.
Scattered records in the Central and Southwest Atlantic and the Central Pacific. Possibly circumglobal in deep tropical seas. Upper to mid slope as well as mesopelagic. 600–1 000 m.

Family Pseudocarchariidae. Crocodile Sharks.

***Pseudocarcharias kamoharai* (Matsubara, 1936).** Crocodile shark.
Cosmopolitan in tropical and warm temperate waters. Epipelagic and mesopelagic. 0–590 m.

Family Mitsukurinidae. Goblin Sharks.

***Mitsukurina owstoni* (Jordan, 1898).** Goblin shark.
Wide-ranging but patchy in the Atlantic and the Indo-Pacific. Shelf, upper to mid slope and seamounts. 0–1 300 m (mainly 270–960 m).

Family Alopiidae. Thresher Sharks.

***Alopias superciliosus* (Lowe, 1839).** Bigeye thresher.
Cosmopolitan in tropical and warm temperate waters. Shelf, epipelagic and mesopelagic. 0-732 m (mostly > 100 m).

Family Cetorhinidae. Basking Sharks.

***Cetorhinus maximus* (Gunnerus, 1765).** Basking shark.
Cosmopolitan in cold to warm-temperate waters. Shelf and upper to mid slope, epipelagic and mesopelagic. 0–904 m.

Order Carcharhiniformes. Ground Sharks.

Family Scyliorhinidae. Catsharks.

***Apristurus albisoma* (Nakaya and Séret, 1999).** White catshark.
Western Central Pacific: Norfolk and Lord Howe Ridges. Submarine ridges. 935–1 564 m.

***Apristurus ampliceps* Sasahara, (Sato and Nakaya, 2008).** Roughskin catshark.
Eastern Indian and Southwest Pacific: Australia and New Zealand. Mid to deep slope and submarine ridges. 800–1 503 m.

***Apristurus aphyodes* (Nakaya and Stehmann, 1998).** White ghost catshark.
Northeast Atlantic: Atlantic Slope. Mid to deep slope. 1 014–1 800 m.

***Apristurus australis* (Sato, Nakaya and Yorozu, 2008).** Pinocchio catshark.
Eastern Indian and Western Pacific: Australia. Upper to mid slope and seamounts. 486-1 035 m.

***Apristurus brunneus* (Gilbert, 1892).** Brown catshark.
Eastern Pacific: Alaska to Mexico, and possibly Southeast Pacific. Shelf and upper to mid slope. 33-1 298 m.

***Apristurus bucephalus* (White, Last and Pogonoski, 2008).** Bighead catshark.
Eastern Indian: western Australia. Mid slope. 920–1 140 m.

***Apristurus canutus* (Springer and Heemstra, in Springer, 1979).** Hoary catshark.
Western Central Pacific: Caribbean Islands and Venezuela. Upper to mid slope. 521–915 m.

***Apristurus exsanguis* (Sato, Nakaya and Stewart, 1999).** Pale catshark.
Southwest Pacific: New Zealand. Upper to mid slope and submarine ridges. 573–1 200 m.

***Apristurus fedorovi* (Dolganov, 1985).** Stout catshark.
Northwest Pacific: Japan. Mid slope. 810–1 430 m.

***Apristurus gibbosus* (Meng, Chu and Li, 1985).** Humpback catshark.
Northwest Pacific: South China Sea off southern China. Mid slope. 913 m.

***Apristurus herklotsi* (Fowler, 1934).** Longfin catshark.
Northwest and Western Central Pacific: Japan, China and the Philippines. Upper to mid slope. 520-910 m.

***Apristurus indicus* (Brauer, 1906).** Smallbelly catshark.
Western Indian: Arabian Sea. Records off southern Africa probably erroneous. Mid to deep slope. 1 289–1 840 m.

***Apristurus internatus* (Deng, Xiong and Zhan, 1988).** Shortnose demon catshark.
Northwest Pacific: East China Sea off China. Upper slope. 670 m.

***Apristurus investigatoris* (Misra, 1962).** Broadnose catshark.
Eastern Indian: Andaman Sea. Mid slope. 1 040 m.

***Apristurus japonicus* (Nakaya, 1975).** Japanese catshark.
Northwest Pacific: Japan. Mid slope. 820–915 m.

***Apristurus kampae* (Taylor, 1972).** Longnose catshark.
Eastern Pacific: United States and Mexico. Provisional from the Galapagos Islands. Outer shelf and upper to deep slope. 180–1 888 m.

***Apristurus laurussoni* (Saemundsson, 1922).** Iceland catshark.
Wide-ranging but patchy in the North and Central Atlantic. Upper to deep slope. 560-2 060 m. Includes the junior synonyms *Apristurus atlanticus* (Koefoed, 1932) and *Apristurus maderensis* Cadenat and Maul, 1966.

***Apristurus longicephalus (*Nakaya, 1975).** Longhead catshark.
Patchy in the Indo-West Pacific. Upper to mid slope and submarine ridges. 500–1 140 m.

***Apristurus macrorhynchus* (Tanaka, 1909).** Flathead catshark.
Northwest Pacific: Japan, China and Taiwan. Upper to mid slope. 220–1 140 m.

***Apristurus macrostomus* (Meng, Chu, and Li, 1985).** Broadmouth catshark.
Northwest Pacific: South China Sea off China. Mid slope. 913 m.

***Apristurus manis* (Springer, 1979).** Ghost catshark.
Patchy records in the North and Southeast Atlantic. Upper to deep slope. 658–1 740 m.

***Apristurus melanoasper* (Iglésias, Nakaya and Stehmann, 2004).** Black roughscale catshark.
Patchy in the Atlantic and Indo-West Pacific. Upper to deep slope and submarine ridges. 512-1 520 m.

***Apristurus microps* (Gilchrist, 1922).** Smalleye catshark.
Patchy in the North and Southeast Atlantic. Upper to deep slope. 700–2 200 m.

***Apristurus micropterygeus* (Meng, Chu and Li, in Chu, Meng, and Li, 1986).** Smalldorsal catshark.
Northwest Pacific: South China Sea off China. Mid slope. 913 m.

***Apristurus nasutus* (de Buen, 1959).** Largenose catshark.
Eastern Pacific: patchy off Central and South America. Eastern Central Atlantic record probably erroneous. Upper to mid slope. 400–925 m.

***Apristurus parvipinnis* (Springer and Heemstra, in Springer, 1979).** Smallfin catshark.
Western Central Atlantic: Gulf of Mexico, Caribbean and northern South America. Upper to mid slope. 636–1 115 m.

***Apristurus pinguis* (Deng, Xiong and Zhan, 1983).** Fat catshark.
Patchy in the Eastern Indian and Western Pacific. Mid to deep slope and submarine ridges. 996-2 057 m.

***Apristurus platyrhynchus* (Tanaka, 1909).** Spatulasnout catshark
Patchy in the Eastern Indian and Western Pacific. Upper to mid slope and submarine ridges. 400-1 080 m. Includes the junior synonyms *Apristurus acanutus* Chu, Meng and Li, in Meng, Chu and Li, 1985 and *Apristurus verweyi* (Fowler, 1934).

***Apristurus profundorum* (Goode and Bean, 1896).** Deepwater catshark.
Northwest Atlantic off United States, possibly Eastern Central Atlantic off West Africa. Deep slope. ~1 500 m. Records from the Indian Ocean require confirmation.

***Apristurus riveri* (Bigelow and Schroeder, 1944).** Broadgill catshark.
Western Central Atlantic: Gulf of Mexico, Caribbean and northern South America. Upper to mid slope. 732–1 461 m.

***Apristurus saldanha* (Barnard, 1925).** Saldanha catshark.
Southeast Atlantic: southern Africa. Upper to mid slope. 344–1 009 m.

***Apristurus sibogae* (Weber, 1913).** Pale catshark.
Western Central Pacific: Indonesia. Upper slope. 655 m.

***Apristurus sinensis* (Chu and Hu, in Chu, Meng, Hu and Li, 1981).** South China catshark.
Eastern Indian and Western Pacific: Australia and South China Sea. Upper to mid slope. 940-1 290 m.

***Apristurus spongiceps* (Gilbert, 1895).** Spongehead catshark.
Patchy in the Western and Central Pacific: Indonesia and Hawaii. Upper to mid slope. 572-1 482 m.

***Apristurus stenseni* (Springer, 1979).** Panama ghost catshark.
Eastern Central Pacific: Panama. Mid slope. 915–975 m.

***Asymbolus galacticus* (Séret and Last, 2008).** New Caledonia spotted catshark.
Western Central Pacific: New Caledonia. Upper slope. 235–550 m.

***Asymbolus pallidus* (Last, Gomon and Gledhill, in Last, 1999).** Pale spotted catshark.
Western Central Pacific: northeastern Australia. Upper slope. 225–400 m.

***Bythaelurus*? *alcocki* (Garman, 1913).** Arabian catshark.
Eastern Indian: Arabian Sea. Mid slope. 1 134–1 262 m. Original and only specimen has been lost, and thus placement of the species in this genus is tentative.

***Bythaelurus canescens* (Günther, 1878).** Dusky catshark.
Southeast Pacific: Peru and Chile. Upper slope. 250–700 m.

***Bythaelurus clevai* (Séret, 1987).** Broadhead catshark.
Eastern Indian: Madagascar. Upper slope. 400–500 m.

***Bythaelurus dawsoni* (Springer, 1971).** Dawson's catshark.
Southwest Pacific: New Zealand. Shelf, upper to mid slope. 50–790 m (most common 300-700 m).

***Bythaelurus hispidus* (Alcock, 1891).** Bristly catshark.
Eastern Indian: India and the Andaman Islands. Upper to mid slope. 293–766 m.

***Bythaelurus immaculatus* (Chu and Meng, in Chu, Meng, Hu and Li, 1982).** Spotless catshark.
Northwest Pacific: South China Sea. Upper to mid slope. 534–1 020 m.

***Bythaelurus incanus* (Last and Stevens, 2008).** Dusky catshark.
Eastern Indian: northwestern Australia. Mid slope. 900–1 000 m.

***Bythaelurus lutarius* (Springer and D'Aubrey, 1972).** Mud catshark.
Western Indian: patchy off East Africa. Upper to mid slope. 338–766 m.

***Cephaloscyllium albipinnum* (Last, Motomura and White, 2008).** Whitefin swellshark.
Eastern Indian and Southwest Pacific: southern Australia. Outer shelf and upper slope. 126-554 m.

***Cephaloscyllium cooki* (Last, Séret and White, 2008).** Cook's swellshark.
Eastern Indian: northwestern Australia and Indonesia. Upper slope. 223–300 m.

***Cephaloscyllium fasciatum* (Chan, 1966).** Reticulated swellshark.
Patchy in the Western Pacific. Upper slope. 219–450 m.

***Cephaloscyllium hiscosellum* (White and Ebert, 2008).** Australian reticulate swellshark.
Eastern Indian: northwestern Australia. Upper slope. 294–420 m.

***Cephaloscyllium isabellum* (Bonnaterre, 1788).** Draughtsboard shark.
Southwest Pacific: New Zealand. Shelf and upper slope. Inshore–690 m.

***Cephaloscyllium signourum* (Last, Séret and White, 2008).** Flagtail swellshark.
Western Central Pacific: northeastern Australia (and possibly elsewhere in Oceania). Upper slope and submarine ridges. 480–700 m.

***Cephaloscyllium silasi* (Talwar, 1974).** Indian swellshark.
Western Indian: India. Upper slope. ~300 m.

***Cephaloscyllium speccum* (Last, Séret and White, 2008).** Speckled swellshark.
Eastern Indian: northwestern Australia. Outer shelf and upper slope. 150–455 m.

***Cephaloscyllium sufflans* (Regan, 1921).** Balloon shark.
Western Indian: South Africa and Mozambique. Shelf and upper slope. 40–440 m.

***Cephaloscyllium variegatum* (Last and White, 2008).** Saddled swellshark.
Western Central and Southwest Pacific: eastern Australia. Outer shelf and upper slope. 114-606 m.

***Cephaloscyllium zebrum* (Last and White, 2008).** Narrowbar swellshark.
Western Central Pacific: northeastern Australia. Upper slope. 444–454 m.

***Cephalurus cephalus* (Gilbert, 1892).** Lollipop catshark.
Eastern Central Pacific: Mexico. Outer shelf and upper to mid slope. 155–927 m.

***Figaro boardmani* (Whitley, 1928).** Australian sawtail catshark.
Eastern Indian and Western Pacific: Australia. Outer shelf and upper slope. 150–640 m.

***Figaro striatus (*Gledhill, Last and White, 2008).** Northern sawtail catshark.
Western Central Pacific: northeastern Australia. Upper slope. 300–419 m.

***Galeus antillensis* (Springer, 1979).** Antilles catshark.
Western Central Atlantic: Straits of Florida and the Caribbean. Upper slope. 293–658 m.

***Galeus arae* (Nichols, 1927).** Roughtail catshark.
Northwest and Western Central Atlantic: United States, Gulf of Mexico, Caribbean and Central America. Upper slope. 292–732 m.

***Galeus atlanticus* (Vaillant, 1888).** Atlantic sawtail catshark.
Patchy in the Northeast Atlantic and Mediterranean. Upper slope. 400–600 m.

***Galeus cadenati* (Springer, 1966).** Longfin sawtail catshark.
Western Central Atlantic: off Panama and Colombia. Upper slope. 439–548 m.

***Galeus eastmani* (Jordan and Snyder, 1904).** Gecko catshark.
Patchy in the Northwest Pacific. Habitat information not available.

***Galeus gracilis* (Compagno and Stevens, 1993).** Slender sawtail catshark.
Eastern Indian and Western Central Pacific: patchy across northern Australia. Upper slope. 290–470 m.

***Galeus longirostris* (Tachikawa and Taniuchi, 1987).** Longnose sawtail catshark.
Northwest Pacific: Japan. Upper slope. 350–550 m.

***Galeus melastomus* (Rafinesque, 1810).** Blackmouth catshark.
Wide-ranging in the Northeast and Western Central Atlantic and the Mediterranean. Shelf and upper to mid slope. 55–1 440 m (mainly 200–500 m).

***Galeus mincaronei* (Soto, 2001).** Brazilian sawtail catshark.
Southwest Atlantic: southern Brazil. Deep reefs on upper slope. 236–600 m.

***Galeus murinus* (Collett, 1904).** Mouse catshark.
Northeast Atlantic: Iceland and the Faeroe Islands. Upper to mid slope. 380–1 250 m.

***Galeus nipponensis* (Nakaya, 1975).** Broadfin sawtail catshark.
Northwest Pacific: Japan. Upper slope and submarine ridges. 362–540 m.

***Galeus piperatus* (Springer and Wagner, 1966).** Peppered catshark.
Eastern Central Pacific: Gulf of California. Upper to mid slope. 275–1 326 m.

***Galeus polli* (Cadenat, 1959).** African sawtail catshark.
Wide-ranging in the Eastern Atlantic off West Africa. Outer shelf and upper slope. 159-720 m.

***Galeus priapus* (Séret and Last, 2008).**
Western Central Pacific: New Caledonia and Vanuatu. Upper to mid slope. 262–830 m.

***Galeus schultzi* (Springer, 1979).** Dwarf sawtail catshark
Western Central Pacific: the Philippines. Shelf (one record) and upper slope. 50–431 m (single record at 50 m, usually 329–431 m).

***Galeus springeri* (Konstantinou and Cozzi, 1998).** Springer's sawtail catshark.
Western Central Atlantic: Greater and Lesser Antilles. Upper slope. 457–699 m.

***Holohalaelurus favus* (Human, 2006).** Honeycomb or Natal izak.
Western Indian: southern Africa. Upper to mid slope. 200–1 000 m.

***Holohalaelurus grennian* (Human, 2006).** East African spotted catshark.
Scattered records in the Western Indian off East Africa. Upper slope. 238–300 m.

***Holohalaelurus melanostigma* (Norman, 1939).** Tropical izak catshark.
Western Indian: off East Africa. Upper slope. 607–658 m.

***Holohalaelurus punctatus* (Gilchrist and Thompson, 1914).** African spotted catshark
Southeast Atlantic and Western Indian: southern Africa. Upper slope. 220–420 m.

***Holohalaelurus regani* (Gilchrist, 1922).** Izak catshark.
Southeast Atlantic and Western Indian: southern Africa. Shelf and upper to mid slope. 40-910 m (mainly ~100–300 m).

***Parmaturus albimarginatus* (Séret and Last, 2007).** Whitetip catshark.
Western Central Pacific: New Caledonia. Upper slope. 590–732 m.

***Parmaturus albipenis* (Séret and Last, 2007).** White-clasper catshark.
Western Central Pacific: New Caledonia. Upper slope. 688–732 m.

***Parmaturus bigus* (Séret and Last, 2007).** Beige catshark.
Western Central Pacific: northeastern Australia. Upper slope. 590–606 m.

***Parmaturus campechiensis* (Springer, 1979).** Campeche catshark.
Western Central Atlantic: Bay of Campeche in the Gulf of Mexico. Mid slope. 1 097 m.

***Parmaturus lanatus* (Séret and Last, 2007).** Velvet catshark.
Eastern Indian: Indonesia. Mid slope. 840–855 m.

***Parmaturus macmillani* (Hardy, 1985).** New Zealand filetail.
Southwest Pacific: New Zealand; Western Indian: south of Madagascar. Submarine ridges. 950-1 003 m (may also occur deeper).

***Parmaturus melanobranchius* (Chan, 1966).** Blackgill catshark.
Western Pacific: East and South China Seas. Upper to mid slope. 540–835 m.

***Parmaturus pilosus* (Garman, 1906).** Salamander shark.
Northwest Pacific: Japan and East China Sea. Upper to mid slope. 358–895 m.

***Parmaturus xaniurus* (Gilbert, 1892).** Filetail catshark.
Eastern Central Pacific: southern United States and Mexico. Outer shelf and upper to mid slope. Juveniles mesopelagic. 91–1 251 m.

***Pentanchus profundicolus* (Smith and Radcliffe, 1912).** Onefin catshark.
Western Central Pacific: the Philippines. Upper to mid slope. 673–1 070 m.

***Schroederichthys maculatus* (Springer, 1966).** Narrowtail catshark.
Western Central Atlantic: patchy off Central and northern South America. Outermost shelf and upper slope. 190–410 m.

***Schroederichthys saurisqualus* (Soto, 2001).** Lizard catshark.
Southwest Atlantic: southwestern Brazil. Outer shelf (sporadic) and deep reefs on the upper slope. 122-500 m.

***Schroederichthys tenuis* (Springer, 1966).** Slender catshark.
Restricted range in the Western Atlantic off Suriname and northern Brazil. Shelf and upper slope. 72-450 m.

***Scyliorhinus boa* (Goode and Bean, 1896).** Boa catshark.
Western Central Atlantic: Caribbean and northern South America. Upper slope. 229–676 m.

***Scyliorhinus capensis* (Smith, in Müller and Henle, 1838).** Yellowspotted catshark.
Southeast Atlantic and Western Indian: southern Africa. Shelf and upper slope. 26–695 m (mostly 200-400 m).

***Scyliorhinus cervigoni* (Maurin and Bonnet, 1970).** West African catshark.
Eastern Atlantic off West Africa. Shelf and upper slope. 45–500 m.

***Scyliorhinus comoroensis* (Compagno, 1989).** Comoro catshark.
Western Indian: Comoro Islands. Upper slope. 200–400 m.

***Scyliorhinus haeckelii* (Ribeiro, 1907).** Freckled catshark.
Western Atlantic: off South America. Deep reefs on the shelf and upper slope. 37–439 m (mostly >250 m).

***Scyliorhinus hesperius* (Springer, 1966).** Whitesaddled catshark.
Western Central Atlantic: Central America and Colombia. Upper slope. 274–457 m.

***Scyliorhinus meadi* (Springer, 1966).** Blotched catshark.
Western Central Atlantic: United States, Gulf of Mexico, Cuba and Bahamas. Upper slope. 329–548 m.

***Scyliorhinus retifer* (Garman, 1881).** Chain catshark.
Northwest and Western Central Atlantic: United States, Gulf of Mexico and Caribbean. Shelf and upper to mid slope. 75–754 m

***Scyliorhinus torrei* (Howell-Rivero, 1936).** Dwarf catshark.
Western Central Atlantic: Florida (United States), Bahamas, Cuba and the Lesser Antilles. Upper slope. 229–550 m (most >366 m).

Family Proscylliidae. Finback Catsharks.

***Eridacnis barbouri* (Bigelow and Schroeder, 1944).** Cuban ribbontail catshark.
Western Central Atlantic: Florida Straits and Cuba. Upper slope. 430–613 m.

***Eridacnis radcliffei* (Smith, 1913).** Pygmy ribbontail catshark.
Wide-ranging but patchy in the Indo-West Pacific. Shelf, upper to mid slope. 71–766 m.

***Eridacnis sinuans* (Smith, 1957).** African ribbontail catshark.
Western Indian off East Africa. Outermost shelf and upper slope. 180–480 m.

Family Pseudotriakidae. False Catsharks.

***Gollum attenuatus* (Garrick, 1954).** Slender smoothhound.
Southwest Pacific: New Zealand. Outer shelf, upper slope and seamounts. 129–724 m (most common 300–600 m).

***Pseudotriakis microdon* (Capello, 1868).** False catshark.
Wide-ranging but patchy in the Atlantic, Indo-West and Central Pacific. Shelf (occasional) and upper to deep slope. 200–1 900 m.

Family Triakidae. Houndsharks.

***Hemitriakis abdita* (Compagno and Stevens, 1993).** Darksnout or deepwater sicklefin houndshark.
Western Central Pacific: northeastern Australia. Upper slope. 225–400 m.

***Iago garricki* (Fourmanoir, 1979).** Longnose houndshark.
Patchy in the Eastern Indian and Western Central Pacific. Upper slope. 250–475 m.

***Iago omanensis* (Norman, 1939).** Bigeye houndshark.
Northern Indian including the Red Sea; possibly in the Bay of Bengal (although this may represent a distinct species). Shelf and upper to mid (possibly to deep) slope. <110–1 000+ m (possibly to 2 195 m in Red Sea).

***Mustelus canis insularis* (Mitchell, 1815).** Dusky smoothhound (island subspecies).
Western Central Atlantic: Caribbean and northern South America. Outer shelf and upper to mid slope. 137–808 m (mostly >200 m). Shelf subspecies (*M. c. canis*) prefers shallow waters (generally <18 m).

***Mustelus stevensi* (White and Last, 2008).** Western spotted gummy shark.
Eastern Indian: northwestern Australia. Outer shelf and upper slope. 121–735 m.
***Mustelus walkeri* (White and Last, 2008).** Eastern spotted gummy shark.
Western Central Pacific: northeastern Australia. Shelf and upper slope. 52–403 m.

Family Carcharhinidae. Requiem Sharks.

***Carcharhinus altimus* (Springer, 1950).** Bignose shark.
Wide-ranging but patchy in tropical and warm-temperate waters of the Atlantic and Indo-Pacific. Shelf and upper slope. 25–430 m (mostly >90 m, young shallower, to 25 m).

APPENDIX 2

Deep-sea chondrichthyan species for FAO Major Fishing Areas[9]

Sharks

Family	Species	FAO Major Fishing Areas
Order Hexanchiformes		
Chlamydoselachidae	*Chlamydoselachus africana*	47, 51
	Chlamydoselachus anguineus	27, 31, 34, 57, 61, 77, 81, 87
Hexanchidae	*Heptranchias perlo*	21, 27, 31, 34, 37, 41, 47, 51, 57, 61, 71, 81, 87
	Hexanchus griseus	21, 27, 31, 34, 37, 41, 47, 51, 57, 61, 67, 71, 77, 81, 87
	Hexanchus nakamurai	27, 31, 34? , 37, 51, 57, 61, 71, 81
Order Squaliformes		
Echinorhinidae	*Echinorhinus brucus*	21, 27, 31, 34, 37, 41, 47, 51, 57, 61, 71, 81
	Echinorhinus cookei	57, 61, 71, 77, 81, 87
Squalidae	*Cirrhigaleus asper*	31, 41, 47, 51, 57?, 77
	Cirrhigaleus australis	57, 81
	Cirrhigaleus barbifer	61, 71
	Squalus albifrons	71, 81
	Squalus altipinnis	57
	Squalus blainville	27, 34, 37, 47, 51, 61?
	Squalus brevirostris	61
	Squalus bucephalus	71, 81
	Squalus chloroculus	57, 81
	Squalus crassispinus	57
	Squalus cubensis	31, 41
	Squalus edmundsi	57
	Squalus grahami	71, 81
	Squalus griffini	81
	Squalus hemipinnis	57
	Squalus japonicus	61, 71
	Squalus lalannei	51
	Squalus megalops	27, 34, 37, 47, 51, 57, 61, 71, 81
	Squalus melanurus	71
	Squalus mitsukurii	31, 34?, 41, 47?, 51, 61, 71, 77, 87
	Squalus montalbani	57, 71, 81
	Squalus nasutus	57, 71
	Squalus notocaudatus	71
	Squalus rancureli	71
	Squalus raoulensis	81
Centrophoridae	*Centrophorus acus*	57, 61, 71
	Centrophorus atromarginatus	51, 57, 61, 71
	Centrophorus granulosus	27, 31?, 34, 37, 41?, 47, 51, 61, 71
	Centrophorus harrissoni	57, 71, 81
	Centrophorus isodon	51, 57, 61, 71
	Centrophorus lusitanicus	27, 34, 51, 61
	Centrophorus niaukang	57, 61, 71

[9] Area 18: Arctic Sea; Area 21: Atlantic, Northwest; Area 27: Atlantic, Northeast, Area 31: Atlantic, Western Central; Area 34: Atlantic, Eastern Central; Area 37: Mediterranean and Black Sea; Area 41: Atlantic, Southwest; Area 47: Atlantic, Southeast; Area 48: Atlantic, Antarctic; Area 51, Indian Ocean, Western; Area 57: Indian Ocean, Eastern; Area 58: Indian Ocean, Antarctic and Southern; Area 61: Pacific, Northwest; Area 67: Pacific, Northeast; Area 71: Pacific, Western Central; Area 77: Pacific, Eastern Central; Area 81: Pacific, Southwest; Area 87: Pacific, Southeast; Area 88: Pacific, Antarctic.

Family	Species	FAO Major Fishing Areas
Centrophoridae	*Centrophorus seychellorum*	51
	Centrophorus squamosus	27, 34, 47, 51, 57, 61, 71, 81
Order Squaliformes		
Centrophoridae	*Centrophorus moluccensis*	51, 57, 61, 71, 81
	Centrophorus tessellatus	31, 61, 77
	Centrophorus westraliensis	57
	Centrophorus zeehaani	57, 81
	Deania calcea	27, 34, 47, 51, 57, 61, 81, 87
	Deania hystricosum	34?, 47, 61, 81
	Deania profundorum	31, 34, 47, 51, 71
	Deania quadrispinosum	47, 51, 57, 61?, 71, 81
Etmopteridae	*Aculeola nigra*	87
	Centroscyllium excelsum	61
	Centroscyllium fabricii	21, 27, 31, 34, 47
	Centroscyllium granulatum	87
	Centroscyllium kamoharai	57, 61, 71?, 81
	Centroscyllium nigrum	77, 87
	Centroscyllium ornatum	51, 57
	Centroscyllium ritteri	61
	Etmopterus baxteri	34?, 47, 51, 57, 81
	Etmopterus bigelowi	31, 34, 41, 47, 51, 57, 61, 71, 81, 87
	Etmopterus brachyurus	57, 61, 71
	Etmopterus bullisi	31
	Etmopterus burgessi	61
	Etmopterus carteri	31
	Etmopterus caudistigmus	71
	Etmopterus decacuspidatus	61
	Etmopterus dianthus	71
	Etmopterus dislineatus	71
	Etmopterus evansi	57, 71
	Etmopterus fusus	57
	Etmopterus gracilispinis	21, 31, 41, 47, 51
	Etmopterus granulosus	41, 87
	Etmopterus hillianus	21, 31
	Etmopterus litvinovi	87
	Etmopterus lucifer	41?, 47?, 51?, 57, 61, 71, 81
	Etmopterus molleri	51?, 61, 81
	Etmopterus perryi	31
	Etmopterus polli	31?, 34, 47
	Etmopterus princeps	21, 27, 34
	Etmopterus pseudosqualiolus	71
	Etmopterus pusillus	27, 31, 34, 41, 47, 51, 57, 61, 77, 81
	Etmopterus pycnolepis	87
	Etmopterus robinsi	31
	Etmopterus schultzi	31
	Etmopterus sentosus	51
	Etmopterus spinax	27, 34, 37, 47
	Etmopterus splendidus	61
	Etmopterus unicolor	47, 51, 57, 61, 81
	Etmopterus villosus	77
	Etmopterus virens	31
	Miroscyllium sheikoi	61
	Trigonognathus kabeyai	61, 77
Somniosidae	*Centroscymnus coelolepis*	21, 27, 31, 34, 37, 41, 47, 51, 57, 61, 71, 81

Family	Species	FAO Major Fishing Areas
	Centroscymnus owstoni	27, 31, 34, 41, 47, 57, 61, 81, 87
	Centroselachus crepidater	27, 34, 47, 51, 57, 61, 71, 81, 87
	Proscymnodon macracanthus	87
	Proscymnodon plunketi	51, 57, 81
	Scymnodalatias albicauda	47, 57, 58, 81
	Scymnodalatias garricki	27
	Scymnodalatias sherwoodi	81
	Scymnodon ringens	27, 34, 81?
	Somniosus antarcticus	41, 47, 57, 58, 81, 87
	Somniosus longus	61, 81
	Somniosus microcephalus	21, 27
	Somniosus pacificus	18, 61, 67, 77
	Somniosus rostratus	27, 31?, 34, 37
	Zameus ichiharai	61
	Zameus squamulosus	27, 31, 34, 41, 51, 57, 61, 71, 77, 81
Oxynotidae	*Oxynotus bruniensis*	57, 81
	Oxynotus caribbaeus	31
	Oxynotus centrina	27, 34, 37, 47
	Oxynotus japonicus	61
	Oxynotus paradoxus	27, 34
Dalatiidae	*Dalatias licha*	21, 27, 31, 34, 37, 47, 51, 57, 61, 71, 77
	Euprotomicroides zantedeschia	41, 47
	Euprotomicrus bispinatus	41, 47, 51, 57, 61, 71, 77, 81, 87
	Heteroscymnoides marleyi	47, 51, 87
	Isistius brasiliensis	31, 34, 41, 47, 51, 57, 61, 67?, 71, 77, 81, 87
	Isistius labialis	61
	Mollisquama parini	87
	Squaliolus aliae	57, 61, 71, 81
	Squaliolus laticaudus	27, 31, 34, 41, 51, 61, 71
Order Squatiniformes		
Squatinidae	*Squatina aculeata*	27, 34, 47
	Squatina africana	51
	Squatina albipunctata	57, 71, 81
	Squatina argentina	41
	Squatina formosa	61, 71
	Squatina pseudocellata	57
	Squatina tergocellata	57
Order Pristiophoriformes		
Pristiophoridae	*Pliotrema warreni*	47, 51
	Pristiophorus delicatus	71
	Pristiophorus schroederi	31
Order Heterodontiformes		
Heterodontidae	*Heterodontus ramalheira*	51
Order Orectolobiformes		
Parascylliidae	*Cirrhoscyllium japonicum*	61
	Parascyllium sparsimaculatum	57
Order Lamniformes		
Odontaspididae	*Odontaspis ferox*	21, 27, 31, 34, 37, 51, 57, 61, 77, 81
	Odontaspis noronhai	31, 34, 41, 71, 77
Pseudocarchariidae	*Pseudocarcharias kamoharai*	31, 34, 41, 47, 51, 57, 61, 71, 77, 81, 87
Mitsukurinidae	*Mitsukurina owstoni*	27, 31, 34, 47, 51, 57, 61, 77, 81
Alopiidae	*Alopias superciliosus*	21, 27, 31, 34, 37, 41, 47, 51, 57, 61, 71, 77, 81, 87
Cetorhinidae	*Cetorhinus maximus*	21, 27, 31, 34, 37, 41, 47, 57, 61, 67, 77, 81, 87

Family	Species	FAO Major Fishing Areas
Order Carcharhiniformes		
Scyliorhinidae	*Apristurus albisoma*	71
	Apristurus ampliceps	57, 81
	Apristurus aphyodes	27
	Apristurus australis	57, 71, 81
	Apristurus brunneus	67, 77, 87?
	Apristurus bucephalus	57
	Apristurus canutus	31
Order Carcharhiniformes		
Scyliorhinidae	*Apristurus exsanguis*	81
	Apristurus fedorovi	61
Scyliorhinidae	*Apristurus gibbosus*	61
	Apristurus herklotsi	61, 71
	Apristurus indicus	51
	Apristurus internatus	61
	Apristurus investigatoris	57
	Apristurus japonicus	61
	Apristurus kampae	77, 87?
	Apristurus laurussoni	21, 27, 31, 34
	Apristurus longicephalus	51, 57, 61, 71
	Apristurus macrorhynchus	61
	Apristurus macrostomus	61
	Apristurus manis	21, 27, 47
	Apristurus melanoasper	21, 27, 57, 71, 81
	Apristurus microps	21, 27, 47
	Apristurus micropterygeus	61
	Apristurus nasutus	77, 87
	Apristurus parvipinnis	31
	Apristurus pinguis	57, 61, 81
	Apristurus platyrhynchus	57, 61, 71, 81
	Apristurus profundorum	21, 34?
	Apristurus riveri	31
	Apristurus saldanha	47
	Apristurus sibogae	71
	Apristurus sinensis	57, 61, 71, 81
	Apristurus spongiceps	71, 77
	Apristurus stenseni	77
	Asymbolus galacticus	71
	Asymbolus pallidus	71
	Bythaelurus? alcocki	51
	Bythaelurus canescens	87
	Bythaelurus clevai	51
	Bythaelurus dawsoni	81
	Bythaelurus hispidus	57
	Bythaelurus immaculatus	61
	Bythaelurus incanus	57
	Bythaelurus lutarius	51
	Cephaloscyllium albipinnum	57, 81
	Cephaloscyllium cooki	57
	Cephaloscyllium fasciatum	61, 71
	Cephaloscyllium hiscosellum	57
	Cephaloscyllium isabellum	81
Scyliorhinidae	*Cephaloscyllium signourum*	71
	Cephaloscyllium silasi	51

Family	Species	FAO Major Fishing Areas
	Cephaloscyllium speccum	57
	Cephaloscyllium sufflans	51
	Cephaloscyllium variegatum	71, 81
	Cephaloscyllium zebrum	71
	Cephalurus cephalus	77
	Figaro boardmani	57, 71, 81
	Figaro striatus	71
	Galeus antillensis	31
	Galeus arae	21, 31
Order Carcharhiniformes		
Scyliorhinidae	*Galeus atlanticus*	27, 37
	Galeus cadenati	31
	Galeus eastmani	61
	Galeus gracilis	57, 71
	Galeus longirostris	61
	Galeus melastomus	27, 34, 37
	Galeus mincaronei	41
	Galeus murinus	27
	Galeus nipponensis	61
	Galeus piperatus	77
	Galeus polli	34, 47
	Galeus priapus	71
	Galeus schultzi	71
	Galeus springeri	31
	Holohalaelurus favus	51
	Holohalaelurus grennian	51
	Holohalaelurus melanostigma	51
	Holohalaelurus punctatus	47, 51
	Holohalaelurus regani	47, 51
	Parmaturus albimarginatus	71
	Parmaturus albipenis	71
	Parmaturus bigus	71
	Parmaturus campechiensis	31
	Parmaturus lanatus	57
	Parmaturus macmillani	51, 81
	Parmaturus melanobranchius	61, 71
	Parmaturus pilosus	61
	Parmaturus xaniurus	77
	Pentanchus profundicolus	71
	Schroederichthys maculatus	31
	Schroederichthys saurisqualus	41
	Schroederichthys tenuis	31, 41
	Scyliorhinus boa	31
	Scyliorhinus capensis	47, 51
	Scyliorhinus cervigoni	34, 47
	Scyliorhinus comoroensis	51
	Scyliorhinus haeckelii	31, 41
	Scyliorhinus hesperius	31
	Scyliorhinus meadi	31
	Scyliorhinus retifer	21, 31
	Scyliorhinus torrei	31
Proscylliidae	*Eridacnis barbouri*	31
	Eridacnis radcliffei	51, 57, 61, 71
	Eridacnis sinuans	51

Family	Species	FAO Major Fishing Areas
Pseudotriakidae	*Gollum attenuatus*	81
	Pseudotriakis microdon	21, 27, 34, 51, 57, 61, 71, 77, 81
Triakidae	*Hemitriakis abdita*	71
	Iago garricki	57, 71
	Iago omanensis	51, 57?
	Mustelus canis insularis	31
	Mustelus stevensi	57
	Mustelus walkeri	71
Carcharhinidae	*Carcharhinus altimus*	31, 34, 37, 41, 51, 57, 61, 71, 77, 81, 87

Batoids – Order Rajiformes

Family	Species	FAO Major Fishing Areas
Rhinobatidae	*Rhinobatos variegatus*	57
Narcinidae	*Benthobatis kreffti*	41
	Benthobatis marcida	31
	Benthobatis moresbyi	51
	Benthobatis yangi	61, 71
	Narcine lasti	57, 71
	Narcine nelsoni	71
	Narcine tasmaniensis	57, 81
	Heteronarce garmani	51
	Heteronarce mollis	51
	Typhlonarke aysoni	81
	Typhlonarke tarakea	81
Torpedinidae	*Torpedo fairchildi*	81
	Torpedo fuscomaculata	51
	Torpedo macneilli	57, 71, 81
	Torpedo microdiscus	87
	Torpedo nobiliana	21, 27, 31, 37, 41, 47
	Torpedo puelcha	41
	Torpedo tokionis	57, 61, 71, 81
	Torpedo tremens	77, 87
Arhynchobatidae	*Arhynchobatis asperrimus*	81
	Bathyraja abyssicola	61, 67, 77
	Bathyraja aguja	87
	Bathyraja albomaculata	41, 87
	Bathyraja aleutica	61, 67, 77
	Bathyraja andriashevi	61
	Bathyraja bergi	61
	Bathyraja brachyurops	41, 87
	Bathyraja caeluronigricans	61
	Bathyraja cousseauae	41
	Bathyraja diplotaenia	61
	Bathyraja eatonii	48, 58, 88
	Bathyraja fedorovi	61
	Bathyraja griseocauda	41, 87
	Bathyraja hesperafricana	34
	Bathyraja interrupta	61, 67, 77
	Bathyraja irrasa	58
	Bathyraja isotrachys	61
	Bathyraja kincaidii	67, 77
	Bathyraja lindbergi	61
	Bathyraja longicauda	87
	Bathyraja maccaini	48, 87
	Bathyraja macloviana	41, 87
	Bathyraja maculata	61, 67
	Bathyraja magellanica	41, 87
	Bathyraja matsubarai	61, 67?
	Bathyraja meridionalis	41, 48
	Bathyraja minispinosa	61, 67
	Bathyraja multispinis	41, 87
	Bathyraja murrayi	48?, 58, 88?
	Bathyraja notoroensis	61
Arhynchobatidae	*Bathyraja papilionifera*	41

Family	Species	FAO Major Fishing Areas
	Bathyraja parmifera	61, 67
	Bathyraja peruana	87
	Bathyraja richardsoni	21?, 27?, 57, 81
	Bathyraja scaphiops	41
	Bathyraja schroederi	41, 87
	Bathyraja shuntovi	81
	Bathyraja smirnovi	61
	Bathyraja smithii	47
	Bathyraja spinicauda	21, 27
	Bathyraja spinosissima	61?, 77, 87
	Bathyraja trachouros	61
	Bathyraja trachura	61, 67, 77
	Bathyraja tzinovskii	61
	Bathyraja violacea	61, 67
	Brochiraja aenigma	81
	Brochiraja albilabiata	81
	Brochiraja asperula	81
	Brochiraja leviveneta	81
	Brochiraja microspinifera	81
	Brochiraja spinifera	81
	Insentiraja laxipella	71
	Insentiraja subtilispinosa	57, 71
	Notoraja azurea	57, 81
	Notoraja hirticauda	57
	Notoraja lira	57
	Notoraja ochroderma	71
	Notoraja sapphira	71, 81
	Notoraja sticta	57
	Notoraja tobitukai	61
	Pavoraja alleni	57
	Pavoraja arenaria	57
	Pavoraja mosaica	71
	Pavoraja nitida	57, 81
	Pavoraja pseudonitida	71
	Pavoraja umbrosa	71, 81
	Psammobatis scobina	87
	Pseudoraja fischeri	31
	Rhinoraja kujiensis	61
	Rhinoraja longi	67
	Rhinoraja longicauda	61
	Rhinoraja obtusa	61
	Rhinoraja odai	61
	Rhinoraja taranetzi	61, 67
Rajidae	*Amblyraja badia*	61, 67, 77
	Amblyraja doellojuradoi	41, 87
	Amblyraja frerichsi	41, 87
	Amblyraja georgiana	41, 48, 58, 87, 88
	Amblyraja hyperborea	21, 27, 47, 57, 61, 67, 77, 81
	Amblyraja jenseni	21, 27
	Amblyraja radiata	21, 27, 47
	Amblyraja reversa	51
	Amblyraja robertsi	47
Rajidae	*Amblyraja taaf*	58
	Breviraja claramaculata	31

Family	Species	FAO Major Fishing Areas
	Breviraja colesi	31
	Breviraja marklei	21
	Breviraja mouldi	31
	Breviraja nigriventralis	31
	Breviraja spinosa	31
	Dactylobatus armatus	31
	Dactylobatus clarki	31
	Dipturus acrobelus	57, 81
	Dipturus apricus	71
	Dipturus batis	27, 34, 37
	Dipturus bullisi	31
	Dipturus campbelli	51
	Dipturus canutus	57, 81
	Dipturus cerva	57, 81
	Dipturus crosnieri	51
	Dipturus doutrei	34, 47
	Dipturus endeavouri	71, 81
	Dipturus garricki	31
	Dipturus gigas	61, 71
	Dipturus grahami	71, 81
	Dipturus gudgeri	57, 81
	Dipturus healdi	57
	Dipturus innominatus	81
	Dipturus johannisdavesi	51
	Dipturus laevis	21
	Dipturus lanceorostratus	51
	Dipturus leptocaudus	41
	Dipturus linteus	21, 27
	Dipturus macrocaudus	61
	Dipturus melanospilus	71, 81
	Dipturus mennii	41
	Dipturus nidarosiensis	27
	Dipturus oculus	57
	Dipturus oregoni	31
	Dipturus oxyrhynchus	27, 34, 37
	Dipturus polyommata	71
	Dipturus pullopunctata	47
	Dipturus queenslandicus	71
	Dipturus springeri	47, 51
	Dipturus stenorhynchus	47, 51
	Dipturus teevani	31
	Dipturus tengu	61, 71
	Dipturus trachydermus	41, 87
	Dipturus wengi	57, 71, 81
	Fenestraja atripinna	31
	Fenestraja cubensis	31
	Fenestraja ishiyamai	31
	Fenestraja maceachrani	51
	Fenestraja mamillidens	57
	Fenestraja plutonia	31
	Fenestraja sibogae	71
Rajidae	*Fenestraja sinusmexicanus*	31
	Gurgesiella atlantica	31, 41
	Gurgesiella dorsalifera	31, 41

Family	Species	FAO Major Fishing Areas
	Gurgesiella furvescens	87
	Leucoraja compagnoi	47, 51
	Leucoraja fullonica	27, 34, 37
	Leucoraja garmani	21, 31
	Leucoraja lentiginosa	31
	Leucoraja leucosticta	34, 47
	Leucoraja melitensis	37
	Leucoraja naevus	27, 34, 37
	Leucoraja pristispina	57
	Leucoraja wallacei	47, 51
	Leucoraja yucatanensis	31
	Malacoraja kreffti	27
	Malacoraja obscura	41
	Malacoraja senta	21, 31
	Malacoraja spinacidermis	27, 34, 47
	Neoraja africana	34
	Neoraja caerulea	27
	Neoraja carolinensis	31
	Neoraja iberica	27
	Neoraja stehmanni	47
	Okamejei arafurensis	57, 71
	Okamejei heemstrai	51
	Okamejei leptoura	57
	Raja africana?	34, 37
	Raja bahamensis	31
	Raja binoculata	61, 67, 77
	Raja inornata	77
	Raja maderensis	34
	Raja polystigma	37
	Raja rhina	67, 77
	Raja stellulata	77
	Raja straeleni	34, 47
	Rajella annandalei	71
	Rajella barnardi	34, 47
	Rajella bathyphila	21, 27, 34
	Rajella bigelowi	21, 27, 31, 34
	Rajella caudaspinosa	47, 51
	Rajella challengeri	57, 81
	Rajella dissimilis	27, 34, 47
	Rajella eisenhardti	87
	Rajella fuliginea	31
	Rajella fyllae	21, 27
	Rajella kukujevi	27
	Rajella leopardus	34, 47, 51?
	Rajella nigerrima	87
	Rajella purpuriventralis	31
	Rajella ravidula	34, 47
	Rajella sadowskyii	41, 87
	Rostroraja alba	27, 34, 37, 47, 51
	Zearaja chilensis	41, 87
Rajidae	*Zearaja nasutus*	81
Anacanthobatidae	*Anacanthobatis americanus*	31, 41
	Anacanthobatis donghaiensis	61
	Anacanthobatis folirostris	31

Family	Species	FAO Major Fishing Areas
	Anacanthobatis longirostris	31
	Anacanthobatis marmoratus	51
	Anacanthobatis nanhaiensis	
	Anacanthobatis ori	51
	Anacanthobatis stenosoma	
	Cruriraja andamanica	51, 57
	Cruriraja atlantis	31
	Cruriraja cadenati	31
	Cruriraja durbanensis	47
	Cruriraja parcomaculata	47, 51
Anacanthobatidae	*Cruriraja poeyi*	31
	Cruriraja rugosa	31
	Cruriraja triangularis	51
	Sinobatis borneensis	61, 71
	Sinobatis bulbicauda	57, 71
	Sinobatis caerulea	57
	Sinobatis filicauda	71
	Sinobatis melanosoma	61, 71
Plesiobatidae	*Plesiobatis daviesi*	51, 57, 61, 71, 77, 81
Urolophidae	*Urolophus expansus*	57
	Urolophus piperatus	71
Hexatrygonidae	*Hexatrygon bickelli*	47, 51, 57, 61, 71, 77
Dasyatidae	*Dasyatis brevicaudata*	47,51, 57, 71, 81

Chimaeras – Order Chimaeriformes

Family	Species	FAO Major Fishing Areas
Rhinochimaeridae	*Harriotta haeckeli*	21?, 27, 34, 57, 81
	Harriotta raleighana	21, 27, 34, 41, 47, 51, 57, 61, 71, 77, 81
	Neoharriotta carri	31
	Neoharriotta pinnata	34, 47
	Neoharriotta pumila	51
	Rhinochimaera africana	47, 51, 57, 61
	Rhinochimaera atlantica	21, 27, 31, 34, 41, 47
	Rhinochimaera pacifica	57, 61, 71, 81, 87
Chimaeridae	*Chimaera argiloba*	57
	Chimaera cubana	31
	Chimaera fulva	57, 81
	Chimaera jordani	51, 61
	Chimaera lignaria	57, 81
	Chimaera macrospina	57, 71, 81
	Chimaera monstrosa	27, 34, 37
	Chimaera obscura	71, 81
	Chimaera owstoni	61
	Chimaera panthera	81
	Chimaera phantasma	61
	Hydrolagus affinis	21, 27, 34
	Hydrolagus africanus	47?, 51
	Hydrolagus alberti	31
	Hydrolagus alphus	87
	Hydrolagus barbouri	61
	Hydrolagus bemisi	81
	Hydrolagus colliei	67, 77
	Hydrolagus homonycteris	57, 81
	Hydrolagus lemures	57, 71, 81
	Hydrolagus lusitanicus	27
	Hydrolagus macrophthalmus	87
	Hydrolagus marmoratus	71, 81
	Hydrolagus matallanasi	41
	Hydrolagus mccoskeri	87
	Hydrolagus melanophasma	77
	Hydrolagus mirabilis	27, 31, 34, 47
	Hydrolagus mitsukurii	61, 71
	Hydrolagus novaezealandiae	81
	Hydrolagus ogilbyi	57, 81
	Hydrolagus pallidus	27
	Hydrolagus purpurescens	61, 77
	Hydrolagus trolli	47, 48, 58?, 71, 81, 88?

APPENDIX 3

Deep-sea chondrichthyan species known to be targeted by fisheries and deep-sea chondrichthyan species known to be taken as bycatch in fisheries

Deep-sea chondrichthyan species known to be targeted by fisheries

Order	Family	Species
Sharks		
Squaliformes	Squalidae	*Squalus cubensis*
		Squalus mitsukurii
	Centrophoridae	*Centrophorus atromarginatus*
		Centrophorus granulosus
		Centrophorus harrissoni
		Centrophorus isodon
		Centrophorus moluccensis
		Centrophorus squamosus
		Centrophorus zeehaani
		Deania calcea
	Etmopteridae	*Etmopterus spinax*
		Etmopterus virens
	Somniosidae	*Centroscymnus coelolepis*
		Centroselachus crepidater
	Dalatiidae	*Dalatias licha*
Lamniformes	Cetorhinidae	*Cetorhinus maximus*
Carcharhiniformes	Scyliorhinidae	*Galeus melastomus*
Batoids		
Rajiformes	Arhynchobatidae	*Bathyraja albomaculata*
		Bathyraja brachyurops
		Bathyraja cousseauae
		Bathyraja griseocauda
		Bathyraja macloviana
		Bathyraja magellanica
		Bathyraja meridionalis
		Bathyraja multispinis
		Bathyraja scaphiops
		Psammobatis scobina
	Rajidae	*Amblyraja doellojuradoi*
		Amblyraja radiata
		Dipturus trachydermus
		Raja binoculata
		Raja inornata
		Raja rhina
		Zearaja chilensis
Chimaeras		
Chimaeriformes	Chimaeridae	*Chimaera monstrosa*
		Hydrolagus bemisi
		Hydrolagus novaezealandiae

Deep-sea chondrichthyan species known to be taken as bycatch in fisheries

Order	Family	Species
Sharks		
Hexanchiformes	Chlamydoselachidae	*Chlamydoselachus anguineus*
	Hexanchidae	*Heptranchias perlo*
		Hexanchus griseus
		Hexanchus nakamurai
Squaliformes	Echinorhinidae	*Echinorhinus brucus*
	Squalidae	*Cirrhigaleus asper*
		Cirrhigaleus barbifer
		Squalus blainville
		Squalus chloroculus
		Squalus cubensis
		Squalus edmundsi
		Squalus grahami
		Squalus griffini
		Squalus hemipinnis
		Squalus japonicus
		Squalus lalannei
		Squalus megalops
		Squalus mitsukurii
		Squalus montalbani
		Squalus raoulensis
	Centrophoridae	*Centrophorus acus*
		Centrophorus atromarginatus
		Centrophorus granulosus
		Centrophorus harrissoni
		Centrophorus isodon
		Centrophorus lusitanicus
		Centrophorus moluccensis
		Centrophorus niaukang
		Centrophorus seychellorum
		Centrophorus squamosus
		Centrophorus tessellatus
		Centrophorus zeehaani
		Deania calcea
		Deania hystricosum
		Deania profundorum
		Deania quadrispinosum
	Etmopteridae	*Centroscyllium excelsum*
		Centroscyllium fabricii
		Centroscyllium granulatum
		Centroscyllium kamoharai
		Centroscyllium nigrum
		Centroscyllium ornatum
		Centroscyllium ritteri
		Etmopterus baxteri
		Etmopterus bigelowi
		Etmopterus brachyurus
		Etmopterus bullisi

Order	Family	Species
		Etmopterus carteri
		Etmopterus caudistigmus
		Etmopterus decacuspidatus
		Etmopterus dianthus
	Etmopteridae	*Etmopterus dislineatus*
		Etmopterus evansi
		Etmopterus gracilispinis
		Etmopterus granulosus
		Etmopterus hillianus
		Etmopterus litvinovi
		Etmopterus lucifer
		Etmopterus molleri
		Etmopterus perryi
		Etmopterus princeps
		Etmopterus pusillus
		Etmopterus robinsi
		Etmopterus schultzi
		Etmopterus sentosus
		Etmopterus spinax
		Etmopterus splendidus
		Etmopterus unicolor
		Etmopterus villosus
		Etmopterus virens
		Miroscyllium sheikoi
		Trigonognathus kabeyai
	Somniosidae	*Centroscymnus coelolepis*
		Centroscymnus owstoni
		Centroselachus crepidater
		Proscymnodon macracanthus
		Proscymnodon plunketi
		Scymnodalatias albicauda
		Scymnodon ringens
		Somniosus antarcticus
		Somniosus longus
		Somniosus microcephalus
		Somniosus pacificus
		Somniosus rostratus
		Zameus ichiharai
		Zameus squamulosus
	Oxynotidae	*Oxynotus bruniensis*
		Oxynotus caribbaeus
		Oxynotus centrina
	Dalatiidae	*Dalatias licha*
		Isistius brasiliensis
		Isistius labialis
		Squaliolus aliae
		Squaliolus laticaudus
		Oxynotus japonicus
		Oxynotus paradoxus
	Squatinidae	*Squatina aculeata*
		Squatina africana

Order	Family	Species
		Squatina albipunctata
		Squatina tergocellata
Pristiophoriformes	Pristiophoridae	*Pristiophorus schroederi*
Lamniformes	Odontaspididae	*Odontaspis ferox*
	Pseudocarchariidae	*Pseudocarcharias kamoharai*
	Mitsukurinidae	*Mitsukurina owstoni*
	Alopiidae	*Alopias superciliosus*
Carcharhiniformes	Scyliorhinidae	*Apristurus canutus*
		Apristurus laurussoni
		Apristurus manis
		Apristurus microps
		Apristurus parvipinnis
		Apristurus platyrhynchus
		Apristurus profundorum
		Apristurus riveri
		Cephaloscyllium albipinnum
		Cephaloscyllium cooki
		Cephaloscyllium fasciatum
		Cephaloscyllium hiscosellum
		Galeus antillensis
		Galeus arae
		Galeus atlanticus
		Galeus eastmani
		Galeus gracilis
		Galeus longirostris
		Galeus melastomus
		Galeus mincaronei
		Galeus murinus
		Galeus nipponensis
		Galeus springeri
		Parmaturus melanobranchius
		Scyliorhinus boa
		Scyliorhinus comoroensis
		Scyliorhinus meadi
		Scyliorhinus retifer
		Scyliorhinus torrei
	Proscylliidae	*Eridacnis barbouri*
		Eridacnis radcliffei
		Eridacnis sinuans
	Pseudotriakidae	*Gollum attenuatus*
		Pseudotriakis microdon
	Triakidae	*Iago garricki*
		Iago omanensis
		Mustelus canis insularis
		Mustelus stevensi
		Mustelus walkeri
	Carcharhinidae	*Carcharhinus altimus*
Batoids		
Rajiformes	Rhinobatidae	*Rhinobatos variegatus*
	Narcinidae	*Benthobatis kreffti*
		Benthobatis marcida

Order	Family	Species
		Benthobatis yangi
		Narcine tasmaniensis
		Heteronarce garmani
		Heteronarce mollis
	Narkidae	*Typhlonarke aysoni*
		Typhlonarke tarakea
	Torpedinidae	*Torpedo fairchildi*
		Torpedo fuscomaculata
		Torpedo macneilli
		Torpedo nobiliana
		Torpedo puelcha
		Torpedo tokionis
		Torpedo tremens
	Arhynchobatidae	*Arhynchobatis asperrimus*
		Bathyraja albomaculata
		Bathyraja aleutica
		Bathyraja bergi
		Bathyraja brachyurops
		Bathyraja caeluronigricans
		Bathyraja cousseauae
		Bathyraja diplotaenia
		Bathyraja eatonii
		Bathyraja fedorovi
		Bathyraja griseocauda
		Bathyraja interrupta
		Bathyraja irrasa
		Bathyraja isotrachys
		Bathyraja kincaidii
		Bathyraja lindbergi
		Bathyraja maccaini
		Bathyraja macloviana
		Bathyraja maculata
		Bathyraja magellanica
		Bathyraja matsubarai
		Bathyraja meridionalis
		Bathyraja minispinosa
		Bathyraja murrayi
		Bathyraja multispinis
		Bathyraja notoroensis
		Bathyraja papilionifera
		Bathyraja parmifera
		Bathyraja peruana
		Bathyraja scaphiops
		Bathyraja shuntovi
		Bathyraja smirnovi
		Bathyraja smithii
		Bathyraja spinicauda
		Bathyraja trachouros
		Bathyraja trachura
		Bathyraja violacea
		Brochiraja albilabiata

Order	Family	Species
		Brochiraja asperula
		Brochiraja leviveneta
		Brochiraja microspinifera
		Brochiraja spinifera
		Notoraja hirticauda
		Pavoraja tobitukai
		Pavoraja alleni
		Pavoraja arenaria
		Pavoraja nitida
		Psammobatis scobina
		Psammobatis kujiensis
		Rhinoraja longi
		Rhinoraja longicauda
		Rhinoraja obtusa
		Rhinoraja odai
		Rhinoraja taranetzi
	Rajidae	*Amblyraja doellojuradoi*
		Amblyraja frerichsi
		Amblyraja georgiana
		Amblyraja hyperborea
		Amblyraja radiata
		Amblyraja taaf
		Breviraja marklei
		Breviraja nigriventralis
		Dipturus batis
		Dipturus campbelli
		Dipturus cerva
		Dipturus crosnieri
		Dipturus doutrei
		Dipturus gigas
		Dipturus gudgeri
		Dipturus innominatus
		Dipturus laevis
		Dipturus leptocaudus
		Dipturus linteus
		Dipturus macrocaudus
		Dipturus mennii
		Dipturus nidarosiensis
		Dipturus oxyrhynchus
		Dipturus pullopunctata
		Dipturus springeri
		Dipturus stenorhynchus
		Dipturus teevani
		Dipturus tengu
		Dipturus trachydermus
		Dipturus wengi
		Fenestraja maceachrani
		Gurgesiella atlantica
		Gurgesiella dorsalifera
		Leucoraja fullonica
		Leucoraja garmani

Order	Family	Species
		Leucoraja lentiginosa
		Leucoraja leucosticta
		Leucoraja melitensis
		Leucoraja naevus
		Leucoraja wallacei
		Malacoraja obscura
		Malacoraja senta
		Malacoraja spinacidermis
		Neoraja caerulea
		Neoraja iberica
		Okamejei arafurensis
		Okamejei leptoura
		Raja africana
		Raja binoculata
		Raja maderensis
		Raja polystigma
		Raja stellulata
		Raja straeleni
		Rajella bathyphila
		Rajella caudaspinosa
		Rajella challengeri
		Rajella dissimilis
		Rajella fyllae
		Raja inornata
		Raja kukujevi
		Raja rhina
		Rajella sadowskyii
		Rostroraja alba
		Zearaja chilensis
		Zearaja nasutus
	Anacanthobatidae	*Anacanthobatis americanus*
		Anacanthobatis donghaiensis
		Cruriraja durbanensis
		Cruriraja parcomaculata
		Cruriraja rugosa
		Sinobatis borneensis
		Sinobatis bulbicauda
		Sinobatis melanosoma
	Plesiobatidae	*Plesiobatis daviesi*
	Hexatrygonidae	*Hexatrygon bickelli*
	Dasyatidae	*Dasyatis brevicaudata*
Chimaeras		
Chimaeriformes	Rhinochimaeridae	*Harriotta raleighana*
		Neoharriotta pinnata
		Rhinochimaera africana
		Rhinochimaera atlantica
	Chimaeridae	*Chimaera cubana*
		Chimaera fulva
		Chimaera lignaria
		Chimaera macrospina
		Chimaera monstrosa

Order	Family	Species
		Chimaera phantasma
		Hydrolagus affinis
		Hydrolagus africanus
		Hydrolagus bemisi
		Hydrolagus colliei
		Hydrolagus homonycteris
		Hydrolagus lemures
		Hydrolagus lusitanicus
		Hydrolagus matallanasi
		Hydrolagus mitsukurii
		Hydrolagus novaezealandiae
		Hydrolagus ogilbyi
		Hydrolagus purpurescens
		Hydrolagus trolli

Global list of cold-water corals (order Scleractinia; sub-order Filifera; sub-class Octocorallia, order Antipatharia) from waters deeper than 200 m, vulnerable species, and draft recommendations for the production of identification guides

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Overview

Following the FAO terms of reference, four lists of the global distribution (in relation to the 19 FAO Major Fishing Areas) of all cold-water species of scleractinians, Filifera and all potential habitat-forming cold-water octocorallians and antipatharians known to occur in waters deeper than 200 m were compiled and briefly described. A relevant bibliography for each species group was assembled. Finally, draft recommendations for the production of identification guides are suggested.

1. List of relevant corals group

There are four orders belonging to two cnidarian classes that fit the term "coral"[1]: (i) class Anthozoa, subclass Hexacorallia – order Scleractinia order Zoanthidea, order Antipatharia; subclass Octocorallia and (ii) class Hydrozoa, subclass Hydroidolina – order Anthoathecata A compilation was made for global distribution (in relation to the 19 FAO Major Fishing Areas) of all cold-water species of scleractinians (797 spp., including undescribed species), filiferians (246 spp.), and all potential habitat-forming cold-water octocorallians (225 spp.) and antipatharians (33 spp.) known to occur in waters deeper than 200 m. Table 1 summarizes the 2 classes down to the family level. See Appendixes 1, 2, 3 and 4 for details on species and their deep-sea depth occurrence. The diversity (number of species) of each selected deep-sea corals group per FAO Major Fishing Area is shown in Table 2.

Table 1
Global species list for FAO Major Fishing Areas

Class	Subclass	Order	Suborder	Family
Anthozoa	Hexacorallia	Scleractinia (see Appendix 1)		• Anthemiphylliidae • Caryophylliidae • Dendrophylliidae • Flabellidae • Fungiacyathidae • Gardineriidae • Guyniidae • Micrabaciidae • Oculinidae • Pocilloporidae • Rhizangiidae • Stenocyathidae • Turbinoliidae
		Antipatharia (see Appendix 2)		• Antipathidae • Aphanipathidae • Cladopathidae • Stylopathidae • Myriopathidae • Schizopathidae • Leiopathidae
	Octocorallia	Gorgonacea (see Appendix 3)		• Chrysogorgiidae • Coralliidae • Isididae • Paragorgiidae • Plexauridae • Primnoidae
Hydrozoa	Hydroidolina	Anthoatherata	Filifera (see Appendix 4)	• Stylasteridae • Hydractiniiidae

[1] Definition from Cairn (2007): "animals in the cnidarian classes Anthozoa and Hydrozoa that produce either calcium carbonate (aragonitic or calcitic) secretions resulting in a continuous skeleton or as numerous microscopic, individualized sclerites, or that have a black, horn-like, proteinaceous axis".

Table 2
Diversity (number of species) of each selected deep-sea corals group per FAO Major Fishing Area[1]

FAO Major Fishing Areas	Poles			Atlantic						M&B*	Indian			Pacific					
	18	48	88	21	27	31	34	41	47	37	51	57	58	61	67	71	77	81	87
Scleractinia	n/a	8	18	10	69	135	78	73	22	35	122	183	9	136	11	383	94	163	62
Filifera	n/a	7	8	3	13	43	10	17	8	1	8	4	1	14	15	36	16	55	19
Octocorallia	n/a	4	5	15	12	33	8	9	2	5	3	7	1	49	20	41	43	20	4
Antipatharia	n/a	1	1	3	2	11	3	2	0	1	2	4	0	1	5	7	11	3	3

***** Mediterranean and Black Sea.
[1] Area 18: Arctic Sea; Area 21: Atlantic, Northwest; Area 27: Atlantic, Northeast, Area 31: Atlantic, Western Central; Area 34: Atlantic, Eastern Central; Area 37: Mediterranean and Black Sea; Area 41: Atlantic, Southwest; Area 47: Atlantic, Southeast; Area 48: Atlantic, Antarctic; Area 51, Indian Ocean, Western; Area 57: Indian Ocean, Eastern; Area 58: Indian Ocean, Antarctic and Southern; Area 61: Pacific, Northwest; Area 67: Pacific, Northeast; Area 71: Pacific, Western Central; Area 77: Pacific, Eastern Central; Area 81: Pacific, Southwest; Area 87: Pacific, Southeast; Area 88: Pacific, Antarctic.

Order Scleractinia

Within the approximately 790 species of azooxanthellate Scleractinia, 540 occur in waters deeper than 200 m; the deepest record being a delicate solitary species (*Fungiacyathus marenzelleri* [Vaughan, 1906]) collected from Pacific waters in the Aleutian Trench at 6 328 m (Keller, 1976). Although, most of the azooxanthellate scleractinians are reported from waters ranging in depth from 200 to 1 000 m (the prime depth for this group [Cairns, 2007]), which is the same depth of most cold-water coral reefs and mounds occur (Roberts *et al*., 2009).

The best-studied areas for deep-sea Scleractinia are found in the north Atlantic waters; the Caribbean and northeast Atlantic (especially Norwegian continental shelf). However, these well-studied regions do not show the scleractinian diversity compared to other less-studied regions. The regions of high diversity are usually found in the western margins of ocean basins or where the continental shelf is "passive" such as the western Indian and the northwestern Atlantic oceans having at least twice as more species compared to the eastern margin of the same oceans. Nevertheless, the northern Indian ocean is considered as one of the poorest known azooxanthellate coral fauna in the world, and its knowledge is based on early expeditionary reports (Alcock, 1893, 1898, 1902a, 1902b, 1902c; Marenzeller, 1907; Gardiner and Waugh, 1938, 1939).

As for polar and sub-polar regions, the scleractinian fauna is depauperate compared to temperate regions. The number of species recorded from tropical Pacific and tropical Atlantic waters is higher than in other regions (Keller, 1998; Cairns, 2007). FAO Major Fishing Area 71 (Pacific, Western Central) being the most diverse area for azooxanthellate Scleractinia.

In Table 3, each one of the 19 FAO Major Fishing Areas is briefly described, and information regarding taxonomic literature, fisheries impact, status on the knowledge, and probability to have additional azooxanthellate Scleractinia records are provided. See Appendix 1 for the extended list of species per FAO Major Fishing Area.

Table 3
Description of 19 FAO Major Fishing Areas and information on taxonomic literature (TL), fisheries impact, status on the knowledge, and probability to have additional records for azooxanthellate Scleractinia

Area	Description	Fisheries impact	Status on knowledge	Prob. of add. spp. records[1]
18	There is no record of deep-sea scleractinians from this area. It could be related to the depth of the aragonite saturation horizon, which is estimated to be very shallow or even reach surface. The north Pacific region (above 40ºN) has one of the shallowest aragonite saturation horizon recorded to date (Guinotte *et al*., 2006). TL: None	Unknown	Good	Very small
21	To date there are 10 species of azooxanthellate Scleractinia recorded from this region, 9 of them are solitary and 1 is colonial (*L. pertusa*). This part of the Atlantic includes both Canada and United States exclusives economics zones (EEZs), and has been extensively trawled in the past years (Gianni, 2004). TL: Cairns (1979, 1981, 2000).	High	Good	Small
27	One of the most extensively studied areas for cold-water corals, the northeastern Atlantic ocean (North of 36ºN) has 69 recorded species of azooxanthellate scleractinians. 10 of them occur only in waters shallower than 200 m. Within the remaining 59 species, 33 belong to the family Caryophylliidae, 9 to Dendrophylliidae, 6 to Flabellidae, 3 to Fungiacyathidae, 2 to Turbinoliidae, 2 to Pocilloporidae, and 1 representative of each: Guyniidae, Oculinidae, Schizocyathidae, and Stenocyathidae. Large concentrations of *L. pertusa*, which together with *S. variabilis* and *M. oculata* are the main deep-sea framework building species in the region. TL: Squires (1961), Zibrowius (1980, 1985), Fosså *et al.* (2002).	High	Excellent	Small
31	The central western Atlantic is one of the best known region for deep-sea azooxanthellate scleractinians, studied especially off Florida and Gulf of Mexico. More recently, additional records and new species have been reported from the Colombian Caribbean. Altogether, there are 135 species recorded in this region (30 restricted to waters shallower than 200 m). Within the remaining 105 species, 42 are known only for this region. TL: Pourtalès (1867, 1868, 1871, 1874, 1878, 1880), Cairns (1977, 1978a, 1978b, 1979, 2000), Humann & Deloach (2002), Santodomingo *et al*. (2007), Reyes *et al*. (2009).	High	Excellent	Small
34	78 species of azooxanthellate scleractinians belonging to all but Anthemiphylliidae, Gardineriidae, and Micrabaciidae are reported to the tropical realm of the eastern Atlantic Ocean. Fourteen of them are restricted to waters shallower than 200 m. The number of species to be reported is likely to increase with further expeditions. TL: Chevalier (1966a, 1966b), Zibrowius (1980, 1983), and Zibrowius and Gili (1990).	High?	Low	High

Area	Description	Fisheries impact	Status on knowledge	Prob. of add. spp. records[1]
37	Despite being extensively studied, the Mediterranean Sea has just 35 species of azooxanthellate scleractinian known to date of which 12 are restricted to shallow waters. Large deep-sea reefs formed mainly by *L. pertusa* and *M. oculata* have been recently described. TL: Zibrowius (1977, 1980, 1983).	High	High	Low/ Medium
41	Considered as a transitional region between the Caribbean and Antarctic azooxanthellate coral fauna, this area has 73 deep-sea scleractinian recorded to date (10 restricted to shallow waters). Amongst the 63 remaining species, large concentrations of *L. pertusa*, *M. oculata*, *S. variabilis* and *P. conferta* are recorded from southern and southeastern coast off Brazil (Pires *et al.*, 2004; Castro *et al.*, 2006; Kitahara, 2006; 2007; Pires, 2007; Kitahara *et al.*, 2008). However, there are at least 5 potentially rich locations for deep-sea Scleractinia that have been poorly or not studied to date: Rio Grande elevation, St. Peter and St. Paul Rocks, Fernando de Noronha Archipelago, and Trindade seamounts chain. Also, the northeastern and northern Brazilian coast never had extensive deep-sea coral sampling. TL: Pourtalès (1874), Tommasi (1970), Cairns (1979, 2000), Zibrowius (1988), and Kitahara (2006, 2007).	High[2]	Medium	High
47	Few species of azooxanthellate scleractinians have been reported to the southeastern (from 6ºS to 50ºS) Atlantic ocean. From the 22 known occurrences, 3 *Balanophyllia*, 1 *Paraconotrochus*, 1 *Sclerhelia*, and 1 *Phyllangia* are restricted to waters shallower than 200 m. It is expected that the number of species reported to this area will increase with upcoming collecting campaigns. TL: Gardiner (1904) and Zibrowius and Gili (1990).	Unknown	Low	High
48, 58, 88	Treated as one large region, the three areas (48, 58, and 88) are located within the Antarctic and sub-Antarctic waters. Despite the large collecting effort only 18, 9, and 8 species have been recorded so far for each of these FAO areas respectively. The only species that occurs in waters shallower than 200 m is the Flabellidae *Flabellum gardineri* (area 48). Other species that apparently are endemic to Antarctic and sub-Antarctic regions are: *Caryophyllia eltaninae* (Cairns, 1982), *C. mabahithi* (Gardiner and Waugh, 1938), *Flabellum curvatum* (Moseley, 1881), *F. flexuosum* (Cairns, 1982), *F. impensum* (Squires, 1962), *Leptopeneus antarcticus* (Cairns, 1989), and *Paraconotrochus antarcticus?* (Gardiner, 1929). According to Guinotte *et al.* (2006), Antarctic and sub-Antarctic regions have shallow aragonite saturation horizon, which delay the establishment of many species of azooxanthellate Scleractinia. TL: Squires (1962), Eguchi (1965), and Cairns (1982).	Low	High	Small
57	According to Cairns (2007) the Bay of Bengal is one of the poorest known coral fauna in the world. To date due to extensive collection effort made by Australian institutions around the western and southern Australian coast, this area counts 183 species of azooxanthellate scleractinian (nearly 30% reported only from waters shallower than 200 m). This area counts 5 of the 11 known "facultative" species, and is one of the most diverse regarding the family Turbinoliidae. TL: Alcock (1894, 1898, 1902c), Cairns and Parker (1992), Cairns and Zibrowius (1997), Cairns (1998, 2004), and Venkataraman (2007).	High[3]	Low	High

Area	Description	Fisheries impact	Status on knowledge	Prob. of add. spp. records[1]
61	This area has the fourth highest number of azooxanthellate scleractinian recorded to a single area (136 spp.). However, more than 30% of these species are reported only for waters shallower than 200 m. Within this region, the number of species decreases significantly towards the Arctic, 55ºN being the northernmost record. TL: Eguchi (1938, 1942, 1965a, 1965b, 1972, 1973, 1975,), Yabe and Eguchi (1942), Mori (1964), Song (1982), Cairns (1994), Ogawa (2006), Tachikawa (2005, 2008), Lam *et al.* (2008).	High	High	Low/ Medium
67	This area is depauperate due to the shallow aragonite saturation horizon depth, the northeastern Pacific ocean (form 40ºN to north) has only 11 species of azooxanthellate Scleractinia recorded to date, from which all but *L. pertusa* are solitary. TL: Cairns (1994)	High	High	Low
71	Considered as the most diverse area (hot-spot) for many deep-sea invertebrate groups, the central Indo-Pacific accumulate almost half of the known species of azooxanthellate scleractinians, with over 383 species being reported (including unpublished data from Kitahara and Cairns), of which 86 are restricted to shallow environments. One of the abiotic factors responsible for the presence of so many scleractinian species in this region is the underwater geomorphology which is one of the most complex in the world due to the large numbers of seamounts, ridges, and islands. Statistically, the azooxanthellates from this region, especially those from New Caledonia, have a strong affinity with the New Zealand ones, once these countries are underwater connected by a series of seamounts. Even with this high number of species recorded, species richness estimators (such Jacknife and Bootstrap) shows that this region is more diverse than known to date, and there is a large collection from New Caledonian waters (over 7 000 specimens) that have never been examined at the Muséum National d'Histoire Naturelle – Paris). Interestingly, this is one of the few regions in the world that the presence of *L. pertusa* is not as extensive as one would imagine, being collected only recently one small fragment of this species in the Philippines (Cairns, personal communication). However, the occurrence *of E. rostrata*, *Dendrophyllia alcocki* (Wells, 1954), *Madrepora* spp., *S. variabilis*, and other colonial species is very strong around the region. It is important to note that for almost all azooxanthellate scleractinian genera, this region is apparently the most diverse one (i.e. *Caryophyllia* (~39 spp.), *Crispatotrochus* (5 spp.), *Deltocyathus* (14 spp.), *Stephanocyathus* (6 spp.), *Trochocyathus* (21 spp.), *Gardineria* (4 spp.), *Balanophyllia* (~28 spp.), *Flabellum* (~21 spp.), *Truncatoflabellum* (22 spp.), and others). TL: Faustino (1927), Wells (1964), Cairns (1989), Cairns and Zibrowius (1997), Kitahara and Cairns (2008, 2009), Kitahara et al. (2010).	High[4]	High	High

Area	Description	Fisheries impact	Status on knowledge	Prob. of add. spp. records[1]
77	With 94 azooxanthellate scleractinians reported (22 from shallow waters) to date, this area is the most diverse eastern oceanic region of the world. However, due to the high number of islands (i.e. Polynesian islands) never (or poorly) sampled, the number of species is probably much higher than observed. Within this area, the Hawaiian and Cocos islands are the most extensively studied. TL: Vaughan (1907), Wells (1954), Durham (1962, 1966), Keller (1981), and Cairns (1984, 1991, 1994, 2006).Wells (1954), Durham (1962, 1966), Keller (1981), and Cairns (1984, 1991, 1994, 2006).	Unknown	Medium	High
81	The azooxanthellates reported from New Zealand and adjacent waters support some of the most extensive fisheries in the world (orange-roughy). To date there are 163 species reported to this area corresponding to the third most diverse region in the world. TL: Eguchi (1973b), Cairns and Parker (1992), and Cairns (1995, 2004).	High	High	Low
87	Despite of the many taxonomic studies for the azooxanthellates from the Galapagos Archipelago (Durham, 1962; 1966; Wells, 1983; Cairns, 1991), the remaining areas of this FAO area still need sampling effort to be better understood in relation to azooxanthellate scleractinians. Recently, Cairns et al. (2005) reviewed the deep-sea corals from Peru-Chile, and interestingly some of the records of this fauna are very shallow in Chilean coast (i.e. *Desmophyllum dianthus* [Esper, 1794]). In total there are 62 species recorded from this FAO area (nearly 31% restricted to shallow environments). All the main deep-sea framework colonial species (*L. pertusa*, *M. oculata*, *S. variabilis*, *G. dumosa*, and *E. rostrata*) are reported to this region. TL: Durham (1962, 1966), Wells (1983), and Cairns (1991).	Unknown	Low/ Medium	Medium/ High

[1] Probability of additional species records.
[2] The fisheries impact is high specially in southern Brazilian waters.
[3] The fisheries impact is high especially around India and Indonesian islands.
[4] The fisheries impact is high in some Philippine and Indonesian regions and probably lower around New Caledonia and northeastern Australia.

Order Antipatharia

With an estimated number of species of 246, the vast majority of antipatharian species is reported from deep-seas (up to 8 600 m) and is widely distributed throughout the world's oceans, including both polar circles. Recently, Roark *et al*. (2009) discovered that some species of *Leiopathes* are among the oldest continuously living organisms on the planet (over 4 000 years). Appendix 2 lists the potential 33 habitat-forming species and follows the recently list published by Roberts *et al.* (2009). According to those authors, this list was based on actual observation of associated organisms and/or by inference based on their large size and local abundance.

Subclass Octocorallia

The sub-class Octocorallia, also known as Alcyonaria and commonly referred as soft-corals, comprises 3 000 estimated species (3 orders, 45 families, and 334 genera)[2] of which nearly 2 400 are reported from waters deeper than 50 m (Cairns, 2007; Roberts *et al*., 2009). The most diverse octocorallian order, the Alcyonacea, includes 30 families of soft corals (octocorals without a supporting skeletal axis) and gorgonians (octocorals with a supporting skeletal axis of scleroproteinous gorgonin and/or calcite) (Bayer, 1981; Daly *et al*., 2007). These colonial organisms have an internal skeleton secreted by mesoglea and polyps with eight tentacles and eight mesenteries (8-fold symmetry). According to Daly *et al*. (2007) alcyonacean families are distinguished primarily on the basis of overall colony growth form, presence or absence of a supporting skeletal axis, and details of axial composition. The form and distribution of sclerites (microscopic calcite crystals embedded in the coenenchymal tissue and polyps) are the most important characters used to distinguish genera and species of octocorals, but are less important for familial distinctions.

With the deepest record of 6 620 m, octocorals are ubiquitous in marine environments, occurring from the Arctic to the Antarctic oceans. To date, no comprehensive list of species has been published; Roberts *et al.* (2009) list only potentially habitat-forming deep-sea species. However, it is important to note that some species listed in the Appendix 3 may not have habitat-forming capacity. According to Sánchez (2005), the paragorgiids are amongst the largest and most important sessile benthic invertebrates in the ocean, with some colonies being up to 10 m in height (Smith, 2001) thus providing an ample habitat for numerous fish and invertebrates (Krieger, 1993; Koslow *et al.*, 2001). Amongst the seven genera of primnoids included in the Appendix 3, the most important habitat-forming is probably *Primnoa*, sometimes up to 2 m in height and 7 m wide. The deep-sea species belonging to this genus were observed in situ in the Gulf of Alaska at depths between 161 and 365 m and 10 megafaunal groups have been identified that associate with them to feed on the coral, use the coral branches for suspension feeding, or for protection (Krieger & Wing, 2002). Lastly, the family Isididae is cosmopolitan in distribution and is reported as deep as 4 850 m (Bayer & Stefani, 1987).

Suborder Filifera

The family Stylasteridae (lace-corals), sub-order filifera, are the second largest group of calcified cnidarians (246 to 250 spp.). They are ubiquitous in the marine environment from shallow to deep-seas and are recorded from the Antarctica to the Bering Sea (Cairns, 1992; Lindner *et al.*, 2008; Roberts *et al.*, 2009). Stylasterids have an extremely varied morphology ranging from encrusting to massive colonial species with very fine dendritic branches or broad flat plates oriented perpendicular to the current. Generally they have slow growth rates, colored skeleton, long life, and internal fertilization (Brooke and Stone, 2007). It is hypothesized that this group is out-competed by aggressive species in high nutrient waters, finding refuge in low nutrient and less competitive environments (Sanders, 1979; Cairns, 1992). Most species occur in deep-seas, being the most diverse bathymetric range for these corals between 200 to 500 m (Cairns, 1984; 1992). Broch (1942) was the first to comment on the worldwide distribution of this group, being followed by Boschma (1953) who

[2] See the online research archive: http://researcharchive.calacademy.org/research/izg/OCTOHT.htm

concluded that the most diverse faunas of lace-corals were in the “East Indies”, off Japan, and around the Aleutian Islands.

More recently, Cairns (1992) shows the distribution of all known Stylasterids primarily found off small volcanic oceanic islands, atolls, archipelagos, and especially seamounts. This distribution pattern was attributed by Cairns (1991b) as an inability of the group to establish in terrigenous sediment. According to Cairns (1992b), although apparently having a widely and homogenously distribution pattern, the stylasterids are either absent or extremely rare near land masses over 105 000 km^2, with exception of Honshu, Japan. Nonetheless, islands smaller than 36 000 km^2 generally support this group with some exceptions from high islands surrounded by broad continental shelves. Areas that are particularly favorable for stylasterids are: Norfolk, Kermadec, and Macquarie Ridges, and New Zealand, which altogether present the highest stylasterid species diversity in the world (Cairns, 1991b). More recently, large concentrations have been found around Antarctic and sub-Antarctic regions (especially around south-Georgia island), and in the Aleutian Trench.

To date, the most diverse regions for stylasterids are found in the Caribbean (55 spp.) and around New Zealand (43 spp.). They are extremely rare from ,northern Indian Ocean, Asian coast to the Sea of Japan, Australia, Africa, northern Indian Ocean, and North, Central, and South America (Cairns, 1991b). However, recently, some shallow and deep-sea species have been collected from Brazilian coast (Lindner, personal communication). According to Cairns (1991b), species of this group have never been found in the Canadian and Russian Arctic oceans, regardless of the island size. The northernmost records of stylasterids in the North Pacific are around 57ºN to 58º17’N including the Gulf of Alaska (Fisher, 1938), Okhotsk Sea (Naumov, 1960), and off Pribilof Island in the Bering Sea (Cairns, 1991a). In Atlantic waters, the northernmost record belongs to Norwegian region at 68º30’ (Zibrowius & Cairns, 1992).

See Appendix 4 for the extended list of species per FAO major fishing areas.

2. Vulnerability of deep-sea corals

Recent studies have highlighted the loss of high-trophic level predatory species (Myers and Worm, 2003) and progressively the lower trophic level fish recorded in landings. Due to escalating demand of food and the collapse of fisheries on continental shelves around the world, the fishing industry has progressively increased efforts on long-lived, slow-growing deep-sea (more than 200 m) demersal fishes (i.e. *Lophius gastrophysus*). According to Roberts *et al.* (2009), this trend brought fishing activity progressively closer to areas where deep-sea corals occur.

Among the four most common demersal fisheries (bottom-trawl, bottom-gillnet, bottom-longline and trap), the bottom-trawl is unquestionably the one causing the most threat and damage to sessile invertebrate communities such as corals and sponges. Furthermore, with the development of robust gears and nets, it is not uncommon for large trawlers to fish over large deep-sea reefs.

Fosså *et al.* (2002) described underwater remotely operated vehicle (ROV) observations on high trawled areas, and in many instances they found that areas previously known as *L. pertusa* habitats, showed only scarred or crushed and broken coral skeleton fragments. They also observed lost trawl warps, nets and furrows ploughed, estimating that up to 50 percent of *L. pertusa* reefs in Norwegian waters have been damaged by trawling. Similar undeniable evidences of large impacts on deep-sea corals have been reported for several countries including Australia (Koslow *et al*., 2001), Canada (Gass and Williams, 2005), Ireland (Hall-Spencer *et al*., 2002), (Probert, 1997), United Kingdom (Wheeler *et al*., 2005), United States (Reed, 2002) and Brazil (Kitahara, 2009).

As well as the obviously direct effects, bottom trawling also disperse seabed sediments, increasing the water-column turbidity. The elevation of turbidity is known to be very harmful for many deep-sea species, especially for lace-corals.

In southern Brazilian waters, Kitahara (2009) showed that not only bottom-trawlers, but also other demersal fisheries were seriously damaging unidentified deep-sea coral reefs. Onboard vessel, scientific observers from the same region concluded that most fishing vessel captains were waiting for signals of corals on their "fish finder" eco sounders to release the fishing gear. Not surprisingly, representatives of scleractinians, octocorallians and antipatharians were usually part of the by-catch. In the same study, Kitahara (2009) compared the main areas used by demersal fisheries and concluded that it overlapped with the known coral distribution of the region.

To date, it is known that not only large colonial species are vulnerable to fishing gear, but also even the very small ones were reported as by-catch. Due to their very low growth rate (mature deep-sea coral reefs take thousands of years to accumulate), their unknown resilience (recovery from trawling impacts, if occurs, is likely to be slow, and where corals were completely destroyed recovery is unlikely [Gianni, 2004]), and their ecological importance (once destroyed, all associated animal community will be lost), it is considered that all known species of deep-sea corals to be "extremely vulnerable" to fishing gear in both, direct and indirect ways.

Other threats to deep-sea corals

- Hydrocarbon industries: Mirroring the offshore trend of fisheries, the hydrocarbon industry is exploiting oil and gas reservoirs in progressively deeper waters (Roberts *et al.*, 2009). To date, the risks imposed by this industry is still poorly understood, however, it may be affecting the nearby deep-sea corals with increasingly turbidity and leaking of fluids.
- Mining: According to Roberts *et al.* (2009, 246), improved undersea technologies have brought deep-sea mining into deep-sea coral regions. These initiatives raise concerns that disturbance from mining operations, including sediment plumes and the release of toxic material, could irreparably damage benthic ecosystems.
- Climate change: Probably the biggest threat facing deep-sea corals today is increasing seawater temperatures, progressive ocean acidification, and the raise of the aragonite saturation horizon. If recent predictions are correct (Guinotte *et al.*, 2006), changes of the carbonate chemistry of the ocean will have devastating implications not only for deep-sea corals, but also for all calcareous organisms and species that rely on the habitats formed by them.
- Coral collection: Many species of octocorallians and antipatharians have been collected for hundreds of years and used as material for the production of jewellery and medicine. In Brazil, it is not uncommon to find pet stores selling small to medium sized skeletons of deep-sea scleractinians (collected as bycatch and brought to the stores by the fishermen as additional source of money) for aquarists.

7. Recommendations for the production of identification guides

Due to i) high phenotypic plasticity of coral morphology; ii) low number of specimens used for species descriptions (especially before 1970); iii) the utilization of mainly macro-morphological characters to identify specimens to species level (especially for scleractinians); iv) differences of morphology during ontogeny; and v) the subjectivity on the interpretation of descriptions, it is not unusual to find species that have been described at least twice, sometimes by the same taxonomist.

One of the most effective ways to minimize this problem is to i) create an illustrated guide for all structures used in the identification for each particular group; ii) develop an illustrated identification key for families, genera, and species; and iii) compile and produce an illustrated identification guide for each one of the species of cold-water coral known to date including all the new information included in this draft report (with some adjustments).

However, it is expected that some difficulties will be faced when the production of the identification guides start, especially for some species described in the nineteenth century that were not illustrated and the types are presumably lost. Also, there are some species from which only the type specimens are known, and if the exchange of specimens be discouraged or impeded by regulations from international transport of specimens (Convention on International Trade in Endangered Species, [CITES]), it will be important that FAO support museum visits. Additional problems that could cause delays is the extensive work needed for the production of the identification guide regarding the sub-class Octocorallia, which is very diverse if compared within the other three groups mentioned in this report.

Extra efforts will be generated if micro structural data will be included in the scleractinians identification guide due to the limited number of scientists/taxonomists able to perform such examination. Focusing on the octocorallians, antipatharians, and Filifera, extra effort will be generated by the production of their respective plates, since most require scanning electron microscope images to be well illustrated.

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APPENDIX 1

Order Scleractinia

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Family Anthemiphylliidae				
Anthemiphyllia	*A. dentata*	50	1 050	57, 61, 71, 81
	A. frustum	209	340	61, 71
	A. macrolobata	369	650	71, 77, 81
	A. multidentata	128	270	57, 71, 81
	A. pacifica	205	342	71, 77, 81
	A. patera costata	320	700	71
	A. patera patera	500	700	31
	A. sp. sensu Kitahara & Cairns, unpublished	346	346	71
	A. spinifera	282	650	71, 81
Family Caryophylliidae				
Anomocora	*A. carinata*	614	785	77
	A. cf. fecunda sensu Cairns, 1995	145	400	77, 81
	A. fecunda	37	640	27, 31, 34, 41, 61
	A. gigas	183	510	51, 71
	A. marchadi	32	229	31, 34, 51, 57, 71
	A. prolifera	30	329	31, 34
Aulocyathus	*A. atlanticus*	450	1 716	27, 34
	A. juvenescens	182	463	51, 71
	A. matricidus	84	207	61
	A. recidivus	128	1 137	51, 57, 61, 71, 81
Bathycyathus	*B. chilensis*	26	420	87
Bourneotrochus	*B. stellulatus*	210	566	71, 77, 81
Caryophyllia	*C. abrupta*	300	650	71
	C. abyssorum	732	2 000	27, 34
	C. alaskensis	102	399	61, 67
	C. alberti	76	506	27
	C. ambrosia ambrosia	311	1 230	21, 27, 34, 37, 47, 51, 57, 61, 71, 81
	C. ambrosia caribbeana	183	1 646	31, 41
	C. antarctica	87	1 435	41?, 48, 58,
	C. antillarum	150	730	31, 41
	C. arnoldi	40	656	67, 77
	C. aspera	400	400	71
	C. atlantica	298	2 165	27, 34, 37, 57, 71, 77, 81
	C. balaenacea	882	1 112	47
	C. barbadensis	129	249	31, 41
	C. berteriana	91	1033	31, 41, 51
	C. calveri	91	340	27, 34, 37
	C. cf. *calveri* sensu Cairns 1999	558	602	71
	C. cinticulata	282	384	51, 71
	C. concreta	215	570	71
	C. cornulum	1 525	2 603	61, 71
	C. corona	60	60	31
	C. corrugata	183	380	31

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	C. crosnieri	133	1 050	51, 57, 71, 81
	C. crypta	12	291	31, 41
	C. cyathus	70	300	27, 34, 37
	C. decamera	124	263	57, 71
	C. dentata	90	263	71
	C. diomedeae	225	2 200	51, 57, 71, 77, 81, 87
	C. eltaninae	101	814	48
	C. ephyala	420	420	51, 57, 71
	C. foresti	155	950	27
	C. grandis	183	596	51, 57, 71
	C. grayi	37	360	57, 61, 71
	C. hawaiiensis	85	650	61, 71, 77, 81
	C. horologium	55	175	31
	C. huinayensis	16	256	87
	C. inornata	0	100	27, 34, 37
	C. japonica	77	1 680	61, 81
	C. jogashimaensis	52	98	61
	C. karubarica	389	477	71
	C. laevigata	410	1 032	71
	C. lamellifera	89	1 152	51?, 71, 81
	C. mabahithi	278	1 022	48
	C. marmorea	331	500	71, 77
	C. oblonga	670	1 005	71
	C. octonaria	182	622	71
	C. octopali	410	627	71, 77
	C. paradoxa	786	786	51
	C. paucipalata	714	843	31
	C. perculta	54	316	87
	C. planilamellata	128	1 220	57, 71, 81
	C. polygona	700	1 817	31
	C. profunda	35	1 116	47, 48, 51, 57, 81
	C. protei	100	100	31
	C. quadragenaria	54	443	57, 61, 71, 77, 81
	C. quangdongensis	167	179	61
	C. ralphae	270	896	71, 81
	C. rugosa	71	724	51, 57, 61, 71, 77, 81
	C. sarsiae	520	2 200	27, 34, 37
	C. scobinosa	302	2 450	41, 51, 61, 71, 81
	C. secta	220	366	71
	C. seguenzae	1 000	1 400	27, 34
	C. sewelli	366	366	51
	C. smithii	40	400	27, 34, 37, 47, 51, 57?
	C. solida	373	488	87
	C. sp. A sensu Kitahara *et al.*, 2010	416	433	71
	C. sp. A sensu Seig & Ziborwius, 1989	570	610	71
	C. sp. B sensu Seig & Ziborwius, 1989	825	860	71
	C. sp. cf. *C. ambrosia* sensu Cairns, 1984	56	206	77

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	C. sp. cf. *C. scobinosa* sensu Cairns, 1994	119	805	61
	C. spinicarens	222	750	71
	C. spinigera	127	347	61, 71
	C. squiresi	406	659	41, 87
	C. stellula	166	420	51, 57
	C. tangaroae	810	1 000	71
	C. transversalis	210	397	71
	C. unicristata	251	620	57, 71
	C. valdiviae	882	2 670	47
	C. versicolorata	215	708	71
	C. zanzibarensis	238	302	51
	C. zopyros	73	618	31
Ceratotrochus	*C. franciscana*	79	80	77?
	C. laxus	583	678	77
	C. magnaghii	7	400	37
Cladocora	*C. debilis*	28	480	31, 34, 37, 41, 47
	C. pacifica	45	274	31, 77, 87
Coenocyathus	*C. anthophyllites*	65	250	27, 34, 37
	C. bowersi	9	302	77
	C. brooki	7	95	81
	C. caribbeana	5	100	31
	C. cylindricus	65	500	34, 37
	C. goreaui	2	6	31
	C. humanni	21	21	31
	C. parvulus	79	399	31, 41
Coenosmilia	*C. arbuscula*	74	622	31, 61, 71
	C. inordinata	244	322	77
Colangia	*C. immersa*	1	347	31
	C. jamaicaensis	10	20	31
	C. moseleyi	18	54	71
	C. multipalifera	20	20	31
Concentrotheca	*C. laevigata*	183	772	27, 31, 41
	C. vaughani	313	316	87
Confluphyllia	*C. juncta*	135	385	71, 81
Conotrochus	*C. asymmetros*	210	510	71
	C. brunneus	97	1 051	51, 71, 81
	C. funicolumna	80	1 078	61, 71, 77, 81
Crispatotrochus	*C. cornu*	220	1 097	41?, 81
	C. curvatus	1 373	2 505	81
	C. foxi	82	272	67, 77
	C. galapagensis	84	806	87
	C. gregarius	460	460	71
	C. inornatus	120	400	57, 81
	C. irregularis	549	549	81
	C. niinoi	104	104	61
	C. rubescens	110	634	61, 71, 77
	C. rugosus	142	1 050	57, 71, 81
	C. septumdentatus	187	400	71
	C. sp. cf. *cornu*	220	241	31
	C. sp.A sensu Cairns 1982	2 305	2 329	81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	C. squiresi	686	822	31
	C. woodsi	77	87	71
Dactylotrochus	*D. cervicornis*	73	400	61, 71
Dasmosmilia	*D. lymani*	37	366	27, 31, 34, 41, 61, 81
	D. valida	490	490	51
	D. variegata	110	600	31, 34, 41, 51
Deltocyathus	*D. agassizii*	494	1 115	31, 41
	D. andamanicus	187	397	51, 57, 71
	D. calcar	81	675	31, 41
	D. cameratus	305	1 175	71, 81
	D. corrugatus	250	600	71, 81
	D. crassiseptum	370	583	71
	D. eccentricus	183	1 000	27, 31, 34, 41
	D. halianthus	46	130	41
	D. heteroclitus	208	600	71
	D. inusitatus	410	777	71
	D. italicus	403	2 634	27, 31, 34, 41, 47
	D. magnificus	88	1 500	57, 61, 71, 81
	D. moseleyi	200	1 372	27, 31, 34, 41
	D. murrayi	1 948	2 312	51
	D. nascornatus	73	2 000	51
	D. ornatus	73	400	71, 81
	D. parvulus	1 940	5 080	87
	D. philippinensis	342	522	71
	D. pourtalesi	311	567	31
	D. rotulus	210	1 300	51, 57, 61, 71, 81
	D. sarsi	44	80	57
	D. sp. A. sensu Cairns & Keller, 1993	207	315	51
	D. sp. sensu Zibrowius, 1974	496	2 278	27
	D. stella	206	597	71, 81
	D. suluensis	142	1 050	57, 71, 81
	D. taiwanicus	320	697	71
	D. varians	655	732	51
	D. vaughani	88	1 097	61, 71
Desmophyllum	*D. dianthus*	8	2 460	21, 27, 31, 34, 37, 41, 47, 48, 51, 57, 61, 67, 71, 77, 81, 87
	D. quinarium	37	37	71
	D. striatum	277	823	31
Ericiocyathus	*E. echinatus*	814	1 401	71
Goniocorella	*G. dumosa*	88	1 488	51, 61, 71, 81, 87
Heterocyathus	*H. aequicostatus* *	0	20	51?, 57, 61, 71
	H. alternatus *	0	319	57, 71
	H. antoniae	20	70	31
	H. hemisphaericus	2	140	57
	H. japonicus	0	20	61
	H. sulcatus *	11	312	57, 71
Hoplangia	*H. durotrix*	0	150	27, 34, 37, 81
Labyrinthocyathus	*L .quaylei*	37	293	77
	L. delicatus	155	1 000	51
	L. facetus	385	402	31
	L. langae	695	810	31

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	L. limatulus	20	508	61, 71, 81
	L. sp. A sensu Cairns & Zibrowius, 1997	210	268	77
	L. sp. sensu Cairns, 1995	665	1 000	81
Lochmaeotrochus	*L. gardineri*	608	1 175	71
	L. oculeus	240	616	71
Lophelia	*L. pertusa*	39	3 383?	21, 27, 31, 34, 37, 41, 47, 51, 61, 67, 71, 77, 81, 87
Monohedotrochus	*M. capitolii*	150	1 200	41
	M. circularis	190	545	57, 71
	M. epithecatus	240	455	71
Nomlandia	*N. californica*	82	82	77
Oxysmilia	*O. corrugata*	180	190	71
	O. rotundifolia	46	640	31
Paraconotrochus	*P. antarctica*	87	728	41, 48, 58,
	P. capense	59	59	47
	P. zeidleri	304	558	57, 71, 81
Paracyathus	*P. andersoni*	?	?	57
	P. arcuatus	201	343	27, 34
	P. cavatus	?	?	51
	P. conceptus	229	805	51
	P. coronatus	?	?	51
	P. darwinensis	0	26	71
	P. ebonensis	?	?	77?
	P. fulvus	350	433	57
	P. humilis	23	104	87
	P. indicus gracilis	?	?	51
	P. indicus indicus	?	?	57
	P. lifuensis	73	73	71
	P. molokensis	161	260	77
	P. montereyensis	75	146	71, 77
	P. parvulus	73	73	71
	P. persicus	<50	<50	51
	P. porcellanus	?	?	77?
	P. profundus	?	?	51?, 57
	P. pruinosus	150	150	51, 61, 71
	P. pulchellus	17	1 260	27, 31, 34, 37, 41
	P. rotundatus	18	66	57, 71
	P. sp. A sensu Kitahara & Cairns, unpublished	305	370	71
	P. sp. sensu Zibrowius, 1974	80	100	27
	P. sp. sensu Cairns & Zibrowius, 1997	90	397	51, 71
	P. stearnsii	20	134	67, 77
	P. stokesi	?	?	51, 57
	P. vittatus	31	31	57
Phacelocyathus	*P. flos*	20	255	31, 41
	P. sp. sensu Zibrowius & Grygier, 1985	55	131	51
Phyllangia	*P. americana americana*	0	53	31, 41

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	P. americana mouchezi	1	55	27, 34, 37
	P. consagensis	0	82	87
	P. dispersa	<50	<50	77
	P. echinosepes	90	90	61
	P. granulata	?	?	47
	P. hayamaensis	5	5	61
	P. papuensis	88	100	71
	P. pequenatae	48	112	31
Polycyathus	*P. andamanensis*	?	?	57
	P. atlanticus	?	?	31?
	P. difficilis	?	?	57
	P. fulvus	30	50	71
	P. furanaensis	6	52	71
	P. fuscomarginatus	?	?	57
	P. hodgsoni	0	35	71
	P. hondaensis	55	64	77?, 87
	P. isabela	14	23	87
	P. marigondoni	35	35	71
	P. mayae	137	309	31
	P. muellerae	0	30	27, 37
	P. norfolkensis	10	20	81
	P. octuplus	90	441	71
	P. palifera	<30	<30	57?
	P. persicus	?	?	51
	P. senegalensis	12	143	31, 34, 41?
	P. verrilli	?	?	51, 57
Pourtalosmilia	*P. anthophyllites*	25	300	27, 34, 37
	P. conferta	55	191	31, 41
Premocyathus	*P. cornuformis*	137	2 360	21, 27, 31, 34, 41
	P. dentiformis	22	960	57, 61, 71, 81
Rhizosmilia	*R. elata*	70	380	71
	R. gerdae	123	549	31
	R. maculata	1	508	31, 41
	R. multipalifera	11	165	57, 71
	R. robusta	66	360	51, 71
	R. sagamiensis	60	98	61, 71
	R. sp. sensu Kitahara & Cairns, unpublished	265	370	71
Solenosmilia	*S. variabilis*	45	2 165	27, 31, 34, 41, 47, 48, 51, 57, 58, 71, 81, 87
Stephanocyathus	*S. campaniformis*	882	1 610	47, 51
	S. coronatus	543	1 989	31, 71, 81
	S. crassus	400	1 557	27, 34
	S. diadema	795	2 553	31, 41
	S. explanans	180	1 016	51, 57, 71
	S. imperialis	2 436	2 474	57, 71
	S. isabellae	493	504	31
	S. laevifundus	300	1 158	31
	S. moseleyanus	1 000	2 000	27, 34
	S. nobilis	609	2 200	27, 34, 51
	S. paliferus	220	715	31, 41
	S. platypus	439	1 219	57, 81
	S. regius	563	2 160	57, 71, 81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	S. sp. sensu Cairns & Parker, 1992	520	520	57
	S. spiniger	120	1 188	51, 57, 61, 71, 81
	S. weberianus	700	1 500	57, 61, 71, 81
Sympodangia	*S. albatrossi*	212	616	71
Tethocyathus	*T. cylindraceus*	183	649	31, 41, 71, 81
	T. endesa	15	240	87
	T. minor	73	73	71, 77
	T. prahli	303	333	31
	T. recurvatus	320	569	31
	T. sp. sensu Kitahara & Cairns, unpublished	400	400	71
	T. variabilis	250	860	27, 31, 34
	T. virgatus	137	1 200	71, 81
Thalamophyllia	*T. gasti*	13	200	34, 37
	T. gombergi	188	220	31
	T. riisei	4	914	31
	T. tenuescens	8	360	57, 71, 81
Trochocyathus	*T. aithoseptatus*	371	454	77
	T. apertus	20	230	57, 71
	T. brevispina	240	560	71
	T. burchae	35	144	57, 71, 77
	T. caryophyllioides	115	344	61, 71
	T. cepulla	398	610	71, 81
	T. cf. *rawsonii* sensu Kitahara & Cairns, unpublished	237	1 100	71
	T. cf. *wellsi* sensu Kitahara & Cairns, unpublished	237	237	71
	T. cooperi	25	100	61, 71
	T. decamera	70	88	61
	T. discus	240	700	71
	T. efateensis	391	437	71
	T. fasciatus	238	238	31
	T. fossulus	205	775	31
	T. gardineri	274	470	71, 77
	T. gordoni	398	710	81
	T. hastatus	366	710	71, 81
	T. japonicus	150	450	61
	T. laboreli	125	300	41
	T. longispina	326	760	71
	T. maculatus	77	550	71, 81
	T. mauiensis	174	278	77
	T. oahensis	75	571	77
	T. patelliformis	1 010	1 250	71, 77
	T. philippinensis	54	330	57, 61, 71
	T. porphyreus	?	?	57
	T. rawsonii	55	700	31, 41, 47?, 51
	T. rhombcolumna	110	530	51, 71, 77, 81
	T. semperi	38	245	71
	T. sp. A sensu Cairns & Keller, 1993	74	315	51

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	T. sp. cf. *aithoseptatus* sensu Cairns, 2004	80	86	71
	T. spinosocostatus	1 575	1 650	27, 34
	T. vasiformis	323	650	71
	T. wellsi	75	86	71
Vaughanella	*V. concinna*	500	3 018	27, 34, 71
	V. margaritata	1 267	1 267	27
	V. multipalifera	920	3 500	71, 81
	V. oreophila	646	1 050	81
	V. sp. cf. *oreophila* Kitahara & Cairns, unpublished	852	852	71
Family Dendrophylliidae				
Astroides	*A. calycularis*	0	30	34, 37
Balanophyllia	*B. bairdiana*	6	548	57, 71, 81
	B. bayeri	274	311	31
	B. bonaespei	?	?	51?, 57?
	B. capensis	27	37	47
	B. caribbeana	33	86	31
	B. carinata	33	124	57, 71
	B. cedrosensis	66	119	77
	B. cellulosa	80	850	27, 34, 37
	B. chnous	140	549	81
	B. corniculans	?	?	71, 77
	B. cornu	60	520	57, 61, 71
	B. crassiseptum	183	250	71
	B. crassitheca	190	508	71, 81
	B. cumingii	65	307	51?, 57, 61, 71
	B. cyathoides	45	494	31
	B. dentata	66	135	57, 71, 81
	B. desmophyllioides	95	1 050	57, 71, 77, 81
	B. diademata	165	165	51
	B. difusa	6	274	51
	B. dilatata	?	?	57
	B. dineta	27	274	31, 41
	B. diomedeae	110	307	77
	B. dubia	55	55	71
	B. elegans	0	293	67, 77
	B. europaea	0	50	37
	B. floridana	13	220	31, 34
	B. galapagensis	18	462	71, 87
	B. gemma	137	522	51, 57, 71
	B. gemmifera	81	81	51
	B. generatrix	96	535	57, 71
	B. gigas	90	640	57, 61, 71, 77, 81
	B. hadros	238	274	31
	B. helenae	18	18	47
	B. imperialis	18	120	57, 71
	B. iwayamaensis	1	3	71?, 77?
	B. japonica	154	237	61
	B. kalakauai	?	?	
	B. laysanensis	238	400	71, 77

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	B. malouinensis	75	1 137	41, 48, 87
	B. merguiensis	?	?	57
	B. palifera	53	708	31
	B. parallela	18	18	71
	B. parvula	192	300	71
	B. pittieri	40	96	31
	B. profundicella	73	73	61, 71
	B. redeviva	90	256	71
	B. regalis	59	59	57
	B. regia	2	100	27, 34, 37
	B. scabra	?	?	57
	B. scabrosa	?	?	71
	B. serrata	190	194	71
	B. sp. 1 sensu Kitahara & Cairns, unpublished	311	470	71
	B. sp. 2 sensu Kitahara & Cairns, unpublished	192	265	71
	B. sp. 3 sensu Kitahara & Cairns, unpublished	235	370	71
	B. sp. 4 sensu Kitahara & Cairns, unpublished	400	748	71
	B. sp. 5 sensu Kitahara & Cairns, unpublished	265	421	71
	B. sp. 6 sensu Kitahara & Cairns, unpublished	248	356	71
	B. sp. A sensu Cairns, 1994	56	100	61
	B. sp. cf. *serrata* Kitahara & Cairns, unpublished	180	216	71
	B. sp. sensu Cairns 1982	247	253	41
	B. spongiosa	11	18	81
	B. stimpsonii	18	95	51, 57, 71, 81
	B. striata	18	18	47
	B. taprobanae	?	?	51?
	B. tenuis	15	15	71
	B. thalassae	385	1 150	27, 34
	B. vanderhorsti	51	59	51, 61
	B. wellsi	412	575	31
	B. yongei	?	?	71
Bathypsammia	*B. fallosocialis*	213	805	31
	B. tintinnabulum	183	549	31
Cladopsammia	*C. echinata*	222	470	71, 77
	C. eguchii	1	85	61, 77, 81, 87
	C. gracilis	0	95	57?, 61, 71, 87
	C. manuelensis	55	366	31, 34, 41
	C. rolandi	12	50	37
	C. willeyi	?	?	71, 77
Dendrophyllia	*D. aculeata*	11	21	71, 77
	D. alcocki	118	1 200	57, 71, 81
	D. alternata	276	900	27, 31, 41
	D. arbuscula	2	353	51, 57, 61, 71, 81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	D. boschmai bochmai	40	200	57, 61
	D. boschmai cyathoheloides	55	100	61
	D. californica	42	462	77, 87
	D. carleenae	?	?	71
	D. cladonia	49	457	51
	D. cornigera	89	600	27, 34, 37, 51
	D. cribrosa	7	40	34, 61
	D. dilatata	97	132	34, 51
	D. florulenta	69	243	61, 71
	D. futojiku	2	2	61
	D. granosa	91	91	57
	D. ijimai	10	366	51, 61, 71, 81
	D. incisa	?	?	71
	D. indica	5	5	51?, 57
	D. johnsoni	373	462	87
	D. laboreli	1	70	34
	D. minima	2	2	61
	D. minuscula	?	?	51, 57
	D. oldroydae	40	576	77, 87
	D. paragracilis	1	10	61
	D. radians	?	?	
	D. ramea	40	150	27, 34, 37
	D. robusta	?	?	57
	D. sp. A	180	230	71
	D. sp. B	180	180	71
	D. suprarbuscula	90	90	61
	D. velata	?	?	71
Dichopsammia	*D. granulosa*	20	30	61
	E. cornucopia	91	960	27, 31
	E. fistula	86	910	51, 71, 77, 81
	E. gaditana	30	998	31, 34, 41, 51, 57, 61, 71, 77, 81
	E. japonica	114	1 050	61, 81
	E. serpentina	200	362	77
	E. strigosa	25	77	31
	E. wellsii	32	196	61, 71
	E. profunda	403	1 748	31
	E. pusilla	371	805	27, 34, 71, 81
	E. rostrata	110	2 165	27, 31, 34, 37, 41, 47, 51, 57, 61, 71, 77, 81, 87
Endopachys	*E. bulbosa*	220	251	57, 71
	E. grayi	37	386	51, 57, 61, 71, 77, 81, 87
Endopsammia	*E. philippensis*	0	62	51, 57, 71
	E. pourtalesi	?	?	87
	E. regularis	8	73	71
Heteropsammia	*H. cochleata* *	6	622	51*, 57, 71
	H. eupsammides *	1	38	57, 71
	H. moretonensis	11	48	71
Leptopsammia	*L. britannica*	160	665	27
	L. chevalieri	70	500	34
	L. columna	20	20	57
	L. crassa	22	187	71
	L. formosa	400	900	27, 34

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	L. poculum	90	90	71
	L. pruvoti	3	150	27, 34, 37
	L. queenslandiae	87	87	71, 81
	L. stokesiana	46	69	71
	L. trinitatis	15	40	31
Notophyllia	*N. etheridgi*	37	238	57, 81
	N. hecki	342	414	71
	N. piscacauda	22	51	57
	N. recta	40	458	57, 81
Pourtalopsammia	*P. togata*	155	775	51
Rhizopsammia	*R. annae*	0	80	51
	R. bermudensis	8	12	31
	R. compacta	35	110	51
	R. goesi	5	119	31, 41
	R. minuta	0	176	51, 61, 71
	R. minuta var. *bikiniensis*	?	?	71
	R. minuta var. *mutsuensis*	0	2	61
	R. nuda	5.5	220	57, 71
	R. pulchra	?	?	77?
	R. verrilli	2	278	57, 71, 77, 87
	R. wellingtoni	2	43	87
	R. wettsteini	4	4	51
Thecopsammia	*T. elongata*	271	576	71, 81
	T. socialis	183	879	31
Trochopsammia	*T. infundibulum*	532	1 472	31
Tubastraea	*T. coccinea*	0	110	31, 41, 51, 57, 61, 71, 77, 81, 87
	T. diaphana	1	30	51, 57, 61, 71, 77
	T. faulkneri	3	5	61, 71, 87
	T. floreana	2	5	87
	T. micranthus	0	50	34, 51, 57, 61, 71
	T. tagusensis	1	43	41, 87
Family Flabellidae				
Blastotrochus	*B. nutrix*	11	18	57, 71
Falcatoflabellum	*F. raoulensis*	366	402	81
Flabellum	*F. alabastrum*	357	2 000	21, 27, 31, 34, 47
	F. angiostomum	?	?	81
	F. angulare	2 000	3 186	21, 27, 31, 34
	F. angustum	?	?	61
	F. aotearoa	130	1 300	71, 81
	F. apertum apertum	220	1 575	41, 48, 51, 58, 61, 71, 81, 87
	F. apertum borealis	307	1 141	61
	F. arcuatile	300	640	61, 71
	F. areum	1 647	2 229	41, 87
	F. atlanticum	357	618	31
	F. australe	36	1 026	57, 71, 81
	F. campanulatum	?	?	71
	F. chunii	200	700	27, 34
	F. conuis	1 994	2 603	61, 71
	F. curvatum	115	1 137	41, 48, 87
	F. daphnense	101	101	87

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	F. deludens	106	1 035	51, 57, 61, 71
	F. flexuosum	101	659	48, 58,
	F. floridanum	80	366	31
	F. folkesoni	124	430	57
	F. gardineri	177	177	48
	F. hoffmeisteri	110	842	57, 71, 81
	F. impensum	46	2 260	41, 48, 58, 67, 81,
	F. japonicum bythios	1 095	1 720	51
	F. japonicum japonicum	128	1 141	51, 57, 61, 71
	F. knoxi	201	1 167	71, 81
	F. lamellulosum	187	490	57, 71, 81
	F. lowekeyesi	278	1 100	51, 57, 81
	F. macandrewi	128	1 260	21, 27, 34
	F. magnificum	225	740	57, 61, 71
	F. marcus	1 050	1 602	71, 77
	F. marenzelleri	179	390	57, 71
	F. messum	368	1 035	51, 57, 71, 81
	F. moseleyi	216	1 097	31
	F. ongulense	570	570	58
	F. patens	204	439	57, 61, 71
	F. pavoninum	73	665	51, 61, 71, 77
	F. politum	40	402	57, 61, 71
	F. sexcostatum	685	1 121	71
	F. sibogae	567	567	51
	F. sp. A sensu Cairns 1991	441	717	87
	F. sp. cf. *moseleyi* sensu Cairns & Zibrowius, 1997	441	1 058	71
	F. sp. sensu Cairns & Zibrowius, 1997	441	1 058	71, 81
	F. thouarsii	71	305	41
	F. transversale conicum	104	188	61
	F. transversale transversale	55	150	57, 61, 71, 81
	F. transversale triangulare	?	920	58?, 61, 71
	F. tuthilli	347	824	57
	F. vaughani	232	369	77
Javania	*J. antarctica*	53	1 280	41, 48, 71,
	J. borealis	247	348	61, 87
	J. cailleti	30	2 165	21, 27, 31, 34, 37, 41, 51, 61, 67, 77, 87
	J. californica	62	170	77
	J. erhardti	35	44	71
	J. exserta	91	455	71, 77
	J. fusca	271	1 045	71, 77, 81
	J. insignis	46	1 050	51, 61, 71, 77, 81
	J. lamprotichum	191	881	57, 71, 77, 81
	J. pseudolabastra	625	1 557	27, 31
	J. sp. 1 sensu Kitahara & Cairns, unpublished	>100	>100	71

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	J. sp. 2 sensu Kitahara & Cairns, unpublished	310	312	71
	J. sp. sensu Cairns & Zibrowius, 1997	209	291	71
Monomyces	*M. pygmaea*	5	150	27, 34, 37
	M. rubrum	0	410	81
Placotrochides	*P.* cf. *minuta* sensu Kitahara & Cairns, unpublished	426	426	71
	P. cylindrica	1 117	1 402	71
	P. frustum	497	1 378	31, 34, 41
	P. minuta	119	458	71, 77
	P. scaphula	462	1 628	51, 57, 61, 71, 81
Placotrochus	*P. laevis*	6	289	57, 71
Polymyces	*P. fragilis*	75	882	31, 41
	P. montereyensis	69	212	77
	P. sp. 1 sensu Kitahara & Cairns, unpublished	>100	>100	71
	P. wellsi	355	1 203	31, 57, 71, 77, 81, 87
Rhizotrochus	*R. flabelliformis*	228	1 050	71, 81
	R. levidensis	1	73	71, 81
	R. tuberculatus	0	73	57
	R. typus	20	1 048	51, 57, 61, 71
Truncatoflabellum	*T. aculeatum*	11	132	57, 71
	T. angiostomum	15	136	57, 71
	T. angustum	195	530	57, 71, 81
	T. arcuatum	350	364	81
	T. australiensis	90	220	57
	T. candeanum	70	290	61, 71
	T. carinatum	30	274	61
	T. crassum	?	?	71
	T. cumingi	46	132	57, 71, 81
	T. dens	286	555	71, 81
	T. formosum	42	933	51, 57, 61, 71
	T. gardineri	138	138	51, 61
	T. inconstans	183	183	51
	T. incrustatum	30	415	71
	T. irregulare	11	42	57, 71
	T. macroeschara	18	201	57, 71
	T. martensii	139	182	71
	T. mortenseni	50	455	57, 71
	T. multispinosum	62	183	51
	T. paripavoninum	394	1 450	51, 57, 71, 81
	T. phoenix	18	441	71, 81
	T. pusillum	85	460	51, 71
	T. sp. A sensu Cairns, 1994	964	3 010	34, 51, 61
	T. sp. A sensu Kitahara & Cairns, unpublished	256	256	71
	T. sp. B sensu Cairns, 1994	80	88	61, 81
	T. sp. B sensu Kitahara & Cairns, unpublished	300	300	71

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	T. sp. C sensu Kitahara & Cairns, unpublished	216	346	71
	T. sp. sensu Kitahara & Cairns, unpublished	227	332	71
	T. spheniscus	2	174	57, 61, 71
	T. stabile	786	3 010	47, 51, 61, 71
	T. stokesii	12	256	51, 57, 71
	T. trapezoideum	1 630	1 630	77
	T. truncum	595	1 896	41, 48, 87
	T. vanuatu	240	335	71
	T. veroni	15	119	57, 71
	T. vigintifarium	288	1 050	71, 81
	T. zuluense	62	84	51
Family Fungiacyathidae				
Fungiacyathus	*F. crispus*	183	1 115	27, 31, 34, 41
	F. dennanti	190	770	57, 71, 81
	F. fissidiscus	282	287	71
	F. fissilis	212	503	77
	F. fragilis	200	2 200	21, 27, 34, 57, 71, 77, 81
	F. granulosus	287	1 050	57, 61, 71, 81
	F. hydra	882	886	47
	F. marenzelleri	1 820	6 328	21, 27, 31, 34, 41, 47, 48, 57, 58, 61, 67, 77, 81, 87,
	F. margaretae	440	1 175	71, 81
	F. multicarinatus	348	350	57
	F. paliferus	69	823	51, 57, 61, 71, 81
	F. pliciseptus	480	480	87
	F. pseudostephanus	3 840	5 120	51, 77?, 87
	F. pusillus pacificus	350	1 050	71, 81
	F. pusillus pusillus	285	685	31
	F. sandoi	77	600	71, 81
	F. sibogae	463	1 914	51, 57?, 71
	F. sp. A sensu Cairns 1994	3 175	4 110	61
	F. stephanus	245	2 000	51, 57, 61, 71, 81
	F. symmetricus	183	1 664	31, 41, 51, 57
	F. turbinolioides	600	930	57, 71, 81
	F. variegatus	84	715	57, 61, 71, 81
Family Gardineriidae				
Gardineria	*G. hawaiiensis*	142	1 200	57, 71, 77, 81
	G. minor	2	146	31
	G. paradoxa	91	700	31, 71
	G. philippinensis	192	494	57, 71
	G. simplex	46	241	31
	G. sp. 1 sensu Kitahara & Cairns, unpublished	265	311	71
New genus sensu Seig & Zibrowius, 1989	sp. nov. sensu Seig & Zibrowius, 1989	315	677	71
Stolarkicyathus	*S. pocilliformis*	342	367	71
Family Guyniidae				
Guynia	*G. annulata*	28	653	27, 31, 34, 37, 51, 57, 61, 71, 77

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Family Micrabaciidae				
Leptopenus	*L. antarcticus*	2 005	2 897	48,
	L. discus	2 842	5 000	31, 41, 48, 57, 58, 61, 67, 77,
	L. hypocoelus	3 949	3 949	87
	L. solidus	2 000	3 250	61, 71
	L. sp. A	221	871	71
Letepsammia	*L. fissilis*	106	458	57, 71, 81
	L. formosissima	97	500	51, 57, 61, 71, 77, 81
	L. franki	50	650	51, 71
	L. sp. 1 sensu Kitahara & Cairns, unpublished	426	426	71
	L. sp. 2 sensu Kitahara & Cairns, unpublished	237	516	71
	L. superstes	77	710	61, 71, 81
Rhombopsammia	*R. niphada*	390	804	57, 61, 71, 81
	R. squiresi	622	1 401	57, 71
Stephanophyllia	*S. complicata*	73	700	51, 57, 71, 81
	S. fungulus	15	653	51, 57, 61, 71
	S. neglecta	49	555	57, 71
	S. sp. sensu Kitahara & Cairns, unpublished	608	608	71
Family Oculinidae				
Bathelia	*B. candida*	500	1 250	41, 87
Cyathelia	*C. axillaris*	12	366	51, 57, 61, 71
Madrepora	*M. arbuscula*	212	658	71
	M. carolina	53	801	31, 41
	M. cf. porcellana	55	238	71
	M. minutiseptum	150	302	61, 71
	M. oculata	55	1 950	27, 31, 34, 37, 41, 51, 57, 61, 71, 77, 81, 87
	M. porcellana	55	516	57, 71
Oculina	*O. diffusa* *	0	25	31
	O. profunda	119	742	71, 77, 87
	O. tenella *	25	159	31
	O. varicosa *	5	128	31
	O. virgosa	29	1 050	71, 81
Petrophyllia	*P. rediviva*	0	7	71
Sclerhelia	*S. hirtella*	18	165	47
Family Pocilloporidae				
Madracis	*M. asanoi*	110	183	71
	*M. asperula**	0	311	31, 34, 41
	M. brueggemanni	51	130	31, 41
	M. hellana	46	46	31, 51, 71
	M. kauaiensis	44	541	71, 77
	M. kauaiensis var. *macrocalyx*	160	260	77
	M. myriaster	37	1 220	31, 41
	M. p. pharensis *	6	333	27, 31, 34, 37, 41, 71
	M. profunda	112	327	27, 34
	M. sp. A sensu Cairns, 1994	46	110	61, 71

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	M. sp. cf. *asperula* sensu Cairns, 1991	46	64	87
	M. sp. cf. *pharensis* (*?) sensu Cairns, 1991	30	343	77, 87
Family Rhizangiidae				
Astrangia	*A. atrata*	3	51	57, 81
	A. browni	0	5	87
	A. californica	29	29	77
	A. conferta	9	33	77
	A. costata	11	31	77
	A. dentata	0	15	77
	A. equatorialis	0	15	87
	A. haimei	1	53	77
	A. howardi	54	91	77
	A. macrodentata	?	?	27?, 34?
	A. mercatoris	3	6	34?
	A. poculata	0	263	31, 34
	A. rathbuni	5	90	31, 41
	A. solitaria	0	51	31, 41
	A. woodsi	18	18	71, 81
Cladangia	*C. exusta*	20	20	57, 71
Culicia	*C. australiensis*	3	378	57, 71
	C. cuticulata	?	?	57?
	C. excavata	?	?	51?, 57?
	C. fragilis	14	20	77?
	C. hoffmeisteri	0	51	57, 71, 81
	C. quinaria	0.5	30	71, 81
	C. rachelfitzhardingeae	2	2	77
	C. rubeola	0	82	57, 61, 81
	C. smithii	?	?	81
	C. sp. cf. *rubeola* sensu Cairns, 1991	0	27	77, 87
	C. stellata	0	100	61, 71, 87
	C. subaustraliensis	?	?	61
	C. tenella natalensis	?	?	51?
	C. tenella tenella	30	30	51, 71, 81
	C. tenuisepes	0.5	1.5	71
Oulangia	*O. bradleyi*	0	64	87
	O. cyathiformis	10	20	71
	O. stokesiana	1	22	57, 61, 71
	O. stokesiana var. *miltoni*	0	135	61
Family Schizocyathidae				
Pourtalocyathus	*P. hispidus*	349	1 006	31
Schizocyathus	*S. fissilis*	88	1 300	27, 31, 34, 41
Temnotrochus	*T. kermadecensis*	321	402	71, 81
Pedicellocyathus	*P. keyesi*	70	194	81
Stenocyathus	*S. vermiformis*	110	1 500	27, 31, 34, 37, 41, 51, 57, 61, 71, 77, 81, 87
Truncatoguynia	*T. irregularis*	80	334	61, 71, 81
Family Turbinoliidae				
Alatotrochus	*A. rubescens*	180	751	57, 61, 71, 81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Australocyathus	*A. vicentinus*	16	148	57, 71
Conocyathus	*C. formosus*	320	367	71
	C. gracilis	22	291	57, 71
	C. zelandiae	4	137	57, 71, 81
Cryptotrochus	*C. brevipalus*	466	700	71
	C. carolinensis	320	338	31
	C. javanus	585	585	71
	C. nascornatus	183	457	51
	C. pileus	123	522	57, 61, 71, 81
Deltocyathoides	*D. orientalis*	44	635	51, 57, 61, 71, 77, 81
	D. stimpsonii	110	600	27, 31, 34, 41
Dunocyathus	*D. parasiticus*	64	549	57, 71, 81
	D. wallaceae	320	414	71
Endocyathopora	*E. laticostata*	46	100	57, 71
Foveolocyathus	*F. alternans*	27	238	57
	F. kitsoni	342	367	57, 71
	F. parkeri	73	183	57
	F. verconis	73	183	57, 71, 81
Holcotrochus	*H. crenulatus*	40	414	57, 71
	H. scriptus	9	342	57, 71
Idiotrochus	*I. alatus*	315	450	71, 81
	I. australis	274	274	71
	I. emarciatus	82	238	57
	I. kikutii	97	645	57, 61, 71
Kionotrochus	*K. suteri*	44	622	81
Lissotrochus	*L. curvatus*	342	367	71
Notocyathus	*N. conicus*	34	1 110	61, 71, 81
	N. venustus	70	555	57, 61, 71
Peponocyathus	*P. dawsoni*	87	988	81
	P. folliculus	30	582	27, 31, 34, 61, 71
	P. minimus	30	903	71
Platytrochus	*P. compressus*	64	130	81
	P. hastatus	27	148	57
	P. laevigatus	22	165	57
	P. parisepta	40	201	57
	P. venustus	200	397	71, 81
	P. zibrowii	1 137	1 137	71
Pseudocyathoceras	*P. avis*	91	183	87
Sphenotrochus	*S. andrewianus andrewianus*	12	105	27, 34, 37
	S. andrewianus moorei	9	42	31
	S. aurantiacus	155	366	51
	S. auritus	15	64	31, 41
	S. cuneolus	42	342	71
	S. evexicostatus	12	73	51
	S. excavatus	?	?	81
	S. gardineri	9	403	41, 87
	S. gilchristi	24	165	51
	S. hancocki	18	274	71, 87
	S. imbricaticostatus	37	347	51
	S. lindstroemi	22	78	31
	S. ralphae	7	104	81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	S. squiresi	66	318	81
Thrypticotrochus	*T. petterdi*	95	925	51, 71, 81
Trematotrochus	*T. corbicula*	400	576	31
	T. hedleyi	150	457	71, 81
Tropidocyathus	*T. labidus*	206	536	57, 61, 71
	T. lessonii	50	421	51, 57, 61, 71
	T. sp.	346	346	71
Turbinolia	*T. stephensoni*	9	32	71

APPENDIX 2

Order Antipatharia

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Family Antipathidae				
Antipathes	*A. atlantica*	21	140	31, 41
	A. caribbeana	11	76	31
	A. curvata	40	604	71, 77
	A. dendrochristos	96	200	77
	A. grandis	30	91	71, 77
Family Aphanipathidae				
Aphanipathes	*A. pedata*	87	292	21, 31
	A. salix	137	263	31
	A. sarothamnoides	67	111	51, 71
	A. verticellata	79	79	61
Family Cladopathidae				
Chrysopathes	*C. formosa*	640	950	77, 87
	C. gracilis	640	640	77
	C. speciosa	225	1 168	67
Sibopathes	*S. gephura*	1 224	1 224	57
	S. macrospina	448	559	31
Trissopathes	*T. psedutristicha*	259	2 544	67, 77
	T. tetracrada	375	2 220	34, 57, 77
	T. tristicha	236	1 330	57, 61?, 71, 81
Family Stylopathidae				
Stylopathes	*S. americana*	159	503	31
Tylopathes	*T. atlantica*	?	?	34
	T. crispa	732	732	87
Family Myriopathidae				
Plumapathes	*P. pennacea*	15	190	31, 51
Tanacetopathes	*T. hirta*	12	262	31, 41
Family Schizopathidae				
Bathypathes	*B. alternata*	182	4 923	21, 31, 41?, 48, 61?, 67, 71, 81, 87, 88
Dendropathypathes	*D. boutillieri*	1 689	2 162	61, 67
Lillipathes	*L. lillei*	?	?	
	L. quadribranchiata	?	?	71
	L. wingi	225	2 083	67
Parantipathes	*P. tetrasticha*	96	1 165	21, 31
Stauropathes	*S. arctica*	1 535	1 850	27
	S. punctata	395	395	77
	S. staurocrada	220	1 770	77, 81
Family Leiopathidae				
Adelopora	*A. crassilabrum*	282	1 169	71, 81
	A. moseleyi	291	360	77, 81
	A. pseudothyron	298	915	41, 81, 87
	A. fragilis	400	1 570	71, 81
Astya	*A. aspidopora*	590	1 058	81
	A. subviridis	914	914	71
Calyptopora	*C. reticulata*	93	2 010	81
	C. sinuosa	142	762	71, 81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Cheiloporidion	*C. pulvinatum*	642	1 137	41
	C. laevis	130	1 052	51?, 61, 71, 81
	C. verrucosa	198	2 626	81, 88
	C. candelabrum	240	1 265	71, 81
	C. tetrastichopora	282	850	71, 81
	C. gigantea	356	544	81
	A. adeta	398	399	71
	C. anthohelia	440	1 175	81
	C. unifacialis	547	547	81
	C. dura	?	?	51?, 57?
Crypthelia	*C. peircei*	89	838	31
	C. micropoma	140	140	51
	C. studeri	142	1 058	81
	C. trophostega	150	1 913	61, 67
	C. insolita	159	720	31
	C. papillosa	161	545	31
	C. glebulenta	166	806	87
	C. cymas	169	1 097	81, 87
	C. cryptotrema	170	474	71
	C. glossopoma	198	864	31
	C. japonica	247	551	61
	C. lacunosa	252	806	87
	C. curvata	287	1 058	81
	C. polypoma	290	966	71, 81
	C. dactylopoma	348	813	87
	C. pudica	368	1 633	57?, 61, 71, 81
	C. robusta	374	709	71, 81
	C. vascomarquesi	390	1 520	27, 34
	C. formosa	419	2 044	41
	C. platypoma	469	469	71
	C. gigantea	475	784	87
	C. eueides	475	813	87
	C. floridana	593	823	31
	C. fragilis	647	2 328	57, 71, 81
	C. affinis	712	2 790?	27
	C. tenuisepta	761	1 557	27, 31, 34
	C. medioatlantica	861	2 644	27
	C. ramosa	1 165	1 264	71
	C. balia	1 633	1 633	71
	C. clausa	?	?	51?, 57?
	C. stenopoma	?	?	71?
	C. lamellata	83	550	67
Distichopora	*D. sulcata*	60	708	31
	D. cervina	68	384	31
	D. barbadensis	108	159	31
	D. contorta	125	368	31
	D. anomala	139	311	31
	D. rosalindae	165	198	31
	D. laevigranulosa	166	806	87
	D. foliacea	174	527	31
	D. asulcata	293	377	77
	D. uniserialis	333	366	31

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	D. anceps	360	736	77
	D. dispar	465	741	81
	D. coccinea	?	?	61?, 71?, 81?
	D. gracilis	?	?	61?, 71?, 81?
	D. livida	?	?	61?, 71?, 81?
	D. profunda	?	?	51?, 57?
	D. providentiae	?	?	51?, 57?
	D. serpens	?	?	51?, 57?
Errina	*E. reticulata*	79	128	
	E. laterorifa	79	2 273	48, 58, 81
	E. aspera	80	200	27?, 34, 37
	E. japonica	85	85	61
	E. kerguelensis	91	567	81, 88
	E. boschmai	100	686	41, 48, 88?
	E. chathamensis	106	688	81
	E. sinuosa	135	1 075	47, 81
	E. dabneyi	140	2 200	27
	E. gracilis	146	1 226	41, 48, 81, 87, 88
	E. cochleata	194	534	31
	E. altispina	198	309	31
	E. cheilopora	198	659	81
	E. bicolor	252	549	81
	E. cooki	256	380	81
	E. laevigata	333	371	81
	E. macrogastra	549	704	77, 87
	E. atlantica	610	983	27
	E. cyclopora	1 647	2 044	41
	E. capensis	?	?	27?, 34?, 47?
	E. porifera	?	?	61?, 71?, 81?
Errinopora	*E. nanneca*	63	375	61, 67
	E. stylifera	108	117	61
	E. latifundata	109	109	61
	E. zarhyncha	207	658	67
	E. cestoporina	339	1 240	41
	E. fenestrata	152	622	41, 87
	E. reticulum	250	771	41
Inferiolabiata	*I. lowei*	164	991	41, 48, 87
	I. spinosa	211	781	81
	I. labiata	238	274	51
Leiopathes	*L. acanthphora*	1 011	1 020	57
	L. glaberrima	37	2 400	27, 31, 34, 37, 71, 77
Lepidopora	*L. clavigera*	130	282	31
	L. glabra	183	1 170	21, 31, 41
	L. biserialis	196	370	81
	L. cryptocymas	197	506	81
	L. polystichopora	197	710	31
	L. decipiens	276	670	31
	L. symmetrica	282	1 058	81
	L. dendrostylus	345	975	81
	L. microstylus	405	1 258	71?, 81
	L. eburnea	460	983	27
	L. sarmentosa	502	1 665	71, 81, 88

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	L. acrolophos	659	686	41
	L. concatenata	680	720	87
	L. diffusa	?	?	27?, 34?, 47?
	L. granulosa	?	?	48?, 58?, 88?
Lepidotheca	*L. cervicornis*	110	110	81
	L. pourtalesi	123	368	31
	L. chauliostylus	130	1 265	71, 81
	L. macropora	169	806	87
	L. tenuistylus	238	274	51
	L. robusta	365	365	81
	L. ramosa	520	520	71
	L. fascicularis	540	2 010	88
	L. brochi	545	864	31
	L. altispina	660	1 570	81
	L. inconsuta	787	1 500	81
	L. horrida	1 089	1 089	71
Paraerrina	*P. dicipiens*	238	274	51
Phalangopora	*P. regularis*	238	274	51
Pliobonthrus	*P. symmetricus*	80	1 600	27, 31, 34
	P. echinatus	165	750	31
	P. tubulatus	419	708	31
	P. fistulosus	546	631	77
	P. gracilis	600	700	34
Pseudocrypthelia	*P. pachypoma*	430	1 089	71
Sporadopora	*S. dichotoma*	250	1 498	41, 48
	S. martenseni	282	282	81
	S. macropora	465	741	81
Stellapora	*S. echinata*	215	1 846	41
Stenohelia	*S. maderensis*	110	1 125	27, 34
	S. profunda	159	2 021	31
	S. concinna	166	806	87
	S. pauciseptata	282	514	31
	S. conferta	?	?	61?, 71?, 81?
	S. echinata	?	?	61?, 71?, 81?
	S. tiliata	?	?	61?, 71?, 81?
	S. umbonata	?	?	61?, 71?, 81?
	S. yabei	?	?	61?, 71?, 81?
Stephanohelia	*S. praecipua*	318	1 277	71, 81
Stylantheca	*S. papillosa*	?	?	67?, 77?, 87?
Stylaster	*S. brochi*	62	582	61, 67
	S. bithalamus	71	71	47
	S. norvegicus	75	1 400	27
	S. brunneus	80	290	71, 81
	S. marenzelleri	84	631	77, 87
	S. verrillii	87	366	67
	S. polyorchis	91	823	67
	S. densicaulis	96	1 362	41, 48
	S. boreopacificus	117	183	61
	S. aurantiacus	123	355	31
	S. moseleyanus	126	518	67
	S. imbricatus	128	1 037	81
	S. miniatus	146	530	31

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	S. erubescens	146	1 440	21, 27, 31
	S. cancellatus	152	582	61, 67
	S. antillarum	174	653	31
	S. filogranus	183	274	31
	S. complanatus	183	707	31
	S. inornatus	198	309	31
	S. elassotomus	210	882	61
	S. horologium	228	1 169	71, 81
	S. galapagensis	252	806	77, 87
	S. gracilis	291	291	81
	S. cocosensis	293	576	77
	S. robustus	300	300	48
	S. griggi	322	583	77
	S. multiplex	372	450	71
	S. spatula	384	549	31
	S. ibericus	500	500	27
	S. bilobatus	520	520	57
	S. infundibuliferus	521	563	77
	S. maroccanus	1 378	1 378	34
	S. alaskanus	?	?	61?, 67
	S. amphiheloides	?	?	47, 48?
	S. bellus	?	?	61?, 71?, 81?
	S. bocki	95	95	61?, 71?, 81?
	S. boschmai	?	?	61?, 71?, 81?
	S. carinatus	?	?	61?, 71?, 81?
	S. crassior	?	?	51?, 57?
	S. dentatus	?	?	61?, 71?, 81?
	S. flabelliformis	?	?	51
	S. granulosus	?	?	61?, 71?, 81?
	S. hattorrii	?	?	61?, 71?, 81?
	S. incompletus	?	?	61?, 71?, 81?
	S. incrassitus (not valid?)	?	?	61?, 71?, 81?
	S. microstriatus	?	?	61?, 71?, 81?
	S. nobilis	?	?	47
	S. polymorphus	?	?	
	S. profundus	?	?	21?, 31?, 41?
	S. profundiporus	?	?	61?, 71?, 81?
	S. pulcher	?	?	61?, 71?, 81?
	S. purpuratus	?	?	61?, 71?, 81?
	S. ramosus	?	?	51?, 57?
	S. scabiosus	?	?	61?, 71?, 81?
	S. solidus	?	?	61?, 71?, 81?
	S. stejnegeri	?	?	67?, 77?, 87?
	S. stellulatus	?	?	61?, 71?, 81?
Systemapora	*S. ornata*	285	725	71, 81

APPENDIX 3

Subclass Octocorallia (Order Gorgonacea)

Genus	Species	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Family Chrysogorgiidae				
Iridogorgia	*I. bella*	748	1 925	77
	I. fontinalis	?	?	31?
	I. magnispiralis	2 143	2 248	31
	I. pourtalesii	1 633	1 633	31, 37
	I. splendens	1 986	1 986	21
Metallogorgia	*M. macrospina*	?	?	71
	M. melanotrichos	235	2 050	27, 34, 71?, 77, 81
	M. splendens	?	?	
	M. tenuis	490	490	61
Family Coralliidae				
Corallium	*C. abyssale*	1 829	2 403	77
	C. borneanse	?	?	71
	C. boshuense	670	715	77
	C. ducale	40?	2 000	77
	C. elatius	?	?	61
	C. halmaheirense	?	?	
	C. imperiale	0	2 000	77
	C. johnsoni	3 150	3 150	27
	C. konojoi	?	?	61
	C. maderense	?	?	34?
	C. medea	522	1 426	31, 41
	C. niobe	659	1 646	21, 31
	C. niveum	200	546	77
	C. porcellanum	670	715	77
	C. pusillum	?	?	
	C. regale	68	1 864	61, 67, 77
	C. reginae	1 210	1 260	71
	C. rubrum	?	?	37
	C. secundum	124	1 100	61, 77
	C. sulcatum	800	800	61
	C. tricolor	?	?	
	C. vanderbilti	?	?	
	C. variabile	?	?	
Paracorallium	*P. inutile*	?	?	
	P. japonicum	?	?	
	P. nix	?	?	
	P. salomonense	?	?	
	P. stylasteroides	?	?	
	P. thrinax	?	?	
	P. tortuosum	0	678	61, 77
Family Isididae				
Acanella	*A. africana*	>1 000	>1 000	71?
	A. arbuscula	110	4 550	21, 27, 31, 34, 41
	A. chiliensis	324	324	87
	A. dispar	216	1 743	77
	A. eburnea	254	2 881	21, 31, 41, 77

Genus	Species	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	A. furcata	?	?	
	A. microspiculata	?	?	
	A. robusta	>1 000?	>1 000?	57
	A. sibogae	244	1 570	61, 71, 81
	A. verticillata	>1 000?	>1 000?	71
	A. weberi	450	1 767?	71, 77?
Isidella	*I. elongata*	320	1 582	27?, 31?, 34?, 37
	I. lofotensis	123	>1 000	27
	I. Longiflora	1 700	1 700	27, 41
	I. trichotoma	370	6 300	77
Keratoisis	*K. chuni*	>1 000?	>1 000?	67
	K. flabellum	415	1 745	77
	K. flexibilis	170	878	21?, 31, 37?, 81
	K. glaesa	406	406	81
	K. gracilis	>50?	>50?	57
	K. grandiflora	384	1 116	71
	K. grandis	1 264	1 563	77?
	K. grayi	1 560	1 560	27, 31?, 37
	K. hikurangiensis	834	951	81
	K. japonica	550	550	61
	K. macrospiculata	1 694	1 694	34
	K. microspiculata	?	?	
	K. palmae	2 082	2 082	34
	K. paucispinosa	348	539	61, 77
	K. philippinensis	567	805	61, 71
	K. profunda	3 230	3 230	67
	K. projecta	743	743	81
	K. siemensii	3 259	3 259	21?, 27?
	K. squatiosa	?	?	
	K. squarrosa	?	?	61
	K. tangentis	406	406	81
	K. wrighti	655	655	71
	K. zelandica	913	1 003	81
Family Paragorgiidae				
Paragorgia	*P. alisonae*	935	1 180	61, 81
	P. aotearoa	700	900	67, 81
	P. arborea	90	1 798	21, 27, 61, 67, 81
	P. coralloides	602	3 000	71, 77, 81
	P. johnsoni	566	608	21, 31, 41
	P. kaupeka	787	949	61, 81
	P. maunga	545	1 121	61, 81
	P. regalis	332	1 743	67, 77
	P. sibogae	522	522	71
	P. splendens	733	925	57
	P. stephencairnsi	350	490	67, 77
	P. tapachtli	1 950	1 950	77
	P. wahine	890	1 000	61, 81
	P. whero	772	951	61, 81
	P. yutlinux	487	861	77
Family Plexauridae				
Alaskagorgia	*A. aluetiana*	137	746	67

Genus	Species	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
Paramuricea	*P. granids*	457	2 180	21, 31
Family Primnoidae				
Callogorgia	*C. affinis*	113	113	71
	C. americana	37	732	31
	C. chariessa	49	90	71
	C. cristata	160	545	61?, 71
	C. dubia	730	730	57?
	C. elegans	143	143	71
	C. flabellum	402	1 250	71, 77
	C. formosa	80	750	71, 77
	C. gilberti	339	1 000	61, 77
	C. gracilis	51	718	31
	C. grimaldii	?	?	31?
	C. indica	82	490	57
	C. joubini	520	520	71
	C. kinoshitae	220	2 472	77
	C. laevis	?	?	57?
	C. linguimaris	501	1 116	31
	C. minuta	90	90	71
	C. modesta	1 075	1 075	71
	C. pennacea	204	204	71
	C. ramosa	?	?	61
	C. robusta	520	1 301	71
	C. sertosa	256	256	71
	C. similis	90	90	71
	C. ventilabrum	162	162	81
	C. versluysi	203	203	71
	C. verticillata	37	2 472	27, 34, 37
Calyptrophora	*C. agassizii*	372	1 545	61, 77, 87
	C. angularis	417	1 723	77
	C. antilla	1 110	1 763	21, 31, 77
	C. clarki	216	2 672	61, 67, 77
	C. clinata	1 315	1 842	21
	C. gerdae	229	556	31
	C. japonica	205	2 794	61, 67, 71, 77
	C. juliae	394	729	71
	C. laevispinosa	3 107	3 107	67
	C. microdentata	686	2 247	21, 31
	C. spinosa	216	1 575	71
	C. trilepis	324	911	31
	C. wyvillei	380	1 370	77, 81
Narella	*N. abyssalis*	4 594	4 594	67
	N. alaskensis	2 377	3 075	67
	N. alata	216	750	77
	N. allmani	622	622	71
	N. alvinae	2 172	3 519	21, 31
	N. ambigua	717	1 463	87
	N. bayeri	3 277	4 091	67
	N. bellissima	439	841	31
	N. biannulata	?	?	61
	N. bowersi	800	2 600	67, 77
	N. clavata	296	296	71

Genus	Species	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	N. compressa	?	?	61
	N. dichotoma	670	1 448	61?, 77
	N. gaussi	2 022	2 897	48
	N. gigas	344	564	77
	N. gilchristi	100	340	51
	N. grandiflora	235	245	61
	N. hawaiiensis	400	1 977	77
	N. horrida	204	204	71
	N. irregularis	188	188	61
	N. japonensis	731	731	61
	N. laxa	3 186	3 186	21
	N. leilae	159	732	71
	N. macrocalyx	1 206	1 807	77
	N. megalepis	224	1 609	57, 61, 71
	N. musikae	215	954	77
	N. obscura	984	984	71
	N. orientalis	235	732	71
	N. ornata	409	1 006	77
	N. parva	1 300	1 633	71
	N. pauciflora	738	1 510	31
	N. regularis	729	729	31
	N. spectabilis	1 485	1 485	31
	N. studeri	1 080	1 264	71, 81
	N. versluysi	659	3 100	21, 27, 31
Paracalyptrophora	*P. carinata*	514	525	31
	P. duplex	49	575	31
	P. josephinae	201	330	27, 31, 34
	P. kerberti	552	552	61
	P. mariae	520	520	61?, 71
	P. simplex	18	531	31
Plumarella	*P. aculeata*	350	586	31
	P. acuminata	330	330	61
	P. adhaerans	180?	180?	61
	P. alba	550	550	61
	P. aurea	388	878	31
	P. delicatissima	256	256	41?
	P. dentata	229	494	41, 51?
	P. dichotoma	494	1 064	31
	P. dofleini	80	250	61
	P. flabellata	188	247	61
	P. gracilis	?	?	61
	P. laevis	90	115	71?
	P. lata	62	68	61
	P. laxiramosa	347	878	31
	P. longispina	198	282	67, 77
	P. pellucida	10	1 200	31
	P. penna	8	10	57
	P. pourtalesii	45	1 435	31
	P. rigida	180	600	61
	P. spicata	779	1 963	61
	P. spinosa	881	881	61
Primnoa	*P. notialis*	549	1 153	

Genus	Species	Depth range (m)		FAO Major Fishing Areas
		Min	Max	
	P. pacifica	9	800	61, 67, 77
	P. resedaeformis	95	1 020	21, 27, 34?
	P. wingi	110	914	61, 67
Thouarella	*T. abies*	100	550	48
	T. affinis	106	128	47
	T. alternata	34	138	61
	T. antarctica	118	118	41
	T. bipinnata	82	1 446	31
	T. brucei	102	183	47
	T. chilensis	73	130	41, 48, 87?
	T. clavata	500	500	41?, 47?
	T. coronata	148	148	61?
	T. crenelata	133	686	48
	T. diadema	1 000	1 000	41
	T. grasshoffi	814	1 805	21, 27, 34
	T. hicksoni	110	360	51
	T. hilgendorfi	174	1 760	34, 61, 71, 77
	T. koellikeri	320	730	87
	T. laxa	400	1 644	51, 57, 61, 71
	T. longispinosa	283	284	48
	T. moseleyi	794	1 080	71, 81
	T. parva	?	?	61
	T. pendulina	?	?	
	T. recta	869	924	61
	T. striata	384	642	67
	T. superba	40	384	61, 67
	T. tydemani	?	?	71?
	T. typica	174	388	61, 77
	T. variabilis	183	366	58
Stylaster	*S. hattorrii*	?	?	61?, 71?, 81?
	S. incompletus	?	?	61?, 71?, 81?
	S. incrassitus (not valid?)	?	?	61?, 71?, 81?
	S. microstriatus	?	?	61?, 71?, 81?
	S. nobilis	?	?	47
	S. polymorphus	?	?	
	S. profundus	?	?	21?, 31?, 41?
	S. profundiporus	?	?	61?, 71?, 81?
	S. pulcher	?	?	61?, 71?, 81?
	S. purpuratus	?	?	61?, 71?, 81?
	S. ramosus	?	?	51?, 57?
	S. scabiosus	?	?	61?, 71?, 81?
	S. solidus	?	?	61?, 71?, 81?
	S. stejnegeri	?	?	61?, 71?, 81?
	S. stellulatus	?	?	61?, 71?, 81?

APPENDIX 4

Order Anthoathecata (Suborder Filifera)

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Max	Min	
Family Hydractiniiidae				
Hydrocorella	*H. africana*	18	57	47
Janaria	*J. mirabilis*	7	137	71, 77
Polyhydra	*P. calcarea*	?	?	27?
Family Stylasteridae				
Adelopora	*A. crassilabrum*	282	1 169	71, 81
	A. moseleyi	291	360	77, 81
	A. pseudothyron	298	915	41, 81, 87
	A. fragilis	400	1 570	71, 81
Astya	*A. aspidopora*	590	1 058	81
	A. subviridis	914	914	71
Calyptopora	*C. reticulata*	93	2 010	81
	C. sinuosa	142	762	71, 81
Cheiloporidion	*C. pulvinatum*	642	1 137	41
Conopora	*C. laevis*	130	1 052	51?, 61, 71, 81
	C. verrucosa	198	2 626	81, 88
	C. candelabrum	240	1 265	71, 81
	C. tetrastichopora	282	850	71, 81
	C. gigantea	356	544	81
	A. adeta	398	399	71
	C. anthohelia	440	1 175	81
	C. unifacialis	547	547	81
	C. dura	?	?	51?, 57?
Crypthelia	*C. peircei*	89	838	31
	C. micropoma	140	140	51
	C. studeri	142	1 058	81
	C. trophostega	150	1 913	61, 67
	C. insolita	159	720	31
	C. papillosa	161	545	31
	C. glebulenta	166	806	87
	C. cymas	169	1 097	81, 87
	C. cryptotrema	170	474	71
	C. glossopoma	198	864	31
	C. japonica	247	551	61
	C. lacunosa	252	806	87
	C. curvata	287	1 058	81
	C. polypoma	290	966	71, 81
	C. dactylopoma	348	813	87
	C. pudica	368	1633	57?, 61, 71, 81
	C. robusta	374	709	71, 81
	C. vascomarquesi	390	1 520	27, 34
	C. formosa	419	2 044	41
	C. platypoma	469	469	71
	C. gigantea	475	784	87

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Max	Min	
	C. eueides	475	813	87
	C. floridana	593	823	31
	C. fragilis	647	2 328	57, 71, 81
	C. affinis	712	2 790?	27
	C. tenuisepta	761	1 557	27, 31, 34
	C. medioatlantica	861	2 644	27
	C. ramosa	1 165	1 264	71
	C. balia	1 633	1 633	71
	C. clausa	?	?	51?, 57?
	C. stenopoma	?	?	71?
	C. lamellata	83	550	67
Distichopora	*D. violacea*	0	122	34, 47, 51
	D. irregularis	6	46	31
	D. borealis	10	881	61, 67, 71
	D. vervoorti	15	20	71
	D. nitida	22	22	71
	D. yucatanensis	39	261	31
	D. sulcata	60	708	31
	D. cervina	68	384	31
	D. barbadensis	108	159	31
	D. contorta	125	368	31
	D. anomala	139	311	31
	D. rosalindae	165	198	31
	D. laevigranulosa	166	806	87
	D. foliacea	174	527	31
	D. asulcata	293	377	77
	D. uniserialis	333	366	31
	D. anceps	360	736	77
	D. dispar	465	741	81
	D. coccinea	?	?	61?, 71?, 81?
	D. gracilis	?	?	61?, 71?, 81?
	D. livida	?	?	61?, 71?, 81?
	D. profunda	?	?	51?, 57?
	D. providentiae	?	?	51?, 57?
	D. serpens	?	?	51?, 57?
Errina	*E. antarctica*	25	903	41, 87
	E. novaezelandiae	30	117	81
	E. dendyi	30	383	81
	E. hicksoni	37	157	81
	E. fissurata	46	1 775	48, 88
	E. reticulata	79	128	81
	E. laterorifa	79	2 273	48, 58, 81, 88
	E. aspera	80	200	27?, 34, 37
	E. japonica	85	85	61
	E. kerguelensis	91	567	81, 88
	E. boschmai	100	686	41, 48
	E. chathamensis	106	688	81
	E. sinuosa	135	1 075	47, 81

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Max	Min	
	E. dabneyi	140	2 200	27
	E. gracilis	146	1 226	41, 48, 81, 87, 88
	E. cochleata	194	534	31
	E. altispina	198	309	31
	E. cheilopora	198	659	81
	E. bicolor	252	549	81
	E. cooki	256	380	81
	E. laevigata	333	371	81
	E. macrogastra	549	704	77, 87
	E. atlantica	610	983	27
	E. cyclopora	1 647	2 044	41
	E. capensis	?	?	27?, 34?, 47?
	E. porifera	?	?	61?, 71?, 81?
Errinopora	*E. pourtalesi*	49	183	77
	E. nanneca	63	375	61, 67
	E. stylifera	108	117	61
	E. latifundata	109	109	61
	E. zarhyncha	207	658	67
	E. cestoporina	339	1 240	41
	E. fenestrata	152	622	41, 87
	E. reticulum	250	771	41
Gyropora	*G. africana*	22	22	47
Inferiolabiata	*I. lowei*	164	991	41, 48, 87
	I. spinosa	211	781	81
	I. labiata	238	274	51
Lepidopora	*L. carinata*	60	494	31
	L. clavigera	130	282	31
	L. glabra	183	1 170	21, 31, 41
	L. biserialis	196	370	31
	L. cryptocymas	197	506	81
	L. polystichopora	197	710	81
	L. decipiens	276	670	31
	L. symmetrica	282	1 058	81
	L. dendrostylus	345	975	81
	L. microstylus	405	1 258	71?, 81
	L. eburnea	460	983	27
	L. sarmentosa	502	1 665	71, 81, 88
	L. acrolophos	659	686	41
	L. concatenata	680	720	87
	L. diffusa	?	?	27?, 34?, 47?
	L. granulosa	?	?	48?, 58?, 88?
Lepidotheca	*L. cervicornis*	110	110	81
	L. pourtalesi	123	368	31
	L. chauliostylus	130	1 265	71, 81
	L. macropora	169	806	87
	L. tenuistylus	238	274	51
	L. robusta	365	365	81
	L. ramosa	520	520	71

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Max	Min	
	L. fascicularis	540	2 010	88
	L. brochi	545	864	31
	L. altispina	660	1 570	81
	L. inconsuta	787	1 500	81
	L. horrida	1 089	1 089	71
Paraerrina	*P. dicipiens*	238	274	51
Phalangopora	*P. regularis*	238	274	51
Pliobonthrus	*P. symmetricus*	80	1 600	27, 31, 34
	P. echinatus	165	750	31
	P. tubulatus	419	708	31
	P. fistulosus	546	631	77
	P. gracilis	600	700	34
Pseudocrypthelia	*P. pachypoma*	430	1 089	71
Sporadopora	*S. dichotoma*	250	1 498	41, 48
	S. martenseni	282	282	81
	S. macropora	465	741	81
Stellapora	*S. echinata*	215	1 846	41
Stenohelia	*S. maderensis*	110	1 125	27, 34
	S. profunda	159	2 021	31
	S. concinna	166	806	87
	S. pauciseptata	282	514	31
	S. conferta	?	?	48?, 58?, 88?
	S. echinata	?	?	61?, 71?, 81?
	S. tiliata	?	?	61?, 71?, 81?
	S. umbonata	?	?	61?, 71?, 81?
	S. yabei	?	?	61?, 71?, 81?
Stephanohelia	*S. praecipua*	318	1 277	71, 81
Stylantheca	*S. prophyra*	0	1	77
	S. petrograpta	0	15	67
	S. papillosa	?	?	67?, 77?, 87?
Stylaster	*S. marshae*	0	13	57
	S. tenisonwoodsi	1	90	57, 71
	S. roseus	2	494	31, 41
	S. sanguineus	3	20	71, 77
	S. papuensis	6	20	71
	S. blatteus	10	10	34
	S. californicus	12	91	67, 77
	S. asper	13	133	71
	S. corallium	13	298	31
	S. laevigatus	20	1 170	31
	S. subviolacea	22	22	47
	S. campylecus	23	518	61, 67
	S. eguchii	24	1 520	71, 81
	S. venustus	27	108	67, 77
	S. lonchitis	30	113	51
	S. rosaceus	37	37	34
	S. gemmascens	40	665	21, 27
	S. eximius (valid?)	40	823	31, 71

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Max	Min	
	S. duchassaingi	40	915	31, 41?
	S. divergens	55	549	87
	S. brochi	62	582	61, 67
	S. bithalamus	71	71	47
	S. norvegicus	75	1 400	27
	S. brunneus	80	290	71, 81?
	S. marenzelleri	84	631	77, 87
	S. verrillii	87	366	67
	S. polyorchis	91	823	67
	S. densicaulis	96	1 362	41, 48
	S. boreopacificus	117	183	61
	S. aurantiacus	123	355	31
	S. moseleyanus	126	518	67
	S. imbricatus	128	1 037	81
	S. miniatus	146	530	31
	S. erubescens	146	1 440	21, 27, 31
	S. cancellatus	152	582	61, 67
	S. antillarum	174	653	31
	S. filogranus	183	274	31
	S. complanatus	183	707	31
	S. inornatus	198	309	31
	S. elassotomus	210	882	61
	S. horologium	228	1 169	71, 81
	S. galapagensis	252	806	77, 87
	S. gracilis	291	291	81
	S. cocosensis	293	576	77
	S. robustus	300	300	48
	S. griggi	322	583	77
	S. multiplex	372	450	71
	S. spatula	384	549	31
	S. ibericus	500	500	27
	S. bilobatus	520	520	57
	S. infundibuliferus	521	563	77
	S. maroccanus	1 378	1 378	34
	S. alaskanus	?	?	61?, 67?
	S. amphiheloides	?	?	47, 48?
	S. bellus	?	?	61?, 71?, 81?
	S. bocki	95	95	61?, 71?, 81?
	S. boschmai	?	?	61?, 71?, 81?
	S. carinatus	?	?	61?, 71?, 81?
	S. crassior	?	?	51?, 57?
	S. dentatus	?	?	61?, 71?, 81?
	S. flabelliformis	?	?	51
	S. granulosus	?	?	61?, 71?, 81?
	S. hattorrii	?	?	61?, 71?, 81?
	S. incompletus	?	?	61?, 71?, 81?
	S. incrassitus (not valid?)	?	?	61?, 71?, 81?
	S. microstriatus	?	?	61?, 71?, 81?

Genus	Species (* facultative species)	Depth range (m)		FAO Major Fishing Areas
		Max	Min	
	S. nobilis	?	?	47
	S. polymorphus	?	?	
	S. profundus	?	?	21?, 31?, 41?
	S. profundiporus	?	?	61?, 71?, 81?
	S. pulcher	?	?	61?, 71?, 81?
	S. purpuratus	?	?	61?, 71?, 81?
	S. ramosus	?	?	51?, 57?
	S. scabiosus	?	?	61?, 71?, 81?
	S. solidus	?	?	61?, 71?, 81?
	S. stejnegeri	?	?	67?, 77?, 87?
	S. stellulatus	?	?	61?, 71?, 81?
Systemapora	*S. ornata*	285	725	71, 81

Towards the development of an identification guide of vulnerable deep-sea sponges

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Overview

Following the FAO terms of reference, a list of the global distribution (in relation to the 19 FAO Major Fishing Areas) of the most relevant deep-sea sponge groups: the entire class Hexactinellida; orders Lithistida and Astrophorida within Demospongiae; some other genera within Demospongiae, was compiled. Also, a relevant bibliography for general taxonomy, historical campaigns, each species group and main international sponge initiatives was assembled. Finally, draft recommendations for the production of identification guides are suggested.

1. List of relevant sponge groups

A compilation of a global species list (for FAO Fishing Areas) of the most relevant deep-sea sponge groups: the entire class Hexactinellida; orders Lithistida and Astrophorida within Demospongiae; some other genera within the Orders Poecilosclerida, Halichondrida and Haplosclerida (Demospongiae), is presented in Table 1. These are the groups that are most likely to be impacted by fisheries.

Table 1
Global species list for FAO Major Fishing Areas

Class	Subclass	Order	Family
Hexactinellida Schmidt, 1870	Amphidiscophora Schulze, 1886	Amphidiscosida Schrammen, 1924	• Hyalonematidae Gray, 1857 • Monorhaphididae Ijima, 1927 • Pheronematidae Gray, 1870
	Hexasterophora Schulze, 1886	Aulocalycoida Tabachnick and Reiswig, 2000	• Aulocalycidae Ijima, 1927 • Uncinateridae Reiswig, 2002
		Fieldingida Tabachnick and Janussen, 2004	• Fieldingiidae Tabachnick and Janussen, 2004
		Hexactinosida Schrammen, 1912	• Aphrocallistidae Gray, 1867 • Craticulariidae Rauff, 1893 • Cribrospongiidae Roemer, 1864 • Dactylocalycidae Gray, 1867 • Euretidae Zittel, 1877 • Farreidae Gray, 1872 • Tretodictyidae Schulze, 1886
		Lychniscosida Schrammen, 1903	• Aulocystidae Sollas, 1887 • Diapleuridae Ijima, 1927
		Lyssacinosida Zittel, 1877	• Euplectellidae Gray, 1867 • Leucopsacidae Ijima, 1903 Rossellidae Schulze, 1885
Demospongiae Sollas, 1885		Astrophorida Sollas, 1887	• Ancorinidae Schmidt, 1870 • Calthropellidae Lendenfeld, 1907 • Geodiidae Gray, 1867 • Pachastrellidae Carter, 1875 • Thrombidae Sollas, 1888

Class	Subclass	Order	Family
		Hadromerida Topsent, 1894	• Stylocordylidae Topsent, 1892 • Suberitidae Schmidt, 1870 • Tethyidae Gray, 1848
		Lithistida Schmidt, 1870	• Scleritodermidae Sollas, 1888 • Corallistidae Sollas, 1888 • Pleromidae Sollas, 1888 • Theonellidae Lendenfeld, 1903 • Siphonidiidae Lendenfeld, 1903 • Neopeltidae Sollas, 1888 • Azoricidae Sollas, 1888 • Desmathidae Topsent, 1894 • Vetulinidae Lendenfeld, 1903 • Phymatellidae Schrammen, 1910 • Isoraphiniidae Schrammen, 1924 • Macandrewiidae Schrammen, 1924 • Phymaraphiniidae Schrammen, 1924
		Poecilosclerida Topsent, 1928	• Cladorhizidae Dendy, 1922 • Acarnidae Dendy, 1922 • Esperiopsidae Hentschel, 1923 • Podospongidae de Laubenfels, 1936 • Isodictyidae Dendy, 1924
		Halichondrida Gray, 1867	• Axinellidae Carter, 1875 • Halichondriidae Gray, 1867
		Haplosclerida Topsent, 1928	• Chalinidae Gray, 1867 • Phloeodictyidae Carter, 1882 • Petrosiidae Van Soest, 1980

A summary of the diversity (number of species) of each selected sponge group per FAO area[1] is presented in Table 2. See Appendixes 1, 2, 3, 4, 5, 6 and 7 for details on species and their deep-sea depth occurrence.

[1] Area 18: Arctic Sea; Area 21: Atlantic, Northwest; Area 27: Atlantic, Northeast, Area 31: Atlantic, Western Central; Area 34: Atlantic, Eastern Central; Area 37: Mediterranean and Black Sea; Area 41: Atlantic, Southwest; Area 47: Atlantic, Southeast; Area 48: Atlantic, Antarctic; Area 51, Indian Ocean, Western; Area 57: Indian Ocean, Eastern; Area 58: Indian Ocean, Antarctic and Southern; Area 61: Pacific, Northwest; Area 67: Pacific, Northeast; Area 71: Pacific, Western Central; Area 77: Pacific, Eastern Central; Area 81: Pacific, Southwest; Area 87: Pacific, Southeast; Area 88: Pacific, Antarctic.

Table 2
Diversity (number of species) of each selected sponge group per FAO area[1]

	Poles		Atlantic						Med	Indian			Pacific					
	48, 88	18	21	27	31	34	41	47	37	51	57	58	61	67	71	77	81	87
Hexactinellida	59	9	18	29	44	2	13	4	3	28	35	7	83	33	181	53	21	7
Astrophorida	6	3	3	60	40	28	25	38	43	37	34	8	67	4	73	37	25	10
Hadromerida	4	5	1	8	5	0	2	1	3	2	1	2	10	1	3	2	2	1
Lithistida	1	0	0	11	38	10	5	7	9	33	10	1	10	0	57	2	32	1
Poecilosclerida	37	18	11	32	6	6	9	10	3	4	4	16	23	8	18	10	10	8
Halichondrida	1	10	3	17	6	0	2	0	3	1	1	0	6	2	3	3	1	0
Haplosclerida	3	1	3	19	7	0	0	1	2	0	1	0	0	1	6	1	4	0

[1] Here, the Antarctic is considered as one region, ANT, and not as two different regions, i.e., 48 and 88.

2. Historical campaigns

A list of the main historical campaigns that yielded extensive reports on deep-sea sponge fauna is presented in Table 3.

Table 3
Main historical campaigns on deep-sea sponge fauna

Expedition	Year	Area	Authors
Porcupine	1869 and 1870	Northeast Atlantic	**Carter.** 1874, 1876.
Norma	1870	Spain	**Kent**. 1870 a, b.
Challenger	1872 to 1876	World	**Sollas**. 1888; **Ridley & Dendy**. 1887; **Polejaeff**. 1883, 1884; **Schulze**. 1887.
Blake	1877-1879	Caribbean	**Schmidt**. 1879, 1880.
Vega	1878-1880	Arctic	**Fristedt**. 1887.
Willem Barents	1878-1884	Arctic	**Vosmaer**. 1882,1885.
Alert	1880-1881	Patagonia, Australia, Seychelles	**Ridley**. 1881, 1884
Albert Monaco (Hirondelle)	1888	Northeast Atlantic, Mediterranean	**Topsent**. 1892.
Caudan	1895	Gulf of Biscay	**Topsent**. 1896.
Ingolf	1895-96	North Atlantic, Arctic	**Lundbeck**. 1902, 1905, 1910; **Burton**. 1928.
Valdivia	1898-1899	World	**Lendenfeld**. 1907. **Schulze**. 1904.
Belgian Antarctic	1897 to 1899	Antarctic	**Topsent**. 1902.
Siboga	1899-1900	Indonesia	**Ijima**. 1927**; Burton**. 1939; **Vosmaer**. 1911; **Vosmaer & Vernhout**. 1902.
Albert Monaco (Alice)	1900	Azores	**Topsent**. 1904.
Investigator	1900	Indian Ocean	**Schulze**. 1902**; Dendy & Burton**. 1926; **Burton**. 1928.
Swedish Antarctic	1901-1903	Antarctic	**Burton.** 1934a.
Südpolar	1901-03	Antarctic	**Hentschel**. 1914; **Lendenfeld**. 1907; **Schulze & Kirkpatrick**. 1910.
Discovery 1	1901-1904	Antarctic	**Kirkpatrick**. 1907, 1908; **Jenkin**. 1908.
1st French Antarctic	1903-05	Antarctic	**Topsent**. 1908.
Scottish Antarctic	1903-04	South Africa, Antarctic	**Topsent**. 1915; **Stephens**, 1915.

Expedition	Year	Area	Authors
Sealark	1905	West Indian Ocean	**Dendy**. 1913, 1916, 1922.
Albert Monaco (Alice2)	1906-07	North Atlantic	**Topsent**. 1913.
Denmark E Greenland	1906-07	East Greenland	**Brøndsted**. 1917.
2nd French Antarctic	1908-10	Antarctic	**Topsent**. 1917.
Albert Monaco (Alice3)		Northeast Atlantic	**Topsent**. 1928.
Terra Nova	1910	Antarctic	**Dendy**. 1924; **Burton**. 1929.
Michael Sars	1910	Northeast Atlantic	**Arnesen**. 1920.
Discovery 2	1925-27	Falklands, Antarctic	**Burton**. 1932.
Albatross 1	1888	North America	**Schulze**. 1899.
Albatross 2	1891-1905	East Pacific	**Wilson**. 1904; **Lendenfeld**. 1910 a, b, 1915.
Albatross 3	1907-10	Philippines	**Wilson**. 1925; **Okada**. 1932.
Australasian Antarctic	1911-1914	Antarctic	**Dendy**. 1918.
Fisheries Ireland	1914	Ireland	**Stephens**. 1915, 1921.
Norwegian E Greenland	1930-31	East Greenland	**Burton**. 1934b.
BANZARE	1929-1931	Antarctic	**Koltun**. 1976.
Allan Hancock	1930-31	East Pacific	**Dickinson**. 1945.
John Murray	1933-34	Arabian Gulf	**Burton**. 1959.
Rosaura	1938	Atlantic	**Burton**. 1954.
Galathea	1950-52	World	**Lévi**. 1964.
Théodore Tissier	1955-56	Northeast Atlantic	**Lévi & Vacelet**. 1958.
Soviet Antarctic	1955-1958	Antarctic	**Koltun**. 1964.
Kuriles-Kamtschatka	1966	North Pacific	**Koltun**. 1970.
CANCAP I-VII	1981-1987	East Atlantic	**de Weerdt & van Soest**. 1986.
Vauban	1983	New Caledonia	**Lévi & Lévi**. 1983 a, b.
Balgim	1984	Mediterranean	**Boury-Esnault *et al***. 1994.
BIOCAL	1985	New Caledonia	**Lévi**. 1993.
Thalassa	1987	Gulf of Biscay	**Borojevic & Boury-Esnault**. 1987.
MUSORSTOM	1987	Philippines	**Lévi & Lévi**. 1989.
MAR-ECO	2002-2004	Mid North Atlantic	**Tabachnick & Collins**. 2008.
BIOSYS	2005-2007	North Atlantic	**van Soest *et al***. 2007.

3. Recommendations for the production of the identification guide

Sponge taxonomy and systematics is mainly based on skeletal structures that require microscopic examination, which greatly limits the number of species that can be included in a field guide. Therefore, and in order to assure maximum geographic and taxonomic coverage, the approach proposed for the sponge guide is to select 15–25 species representing the different deep-sea sponge groups for each FAO area (global total of 300–450 spp.).

Criteria for species selection should include:

- Morphological distinctness – select species that due to macro-morphological characteristics are more likely to be confidently and accurately identified in the field.
- Vulnerability – with exception of the abyssal species (>3 500 m depth) all deep-sea sponge species are potentially vulnerable to fishing. However, larger species or those with more elaborate growth forms (massive, cup-shaped, branching) are more likely to be by-caught in fishing operations. Background knowledge on which species are more commonly represented in the by-catch would also be very useful for this selection.
- Structural role – all species known to form dense aggregations should always be included in the guide.

A Working Group encompassing sponge taxonomists with expertise in each of the main deep-sea sponge groups (orders/families) and focal geographical areas should be built. The working group should meet regularly during workshops organized by FAO in collaboration with its members.

The Northeast Atlantic is one of the areas for which the deep-sea sponge fauna has been most comprehensively studied, both in historic as well as more recent times. This area should therefore be selected as pilot for the production of the first regional guide.

An image bank comprising deep-sea ROV, submersible or drop-down camera images and films as well as illustrations in historical monographs should be assembled to assist the selection of species.

Each species sheet should contain scaled *in situ* (optional) and on-deck (obligatory) pictures as well as a description and line drawings highlighting the main macro-morphological diagnostic characteristics (shape, consistency, texture, size, surface ornamentation). Most species lack common names and therefore some effort could be made in either creating suitable common names or attributing unique codes to each species.

Each species sheet should include a distribution map, habitat and depth range. The distribution map should include both an expert map as well as all point records available, especially the species type locality. For some species it would be possible to build predictive habitat-suitability maps through ecological modelling techniques. This would require extra effort but it would be well worth for the structural species, i.e. species known to form dense aggregations (sponge grounds or reefs).

Some species commonly form a characteristic multispecific assemblage (e.g. *Geodia*, *Stryphnus*, *Isops*) or are associated with a particular substrate type (e.g. *Thenea* spp. are always in soft sediment) and therefore this information should be included in the respective sheets.

For regional guides, organizing species by growth form (e.g. massive spherical, branching, vase-shaped, etc) may be more practical than following the classification system.

Some species have large spicules that protrude the sponge surface and can be harmful or at least painful if not handled with care. A small note should be included in these species' sheets.

Potential limitations:

There is a general lack of information on species geographic/bathymetric distribution, and abundance. Many records are unique for a given species and constitute the species type locality.
Except for some regions, the deep-sea sponge fauna is largely unstudied and therefore many of the vulnerable species may constitute new (undescribed) species.

There is a strong bias in both quality and quantity of available information towards the areas that were more comprehensively studied in the past or those that are the focus of more intensive study in recent times (e.g. Northeast Atlantic, Brazil, New Zealand).

Last but not least, as in most taxonomic groups also in Porifera there is a general shortage of taxonomists especially in some deep-sea groups.

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WebPages of the main international sponge initiatives

World Porifera Database (WPD): www.marinespecies.org/porifera
Sponge Barcoding Project (SBP): www.spongebarcoding.org
Porifera Tree of Life Project (PorToL): www.portol.org

APPENDIX 1

Hexactinellida

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
Order Amphidiscosida				
Family Hyalonematidae				
	Hyalonema			
		(Cyliconema)	*abyssale*	51
		(Leptonema)	*acuferum*	71
		(Ijimaonema)	*aculeatum*	57
		(Oonema)	*aequatoriale*	77
		(Onconema)	*agassizi*	77
		(Prionema)	*agujanum*	77
		(Paradisconema)	*alcocki*	57
		(Cyliconema)	*apertum apertum*	61
		(Cyliconema)	*apertum simplex*	61
		(Prionema)	*azuerone*	77
		(Oonema)	*bianchoratum bianchor*	77
		(Oonema)	*bianchoratum pinulina*	77
		(Oonema)	*bipinnulum*	81
		(Phialonemiella)	*brevancora*	77
		(Corynonema)	*calix*	57
		(Leptonema)	*campanula campanula*	77
		(Leptonema)	*campanula longispicula*	47
		(Ijimaonema)	*cebuense*	71
		(Leptonema)	*choaniferum*	51
		(Corynonema)	*clathratum*	61
		(Ijimaonema)	*clavigerum*	58
		(Cyliconema)	*coniforme*	51
		(Coscinonema)	*conus*	81
		(Oonema)	*crassipinulum*	77
		(Prionema)	*crassum*	77
		(Corynonema)	*cupressiferum*	77
		(Cyliconema)	*curvisclera*	51
		(Oonema)	*densum*	77
		(Corynonema)	*depressum*	77
		(Leptonema)	*divergens*	71
		(Cyliconema)	*drygalskii*	(48, 88)
		(Coscinonema)	*elegans*	71
		(Cyliconema)	*eupinnulum*	51
		(Prionema)	*fimbriatum*	77
		(Leptonema)	*flagelliferum*	71
		(Oonema)	*geminatum*	77
	Hyalonema	*(Cyliconema)*	*globiferum*	57

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
		(Ijimaonema)	*globus*	71
		(Coscinonema)	*gracile*	71
		(Corynonema)	*grandancora*	77
		(Ijimaonema)	*heideri*	57
		(Oonema)	*henshawi*	77
		(Corynonema)	*hercules*	77
		(Cyliconema)	*hozawai*	61
		(Coscinonema)	*indicum andamanense*	57
		(Coscinonema)	*indicum indicum*	57
		(Coscinonema)	*indicum laccadivense*	57
		(Cyliconema)	*infundibulum*	27
		(Hyalonema)	*intermedium*	71
		(Corynonema)	*intersubgenerica*	71
		(Paradisconema)	*investigatoris*	51
		(Hyalonema)	*keianum*	71
		(Cyliconema)	*keiense*	71
		(Coscinonema)	*kenti*	31
		(Coscinonema)	*kirkpatricki globosum*	61
		(Coscinonema)	*kirkpatricki kirkpatricki*	71
		(Coscinonema)	*lamella*	57
		(Cyliconema)	*lanceolata*	57
		(Leptonema)	*lusitanicum*	21
		(Cyliconema)	*madagascarense*	51
		(Cyliconema)	*martabanense*	57
		(Cyliconema)	*masoni*	57
		(Oonema)	*microstauractina*	71
		(Cyliconema)	*molle*	51
		(Corynonema)	*natalense*	51
		(Cyliconema)	*nicobaricum*	57
		(Onconema)	*obtusum*	77
		(Coscinonema)	*ovatum*	61
		(Cyliconema)	*ovatum*	67
		(Oonema)	*ovichela*	51
		(Leptonema)	*ovuliferum*	67
		(Corynonema)	*owstoni*	67
		(Hyalonema)	*parallela*	71
		(Coscinonema)	*pateriferum*	77
		(Oonema)	*pedunculatum*	77
		(Hyalonema)	*pellucidum*	61
		(Prionema)	*pinulifusum*	77
		(Cyliconema)	*pirum*	57
	Hyalonema	*(Corynonema)*	*placuna*	77
		(Prionema)	*poculum*	

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
		(Cyliconema)	*polycaulum*	77
		(Coscinonema)	*polycoelum*	71
		(Corynonema)	*populiferum*	67
		(Hyalonema)	*proximum*	71
		(Cyliconema)	*rapa*	57
		(Prionema)	*repletum*	31
		(Oonema)	*robustum*	61
		(Corynonema)	*rotundum*	71
		(Coscinonema)	*schmidti*	31
		(Oonema)	*sequoia*	77
		(Hyalonema)	*sieboldi*	61
		(Cyliconema)	*simile*	51
		(Hyalonema)	*soelae*	57
		(Leptonema)	*solutum*	71
		(Cyliconema)	*somalicum*	51
		(Leptonema)	*spatha*	71
		(Prionema)	*spinosum*	77
		(Cyliconema)	*tasmani*	81
		(Cyliconema)	*tenerum*	71
		(Coscinonema)	*tenue*	41
		(Corynonema)	*tenuifusum*	77
		(Thamnonemiella)	*thamnophorum*	71
		(Cyliconema)	*thomsoni exiguum*	21
		(Cyliconema)	*thomsoni thomsoni*	21
		(Cyliconema)	*timorense*	71
		(Ijimaonema)	*topsenti*	71
		(Coscinonema)	*toxeres*	31
		(Oonema)	*trifidum*	71
		(Cyliconema)	*tulipa*	71
		(Corynonema)	*tylostylum*	77
		(Oonema)	*umbraculum*	77
		(Onconema)	*uncinata*	71
		(Leptonema)	*urna*	37
		(Cyliconema)	*valdiviae*	58
		(Prionema)	*validum*	51
		(Paradisconema)	*vosmaeri*	71
		(Corynonema)	*weltneri*	57
	Platella			
			polybasalia	71
	Compsocalyx		*gibberosa*	57
	Lophophysema			
			australicum	71

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			gilchristi	51
			inflatum	57
	Chalaronema			
			sibogae	71
Monorhaphididae				
	Monorhaphis			
			chuni	71
Pheronematidae				
	Pheronema			
			amphorae	81
			annae	31
			barbulosclera	71
			carpenteri	27
			conicum	71
			echinatum	71
			giganteum	71
			gigas	81
			globosum globosum	71
			globosum kagoshimensis	61
			hemisphaericum	71
			ijimai	61
			megaglobosum	71
			nascaniensis	
			pilosum	71
			pseudogiganteum	71
			raphanus	57
			semiglobosum	71
			surugense	61
			weberi	71
	Platylistrum			
			platessa	51
	Poliopogon			
			amadou amadou	27
			amadou pacifica	71
			claviculus	71
			maitai	71
			mendocino	67
			micropentactinus	71
			zonecus	71
	Schulzeviella			
			gigas	81
	Semperella			
			abyssalis	71

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			alba	71
			crosnieri	71
			cucumis	57
			schultzei	71
			similis	71
			spicifera	71
			stomata	67
			varioactina	71
	Sericolophus			
			calsubus	71
			cidaricus	71
			hawaiicus	71
			neocaledonicus	71
			reflexus	67
Order Aulocalycoida				
Aulocalycidae				
	Aulocalyx			
			irregularis	51
			serialis	51
	Rhabdodictyum			
			delicatum	31
			kurense	71
	Leioplegma			
			polyphyllon	31
	Euryplegma			
			auriculare	81
Order Fieldingida				
Uncinateridae				
	Uncinatera			
			plicata	(48, 88)
	Tretopleura			
			candelabrum	71
			styloformis	71
Fieldingiidae				
	Fieldingia			
			lagettoides	27
			valentini tizardi	71
			valentini valentini	71
Order Hexactinosida				
Aphrocallistidae				
	Aphrocallistes			
			beatrix beatrix	71

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			beatrix orientalis	71
			bocagei	27
			intermedia	61
			subglobosa	71
			vastus	67
			yatsui	61
	Heterochone			
			aleutiana	61
			calyx	61
			hamata	81
			incognita	61
			tenera	67
Craticulariidae				
	Laocoetis			
			perion	71
Cribrospongiidae				
	Stereochlamis			
			incertum	71
Dactylocalycidae				
	Auloplax			
			auricularis	27
			filholi	27
	Iphiteon			
			compressa	31
			panicea	31
	Dactylocalyx			
			crispus	31
			patella	27
			potatorum	31
			pumiceus	31
			subglobosus	31
Euretidae				
	Lefroyella			
			ceramensis	71
	Calyptorete			
			ijimai	61
	Eurete			
			atlanticum	41
	Eurete		*bowerbanki*	61
			freelandi	71
			irregulare	61
			lamellina	71
			marshalli	71

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			nipponicum	61
			sacculiforme	61
			schmidti kampeni	71
			schmidti schmidti	71
			schmidti treubi	71
			simplicissimum	71
			spinosum	77
			trachydocus	71
	Conorete			
			erectum erectum	77
			erectum gracile	77
			erectum mucronatum	77
			erectum tubulifer	77
	Pityrete			
			azoricum	(48, 88)
	Endorete			
			pertusum	27
	Pararete			
			baliense	71
			carteri	71
			farreopsis fragiferum	71
			farreopsis jakosalemi	71
			farreopsis	71
			farrreopsis subglobosum	71
			freeri	71
			gerlachei	(48, 88)
			kangeanganum	71
			semperi	71
	Gymnorete			
			alicei	(48, 88)
	Heterorete			
			pulchrum	51
	Chonelasma			
			choanoides	(48, 88)
			doederleini	61
			ijimai	(48, 88)
			lamella	81
	Bathyxiphus			
			subtilis	67
	Myliusia			
			callocyathus	31
			challengeri	71
			conica	31

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			lanterna	31
			seriata	31
			verrucosa	71
	Periphragella			
			antarctica	(48, 88)
			challengeri	71
			elisae	71
			irregularis	71
			lusitanica	27
			parva	71
	Pleurochorium			
			annandalei	(48, 88)
			cornutum	71
	Tretochone			
			duplicata	27
	Verrucocoeloidea			
			burtoni	71
Farreidae				
	Sarostegia			
			oculata	34
	Asceptrulum			
			axialis	67
	Farrea			
			aculeata	31
			aculeata	67
			beringiana	61
			convolvulus	61
			deanea	31
			fistulata	31
			foliascens	21
			gassiotti	31
			hanitschi	71
			herdendorfi	21
			inermis	31
			intermedia	71
			irregularis	37
	Farrea		*kurilensis*	61
			laevis	31
			laminaris	21
			lendenfeldi	71
			mexicana	77
			nodulosa	71
			occa claviformis	77

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			occa clavigera	71
			occa cuspidata	71
			occa erecta	71
			occa mammillata	71
			occa microclavula	71
			occa occa	61
			occa ouwensi	71
			occa polyclavula	71
			occa scutella	77
			occa subclavigera	71
			parasitica	31
			perarmata	31
			pocillum	31
			robusta	31
			seiri	58
			sollasi sollasi	61
			sollasi yakushimensis	61
			spinifera	31
			spinulenta	37
			spirifera	71
			vosmaeri	61
			watasei	61
			weltneri	(48, 88)
			woodwardi	27
	Claviscopulia			
			facunda	31
	Lonchiphora			
			inversa	71
	Aspidoscopulia			
			furcillata	71
Tretodictyidae				
	Anomochone			
			expansa	71
			globosa	71
	Cyrtaulon		*sigsbeei*	31
			solutus	71
	Tretocalyx			
			polae	51
	Sclerothamnopsis			
			compressa	77
			schulzei	71
	Sclerothamnus			

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			clausi	71
	Tretodictyum			
			labyrinthicum	77
			montereyense	67
			pumicosum	71
			schrammeni	71
			tubulosum	61
	Psilocalyx			
			wilsoni	71
	Hexactinella			
			carolinensis	21
			divergens	41
			grimaldii	27
			lata	71
			lingua	71
			minor	57
			monticularis	77
			rugosa	71
			spongiosa	71
			ventilabrum	61
			vermiculosa	71
Order Lychniscosida				
Aulocystidae				
	Lychnocystis			
			superstes	31
	Neoaulocystis			
			grayi	31
			polae	71
			zitteli sibogae	71
			zitteli	71
Diapleuridae				
	Scleroplegma			
			herculeum	31
			lanterna	31
	Scleroplegma		*maasi*	71
			seriatum	31
Order Lyssacinosida				
Euplectellidae				
	Placopegma			
			plumicomum	71
			solutum	57
	Acoelocalyx			

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			brucei	(48, 88)
	Malacosaccus			
			coatsi	(48, 88)
			erectus	81
			floricomatus	(48, 88)
			heteropinularia	47
			pedunculatus	(48, 88)
			unguiculatus	34
			vastus	58
	Docosaccus			
			ancoratus	(48, 88)
	Euplectella			
			aspera	57
			aspergillum aspergillum	71
			aspergillum indonesicum	71
			aspergillum regalis	81
			crassistellata	71
			cucumer	51
			curvistellata	(48, 88)
			gibbsa	21
			imperialis	67
			jovis	31
			marshalli	67
			nobilis	27
			nodosa	31
			oweni	61
			paratetractina	57
			plumosum	71
			simplex	57
			suberea	27
			timorensis	71
	Holascus			
			ancoratus	77
			belyaevi	61
	Holascus		*edwardsi*	77
			euonyx	77
			fibulatus	81
			obesus	(48, 88)
			polejaevi	(48, 88)
			pseudostellatus	(48, 88)
			ridleyi	71
			robustus	57

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			stellatus	41
			taraxacum	77
			tener	57
			tenuis	(48, 88)
			undulatus	18
	Trachycaulus			
			gurlitti	81
	Caledoniella			
			caulophacoides	71
	Caulocalyx			
			tener	47
	Saccocalyx			
			careyi	(48, 88)
			pedunculatus	57
	Bolosoma			
			biocalum	71
			cavum	71
			charcoti	71
			cyanae	71
			meridionale	71
			musorstomum	71
			paradictyum	61
			volsmarum	71
	Vityaziella			
			renki	57
	Amphidiscella			
			atlantica	61
			caledonica	71
			monai	41
	Hyalostylus			
			dives	81
			monomicrosclerus	71
	Hertwigia			
			falcifera	31
	Pseudoplectella			
			dentatum	
	Corbitella			
			discasterosa	71
			elegans	71
			pulchra	71
			speciosa	71
	Dictyaulus			
			elegans	57

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			marecoi	21
			starmeri	71
	Heterotella			
			corbicula	51
			midatlantica	21
			pacifica	71
			pomponae	31
	Regadrella			
			cylindrica	71
			decora	57
			delicata	77
			heterotelliformis	71
			komeyamai	61
			okinoseana	67
			peru	
			phoenix	31
			rhizophora	71
	Atlantisella			
			incognita	27
	Walteria			
			flemmingi	81
			leuckarti leuckarti	67
			leuckarti longipina	71
	Dictyocalyx			
			gracilis	71
			lifousantalis	71
	Symplectella			
			rowi	81
	Ijimaiella			
			beringiana	18
	Rhabdopectella			
			tintinnus	31
Leucopsacidae				
	Oopsacas			
			minuta	27
	Leucopsacus			
			distantus	71
			ingolfi	27
			orthodocus	61
			scoliodocus retroscissus	21
			scoliodocus scoliodocus	61
	Chaunoplectella			
			cavernosa	67

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			spinifera	61
			stelleta	71
Rosselidae				
	Crateromorpha			
		(Craterochone)	*bermudensis*	71
		(Caledochone)	*caledoniensis*	71
		(Aulochone)	*cylindrica*	81
			haliprum	71
		(Neopsacas)	*krinovi discoli*	77
		(Neopsacas)	*krinovi krinovi*	21
		(Crateromorpha)	*lankesteri*	51
		(Aulochone)	*lilium*	71
		(Crateromorpha)	*meyeri corrugata*	61
		(Crateromorpha)	*meyeri meyeri*	71
		(Crateromorpha)	*meyeri rugosa*	61
		(Crateromorpha)	*meyeri tuberosa*	61
		(Crateromorpha)	*meyeri tubulosa*	61
		(Crateromorpha)	*murrayi*	71
		(Neopsacas)	*obi*	51
		(Crateromorpha)	*pachyactina*	61
		(Aulochone)	*pedunculata*	71
		(Crateromorpha)	*thierfelderi*	71
		(Crateromorpha)	*tumida*	71
		(Neopsacas)	*variata*	27
	Caulophacella			
			tenuis	77
	Caulophacus			
		(Caulophacus)	*abyssalis*	41
		(Caulophacus)	*agassizi*	21
		(Caulophacus)	*antarcticus*	(48, 88)
		(Caulophacus)	*arcticus*	18
		(Caulophacus)	*basispinosus*	51
	Caulophacus	*(Caulodiscus)*	*brandti*	(48, 88)
		(Caulophacus)	*cyanae*	71
		(Caulophacus)	*discohexactinus*	(48, 88)
		(Caulophacus)	*discohexaster*	71
		(Caulophacus)	*elegans*	61
		(Caulophacus)	*galatheae*	51
		(Caulophacus)	*hadalis*	81
		(Caulophacus)	*instabilis*	(48, 88)
		(Caulophacus)	*latus*	58
		(Caulophacus)	*lotifolium similis*	71
		(Caulodiscus)	*onychohexactinus*	71

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
		(Caulodiscus)	*otifolium*	61
		(Caulophacus)	*oviformis*	(48, 88)
		(Caulophacus)	*pipetta*	(48, 88)
		(Caulodiscus)	*polyspicula*	47
		(Caulophacus)	*schulzei*	77
		(Caulophacus)	*scotiae*	(48, 88)
		(Caulodiscus)	*valdiviae*	(48, 88)
		(Caulophacus)	*variens juvenilis*	71
		(Caulophacus)	*variens*	71
		(Oxydiscus)	*weddelli*	(48, 88)
	Asconema			
			bispiculigastrum	18
			foliatum	18
			fristedti fristedti	21
			fristedti islandiense	27
			fristedti nordazoriense	27
			megaatrialia biacorica	21
			megaatrialia megaatrialia	27
			megaatrialia nordiense	18
			megaatrialia seamounti	21
			setubalense	27
			topsenti	27
	Aphorme			
			horrida	61
	Trichasterina			
			borealis	27
			sagittaria	(48, 88)
	Bathydorus			
			fimbriatus	61
			laevis ciliatus	(48, 88)
			laevis laevis	57
	Bathydorus		*laevis spinosus*	77
			servatus	27
			spinosissimus	77
			spinosus	58
			uncifer	67
	Vitrollula			
			fertilis	61
	Schaudinnia			
			rosea	18
	Hyalascus			
			anisoactinus	71

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			attenuatus	61
			baculifer	81
			giganteus	61
			hodgsoni	(48, 88)
			pinulohexactinus	71
			sagamiensis	67
			similis	61
			stellatus	41
	Vazella			
			pourtalesi	31
	Acanthascus			
		(Staurocalyptus)	*affinis*	61
		(Acanthascus)	*alani*	61
		(Rhabdocalyptus)	*arcticus*	18
		(Rhabdocalyptus)	*asper*	67
		(Rhabdocalyptus)	*australis*	(48, 88)
		(Rhabdocalyptus)	*baculifer*	51
		(Rhabdocalyptus)	*bidentatus*	61
		(Rhabdocalyptus)	*borealis*	61
		(Acanthascus)	*cactus*	61
		(Rhabdocalyptus)	*capillatus*	61
		(Staurocalyptus)	*celebesianus*	71
		(Rhabdocalyptus)	*dawsoni*	67
		(Staurocalyptus)	*dowlingi*	67
		(Staurocalyptus)	*entacanthus*	61
		(Staurocalyptus)	*fasciculatus*	67
		(Staurocalyptus)	*fuca*	71
		(Staurocalyptus)	*glaber*	61
		(Staurocalyptus)	*hamatus*	77
		(Staurocalyptus)	*heteractinus*	61
		(Rhabdocalyptus)	*heteraster*	61
	Acanthascus	*(Staurocalyptus)*	*microchetus*	61
		(Rhabdocalyptus)	*mirabilis*	67
		(Rhabdocalyptus)	*mollis*	61
		(Rhabdocalyptus)	*monstraster*	51
		(Rhabdocalyptus)	*nodulosus*	67
		(Acanthascus)	*pachyderma*	61
		(Acanthascus)	*platei*	67
		(Staurocalyptus)	*pleorhaphides*	61
		(Rhabdocalyptus)	*plumodigitatus*	51
		(Staurocalyptus)	*roeperi*	
		(Staurocalyptus)	*rugocruciatus*	61
		(Staurocalyptus)	*solidus*	67

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
		(Rhabdocalyptus)	*tener*	67
		(Rhabdocalyptus)	*tenuis*	67
		(Staurocalyptus)	*tubulosus*	61
		(Rhabdocalyptus)	*unguiculatus*	61
		(Rhabdocalyptus)	*victor*	61
	Rossella			
			antarctica	(48, 88)
			aperta	(48, 88)
			dubia	
			fibulata	(48, 88)
			gaini	(48, 88)
			ijimai	81
			inermis	(48, 88)
			levis	(48, 88)
			longstaffi	(48, 88)
			lychnophora	(48, 88)
			mixta	(48, 88)
			mortensi	27
			nodastrella	27
			nuda	(48, 88)
			pilosa	(48, 88)
			podagrosa tenuis	(48, 88)
			podagrosa	(48, 88)
			racovitzae hexactinophila	(48, 88)
			racovitzae microdiscina	(48, 88)
			racovitzae racovitzae	(48, 88)
			schulzei	(48, 88)
			vanhoeffeni armata	(48, 88)
			vanhoeffeni vanhoeffeni	(48, 88)
			villosa	(48, 88)
	Rossella		*vitiosa*	(48, 88)
	Anoxycalyx			
		(Anoxycalyx)	*ijimai*	(48, 88)
		(Scolymastra)	*joubini*	(48, 88)
		(Anoxycalyx)	*laceratus*	61
	Aulosaccus			
			albatrossi	61
			fissuratus shimushirensis	61
			fissuratus	61
			ijimae	67
			mitsukurii	61
			pinularis	61

Order	Genus	Subgenus	Species	FAO Major Fishing Areas
			schulzei	67
			solaster	61
	Scyphidium			
			australiense	81
			chilense	
			jamatai	61
			longispinum	67
			namiyei	61
			septentrionale	18
			tuberculatum	61
	Calycosoma			
			validum	21
	Sympagella			
			anomala	61
			cantharellus	77
			clavipinula	71
			gracilis	71
			johnstoni	58
			multihexastera	57
			nux	31
	Doconesthes			
			sessilis	27
	Lanuginella			
			pupa	31
	Lanugonychia			
			flabellum	77
	Lophocalyx			
			atlantiensis	41
			biogasi	41
			brasiliensis	41
	Lophocalyx		*moscalevia*	71
			oregoni	41
			philippinensis	71
			profunda	(48, 88)
			pseudovalida	41
			reiswigi	41
			spinosa	57
			suluana	71
			topsenti	(48, 88)
	Mellonympha			
			velata	21

APPENDIX 2

Astrophorida

Family	Genus	Species	FAO Major Fishing Areas
Ancorinidae			
	Stelletta		
		addita	37
		aeruginosa	81
		agglutinans	57
		agulhana	47
		agulhana paucistella	47
		anancora	41
		anasteria	41
		arenaria	81
		aruensis	71
		aspera	71
		atrophia	61
		beae	41
		bocki	57
		boglicii	37
		brevidens	71
		brevioxea	51
		brevis	57
		calyx	61
		capensis	47
		carolinensis	21
		cavernosa	51, 57, 58
		centroradiata	71
		centrotyla	57
		ceylonica	57
		clarella	77
		clavosa	71
		communis	57, 71, 81
		conulosa	81
		crassicula	51
		crassispicula	34, 41
		crater	81
		cyathoides	47
		cylindrica	51
		debilis	71
		debilis stenospiculata	31
		digitifera	34
		discolor	51
		dorsigera	37

Family	Genus	Species	FAO Major Fishing Areas
	Stelletta	*durissima*	71
		estrella	77
		farcimen	47
		fibrosa	31
		fibulifera	37
		freitasi	51
		gigantea	61
		gigas	41
		globulariformis	31
		grubii	27, 37
		grubioides	47
		hajdui	41
		herdmani	47, 57
		herdmani robusta	51
		hispida	34, 37
		horrens	47
		horrens subcylindrica	47
		hyperoxea	71
		incrustans	27
		incrustata	31
		individua	31
		inermis	27
		japonica	61
		jonesi	51
		kallitetilla	31
		kundukensis	61
		lactea	27, 37
		latiancora	34
		lithodes	81
		longicladus	57
		mamilliformis	57
		maori	81
		mauritiana	51
		maxima	61, 81
		mediterranea	37
		misakensis	61
		morikawai	61
		moseleyi	57, 71, 81
		naseana	61
		normani	21, 27
		novaezealandiae	81
		orientalis	61
		orthotriaena	61

Family	Genus	Species	FAO Major Fishing Areas
	Stelletta	*osculifera*	51
		ovalae	61
		pachydermata	77
		parva	51
		parvispicula	71
		paucistellata	34
		phialimorpha	81
		phrissens	87
		pisum	61
		plagioreducta	71
		porosa	71
		pudica	31
		pulchra	71
		pumex	37
		purpurea	51, 57, 61, 71, 81
		pygmaeorum	31
		pyriformis	71
		radicifera	71
		radicifera robusta	71
		retroclada	47
		rhaphidiophora	27
		ridleyi	71
		ruetzleri	41
		rugosa	47
		sandalinum	81
		siemensi	51
		sigmatriaena	71
		simplicissima	37
		solida	31
		solida	61
		solidissima	31
		soteropolitana	41
		sphaerica	47
		sphaeroides	71
		spinulosa	61
		splendens	61
		stellata	37
		stellata	37
		stellifera	71
		subtilis	61
		tenuispicula	31
		teres	61
		tethyopsis	57

Family	Genus	Species	FAO Major Fishing Areas
	Stelletta	*tetrafurcata*	61
		toxiastra	81
		trichotriaena	57
		trisclera	47
		tuba	61
		tuberculata	57
		tuberosa	27
		tulearensis	51
		vaceleti	81
		validissima	61
		variabilis	31
		variohamata	71
		ventricosa	27
		vestigium	51
		vosmaeri	87
	Tethyopsis		
		brondstedi	(48, 88)
		calcifera	81
		longispinus	(48, 88)
		patriciae	71
		radiata	81
	Ancorina		
		diplococcus	81
		multistella	34
	Stryphnus		
		fortis	27
		mucronatus	37
		ponderosus	27
		progressus	47
	Penares		
		cortiusorientalis	61
		foliaformis	77
		mastoidea	31
		micraster	71
		palmatoclada	71
		sclerobesa	27
		sphaera	47
Calthropellidae			
	Calthropella		
		simplex	27
		simplex durissima	27
	Pachataxa		
		enigmatica	71

Family	Genus	Species	FAO Major Fishing Areas
	Pachataxa	*lithistina*	31
		n.sp.	77
Geodiidae			
	Erylus		
		aleuticus	67
		amissus	71
		amorphus	47
		amphiastera	31
		aspidodiscus	37
		bahamensis	31
		burtoni	71
		caliculatus	77
		cantabricus	27
		carteri	57
		circus	71
		citrus	71
		corneus	41
		cornutus	71
		cylindriger	51
		decumbens	71
		deficiens	34
		diminutus	41
		discastera	77
		discophorus	27, 37
		euastrum	37
		expletus	27
		fibrillosus	71
		formosus	41
		fromontae	57
		geodioides	57
		gilchristi	47
		goffrilleri	31
		inaequalis	71
		incrustans	31
		lendenfeldi	57
		mamillaris	27, 37
		monticularis	71
		nobilis	71
		nummulifer	27
		oblongus	27
		oxyaster	87
		papillatus	27
		philippinens	71

Family	Genus	Species	FAO Major Fishing Areas
	Erylus	*placenta*	61
		polyaster	47
		proximus	57
		rotundus	77
		rotundus	77
		rotundus	77
		rotundus	77
		soesti	41
		sollasi	77
		topsenti	27
		toxiformis	41
		transiens	27, 31
		trisphaerus	31
	Caminus		
		albus	71
		awashimensis	61
		chinensis	61
		sphaeroconia	41
		vulcani	34, 37
	Pachymatisma		
		areolata	57
		bifida	51
		geodiformis	31
		johnstonia	27
		monaena	47
		normani	27
	Geodia		
		acanthylastra	77
		agassizi	77
		alba	71
		alba minor	71
		amadaiba	61
		amphistrongyla	87
		arabica	51
		areolata	57
		arripiens	71
		ataxastra	77
		ataxastra angustana	77
		ataxastra latana	77
		auroristella	51
		australis	41
		barretti	27, 34, 37
		basilea	47

Family	Genus	Species	FAO Major Fishing Areas
	Geodia	*berryi*	61
		breviana	77
		carteri	57
		cidaris	37
		composita	51
		conchilega	37
		cooksoni	87
		crustosa	51
		cumulus	31
		cydonium	27, 37
		cydonium aegagropila	37
		cylindrica	61
		dendyi	47
		depressa	37
		distincta	71
		divaricans	34
		dura	71
		dysoni	77
		echinastrella	27
		eosaster	27
		erinacea	57
		exigua	61
		gallica	47
		geodina	37
		gibberella	77
		gibberosa	31
		gigas	37
		glariosa	41
		globosa	47
		globostellifera	51, 57
		globus	27
		hilgendorfi	61
		hilgendorfi	61
		hirsuta	71
		hyotania	61
		inconspicua	71
		isabella	77
		japonica	61
		japonica spherulifera	71
		kuekenthali	71
		labyrinthica	47
		libera	47, (48, 88)
		lindgreni	57, 71

Family	Genus	Species	FAO Major Fishing Areas
	Geodia	*littoralis*	47, (48, 88)
		lophotriaena	81
		macandrewi	27
		magellani	87
		media	77
		media leptorhaphes	31
		megaster	47
		megastrella	27, 34
		megastrella laevispina	27
		mesotriaena	77
		mesotriaena	18
		mesotriaenella	77
		micropora	87
		micropunctata	51
		nigra	57
		nodastrella	27, 34
		normani	27
		orthomesotriaena	61
		ovifractus	47
		ovifractus cyathioides	47
		ovis	67
		papyracea	31
		pergamentacea	27
		peruncinata	51
		philippinensis	71
		piriformis	51
		placenta	37
		pleiades	51
		poculata	51
		punctata	57
		ramodigitata	51
		ramosa	34
		regina	81
		reniformis	61
		reniformis robusta	61
		riograndensis	41
		robusta	47
		robusta carolae	67
		robusta megaclada	67
		robusta megasterra	77
		roviniensis	37
		senegalensis	34
		simplex	27

Family	Genus	Species	FAO Major Fishing Areas
	Geodia	*simplicissima*	27
		sparsa	71
		sphaeroides	71
		spheranthastra	51
		spherastrea	31
		spherastrella	27
		spherastrosa	71
		splendida	41
		stellata	47
		stellosa	37
		stromatodes	31
		strongyla	61
		thomsoni	31
		tuber	37
		tuberculosa	77
		tuberosa	37
		tylastra	41
		variospiculosa	61
		variospiculosa clavigera	61
		variospiculosa intermedia	61
		variospiculosa micraster	61
		variospiculosa aapta	61
		vaubani	71
		vestigifera	81
	Isops		
		apiarum	31
		canaliculata	37
		contorta	71
		imperfecta	71
		loricata	37
		maculosus	37
		micraster	51
		nigra	71
		obscura	61
		ostracomorpha	71
		pachydermata	27, 31
		perarmata	51
		phlegraei	18, 27
		sollasi	71
		velata	61
	Sidonops		
		angulata	77

Family	Genus	Species	FAO Major Fishing Areas
	Sidonops	*atlantica*	27
		bicolor	77
		californica	77
		corticostylifera	41
		flemingi	81
		microspinosa	71
		neptuni	41
		nitida	41
		oxyastra	77
		picteti	71
		reticulata	77
		vosmaeri	41
Pachastrellidae			
	Characella		
		abbreviata	71
		agassizi	31
		aspera	41
		capitolii	41
		connectens	31
		enae	31
		flexibilis	71
		ijimai	61
		laevis	61
		pachastrelloides	27, 34
		reticulata	61
		stellettodes	61
		tripodaria	37
	Cladothenea		
		andriashevi	(48, 88)
	Pachastrella		
		abyssi	27, 31
		caliculata	47
		chuni	34
		cribrum	61
		dilifera	31
		echinorhabda	37
		fusca	61
		incrustata	81
		isorrhopa	47
		monilifera	27, 34, 37, 47
		multipora	77
		ovisternata	27
		scrobiculosa	61

Family	Genus	Species	FAO Major Fishing Areas
	Poecillastra		
		amygdaloides	27, 34,
		ciliata	71
		compressa	27, 34, 37, 47
		compressa antarctica	(48, 88)
		crassiuscula	27, 34
		cribraria	87
		eccentrica	57
		fragilis	37
		incrustans	47
		japonica	61
		laminaris	71
		nana	57
		rickettsi	77
		saxicola	37
		schulzei	58
		stipitata	71
		symbiotica	27
		tenuilaminaris	71
		tenuirhabda	47
		tuberosa	47
		wondoensis	61
	Thenea		
		abyssorum	18
		andamanensis	57
		bojeadori	34
		calyx	61
		centrotyla	58
		compacta	61
		compressa	61
		corallophila	57
		delicata	58
		echinata	77
		echinata	21
		fenestrata	31
		grayi	71
		grayi lateralis	61
		grayi sulcata	71
		hemisphaerica	61
		irregularis	61
		lamelliformis	77
		levis	27
		malindiae	51

Family	Genus	Species	FAO Major Fishing Areas
	Thenea	*megaspina*	58
		megastrella	34
		mesotriaena	58
		microclada	34
		microspina	58
		microspirastra	71
		multiformis	58
		muricata	27, 31, 34, 37
		nicobarensis	57
		novaezealandiae	81
		nucula	61
		pendula	51
		pyriformis	77
		rotunda	51
		schmidti	27
		shimodensis	61
		tyla	51
		valdiviae	27
		wrightii	87
		wyvillei	71
	Vulcanella		
		annulata	57
		ornata	27, 34
		schmidti	31
		verrucolosa	37
		aberrans	37
		acanthoxea	61
		armata	27
		bifacialis	71
		cribrifera	34
		cribriporosa	61
		doederleini	61
		gracilis	27, 34
		horrida	27, 31, 34
		linaresi	27
		netheides	61
		orthotriaena	81
		osculanigera	77
		porosa	61
		theneides	51
		tricornis	87

Family	Genus	Species	FAO Major Fishing Areas
Thrombidae	***Thrombus***	*abyssi*	27
		abyssi niger	27
		challengeri	71
		kittoni	31
		ornatus	51

APPENDIX 3

Hadromerida

Family	Genus	Species	FAO Major Fishing Areas
Stylocordylidae			
	Stylocordyla		
		borealis	18, 21, 27, 61
		borealis acuata	(48, 88)
		borealis eous	18, 61
		borealis globosa	58
		borealis irregularis	(48, 88)
		borealis typica	27
		chupachups	41, (48, 88)
		fragilis	81
		longissima	18, 61
		muta	31
		pellita	27
Suberitidae			
	Homaxinella		
		balfourensis	(48, 88) , 58
		subdola	18, 27, 61
	Rhizaxinella		
		arborescens	61
		australiensis	51
		biseta	27
		burtoni	61
		cervicornis	61
		clava	31
		clavata	61
		dichotoma	71
		durissima	81
		elevata	61
		elongata	27
		gadus	67
		gracilis	37
		incrassata	61
		nuda	71
		pyrifera	37
		ramulosa	51, 77
		ramulosa cilidrifera	77
		schaudinni	18
		shikmonae	37
		spiralis	87
		uniseta	27
Tethyidae	***Halicometes***		

Family	Genus	Species	FAO Major Fishing Areas
		cometes	31
		elongata	27
		hooperi	71
		minuta	41
		pediculata	47
		stellata	31
		stonei	57
		thyris	31

APPENDIX 4

Lithistida

Family	Genus	Species	FAO Major Fishing Areas
Scleritodermidae			
	Aciculites		
		ciliata	71
		cribrophora	31
		higginsi	31
		manawatawhi	81
		mediterranea	37
		orientalis	57, 71
		oxytylota	71
		papillata	71
		pulchra	81
		spinosa	51
		sulcus	81
		tulearensis	51
	Amphibleptula		
		madrepora	31
	Microscleroderma		
		chonelleides	61
		herdmani	57, 71
		hirsutum	58
		lamina	37
		novaezelandiae	81
		spirophora	34
		stoneae	71
	Scleritoderma		
		camusi	71
		cyanea	31
		flabelliforme	71, 81
		nodosum	71
	Setidium		
		obtectum	31
Corallistidae			
	Awhiowhio		
		osheai	81
		sepulchrum	81
		unda	81
	Corallistes		
		aculeata	51
	Corallistes	*australis*	71
		bispiraster	41

Family	Genus	Species	FAO Major Fishing Areas
		bowerbanki	34
		elegantior	27
		elegantissima	51
		fulvodesmus	71, 81
		isabela	87
		masoni	34, 37
		microstylifer	71
		microtuberculatus	34
		multituberculatus	71
		paratypus	31
		thomasi	71
		tubulatus	31
		typus	31
		undulatus	71
		verrucosa	51
	Herengeria		
		auriculata	71, 81
		vasiformis	71, 81
	Isabella		
		mirabilis	71
	Neophrissospongia		
		nana	37
		nolitangere	27, 31
	Neoschrammeniella		
		antarctica	(48, 88) , 81
		castrum	71
		moreti	71
		norfolki	71
Pleromidae			
	Anaderma		
		rancureli	71
	Pleroma		
		aotea	81
		menoui	71, 81
		torquilla	31
		turbinatum	71, 81
	Discodermia		
		aspera	51
		calyx	61
		claviformis	71
	Discodermia	*discifera*	51, 57
		discifurca	81
		dissoluta	31
		dubia	51

Family	Genus	Species	FAO Major Fishing Areas
		emarginata	51
		emarginata	71
		gorgonoides	57
		inscripta	31
		interspersa	57
		irregularis	61
		japonica	61
		jogashima	61
		kiiensis	61
		laevidiscus	51
		natalensis	51
		ornata	
		panoplia	71
		papillata	51
		polydiscus	31
		proliferans	71, 81
		ramifera	27
		simillima	
		sinuosa	51
		stylifera	51
		tuberosa	51
		vermicularis	61
		verrucosa	31, 34
Theonellidae			
	Manihinea		
		conferta	51
	Racodiscula		
		asteroides	31
		clava	27, 31, 34
		incrustans	51
		sceptrellifera	51
		sceptrellifera	51
		sceptrellifera	51
		spinispirulifera	51
	Siliquariaspongia		
		japonica	61
	Theonella		
		annulata	34
	Theonella	*atlantica*	31
		complicata	51
		conica	51, 71
		cupola	51
		cylindrica	71
		ferruginea	

Family	Genus	Species	FAO Major Fishing Areas
		incerta	71
		invaginata	71
		lacerata	71
		levior	57
		mirabilis	71
		pulchrifolia	51, 57
		swinhoei	51, 57, 61
		swinhoei var verrucosa	71
Siphonidiidae			
	Gastrophanella		
		cavernicola	41
		implexa	31, 41
		mammilliformis	47
		phoeniciensis	37
		primore	77
	Lithobactrum		
		forte	47
	Siphonidium		
		capitatum	71
		dendyi	57
		dubium	34
		geminum	31
		ramosum	27, 31, 37
Neopeltidae			
	Callipelta		
		cavernicola	51
		mixta	51
		ornata	71
		punctata	71, 81
		sollasi	71
		thoosa	51
	Daedalopelta		
		nodosa	31
	Homophymia		
		lamellosa	51
		pollubrum	71
	Homophymia	*stipitata*	81
	Neopelta		
		amphiaster	31
		imperfecta	31
		perfecta	31
		plinthosellina	71
		pulvinus	81

Family	Genus	Species	FAO Major Fishing Areas
Azoricidae			
	Desmascula		
		desdemona	31
	Jereicopsis		
		graphidophora	71
	Leiodermatium		
		colini	81
		crassiusculum	
		dampieri	81
		deciduum	31
		heteroformis	61
		linea	81
		lynceus	27, 31, 34, 51
		marginatum	71
		paniceus	71
		pfeifferae	27, 31
Desmanthidae			
	Desmanthus		
		incrustans	31, 37
		levii	77
		meandroides	41
		rhabdophorus	71
		topsenti	71
	Paradesmanthus		
		macphersoni	47
	Petromica		
		ciocalyptoides	31
		citrina	41
		pacifica	71
		digitata	47
		grimaldii	27, 37
		massalis	57
		plumosa	47
		tubulata	47
	Sulcastrella	*clausa*	31
		leviorum	31
		tenens	31, 37
Vetulinidae			
	Vetulina		
		stalactites	31
Phymatellidae			
	Neoaulaxinia		
		clavata	71, 81

Family	Genus	Species	FAO Major Fishing Areas
		persicum	81
		zingiberadix	81
	Neosiphonia		
		fruticosa	71
		motukawanui	81
		schmidti	31
		superstes	71, 81
	Reidispongia		
		coerulea	71, 81
		tuberculata	71
Isoraphiniidae			
	Costifer		
		vasiformis	71
		wilsoni	71, 81
Macandrewiidae			
	Macandrewia		
		auris	47
		azorica	27, 34
		clavatella	31
		nodosa	31
		ramosa	27
		rigida	71
		robusta	27
		spinifoliata	71, 81
Phymaraphiniidae			
	Exsuperantia		
		clava	31
	Kaliapsis		
		cidaris	71
		incrustans	51
		permollis	51
	Lepidothenea		
		incrustans	81

APPENDIX 5

Poecilosclerida

Family	Genus	Species	FAO Major Fishing Areas
Cladorhizidae			
	Asbestopluma		
		agglutinans	87
		pennatula	18, 27,
		formosa	71
		stylivarians	34
		belgicae	(48, 88)
		bilamellata	71
		biserialis	71
		biserialis californiana	77
		callithrix	(48, 88)
		calyx	(48, 88)
		comata	27
		cupressiformis	18, 27
		flabellum	61
		furcata	27
		globularis	77
		gracilior	31
		gracilis	61
		hadalis	81
		hydra	27
		hypogea	37
		infundibulum	18, 27
		infundibulum orientalis	61
		lebedi	61
		lycopodium	18, 21, 27, 61
		minuta	27
		occidentalis	67
		quadriserialis	27
		ramosa	61
		robusta	18
		wolffi	81
	Chondrocladia		
		occulta	67
		stipitata	58
		tasmaniensis	57
		turbiformis	81
		albatrossi	41
		amphactis	31
	Chondrocladia	*antarctica*	(48, 88)
		arctica	27

Family	Genus	Species	FAO Major Fishing Areas
		arenifera	61
		asigmata	81
		burtoni	34
		clavata	71
		concrescens	31
		crinita	71
		dichotoma	51
		fatimae	58
		gigantea	21, 27
		gracilis	51
		guiteli	27
		koltuni	61
		lampadiglobus	87
		levii	47
		magna	61
		michaelsarsi	34
		multichela	51
		nani	58
		nicolae	47
		nucleus	27
		pulvinata	71
		scolionema	71
		vaceleti	47
		verticillata	31
		virgata	27, 37
		yatsui	61
	Cladorhiza		
		abyssicola	27, 34
		arctica	18,
		bathycrinoides	61
		corona	67
		corticocancellata	27
		depressa	71
		ephyrula	47
		flosabyssi	34
		fristedti	21
		gelida	18, 21, 27
		grandis	21,
		grimaldii	34
		inversa	41
	Cladorhiza	*linearis*	81
		longipinna	77
		mani	(48, 88)
		methanophila	31

Family	Genus	Species	FAO Major Fishing Areas
		microchela	61
		mirabilis	87
		moruliformis	57
		nematophora	57
		nobilis	27,
		oxeata	27,
		pteron	77
		rectangularis	61
		schistochela	71
		segonzaci	77
		septemdentalis	61
		similis	77
		tenuisigma	18, 27
		thomsoni	47
		tridentata	21
Acarnidae			
	Iophon		
		abnormalis	(48, 88) , 58
		aceratum	(48, 88)
		cheliferum	21, 47, 58, 67
		chilense	87
		cylindricum	81
		dubium	18, 21, 27
		flabellodigitatum	(48, 88)
		flabellodigitatum gaussi	(48, 88)
		frigidum	18, 21, 27
		frigidum gracile	18,
		gaussi	(48, 88)
		hesperidesi	(48, 88)
		indentatum	77
		lamella	77
		lamella indivisa	77
		laminale	58
		omnivorus	81
		ostiamagna	77
		piceum	18, 27, 61
		piceum abipocillus	61
		piceum orientale	61
	Iophon	*piceum pacificum*	18,
		pluricorne	(48, 88)
		pluricorne trulliferum	(48, 88)
		proximum	41, (48, 88) , 57, 58, 87
		radiatum	(48, 88) 87
		spatulatum	41, (48, 88)

Family	Genus	Species	FAO Major Fishing Areas
		terranovae	(48, 88)
		unicorne	(48, 88) , 58
Esperiopsidae			
	Esperiospsis		
		bathyalis	41
		challengeri	71
		challengeri meangensis	71
		chindoensis	61
		decora	27
		desmophora	71
		diasolenia	71
		flagellum	21, 27
		flagrum	67
		flava	71
		heardi	58
		incognita	27
		inodes	71
		koltuni	61
		lesliei	47
		lingua	61
		macrosigma	27
		macrosigma novaezealandiae	81
		magnifolia	71
		megachela	81
		plumosa	61
		polymorpha	27,
		praedita	27
		profunda	58
		pulchella	58, 71
		rugosa	41, 47, (48, 88) , 58, 87
		scotiae	(48, 88)
		stipula	18, 61
		strongylophora	37
		symmetrica	58
		varia	87
		villosa	18, 27, (48, 88)
Podospongidae	***Podospongia***		
		india	31
		loveni	27
		natalensis	51
		similis	71
Isodictyidae			
	Isodictya		

Family	Genus	Species	FAO Major Fishing Areas
		alata	47
		bentarti	(48, 88)
		cavicornuta	(48, 88) , 81
		chichatouzae	47
		delicata megachela	(48, 88)
		doryphora	(48, 88)
		dufresni	58
		echinata	(48, 88)
		erinacea	(48, 88)
		histodermella	18,
		kerguelenensis	41, (48, 88) , 58
		lankesteri	(48, 88)
		maeandrina	(48, 88)
		microchela	41, (48, 88)
		obliquidens	41, (48, 88)
		palmata	21, 27
		pulviliformis	61
		quatsinoensis	18, 67
		rigida	18, 67
		setifera	(48, 88)
		spinigera	(48, 88)
		toxophila	(48, 88)
		trigona	(48, 88)
		vancouverensis	67
		verrucosa	(48, 88) , 58

APPENDIX 6

Halichondrida

Family	Genus	Species	FAO Major Fishing Areas
Axinellidae			
	Axinella		
		anamesa	77
		antarctica	(48, 88)
		arctica	18, 27
		australiensis	
		bidderi	51
		blanca	18, 61
		brondstedi	
		damicornis	27, 31, 37
		elegans	81
		flustra	27
		hirondellei	27
		hispida	18
		infundibuliformis	
		lifouensis	71
		profunda	61
		profunda kurushima	61
		pyramidata	27
		rugosa	18, 27, 61
		setosa	18, 27
		solenoeides	77
		trichophora	18
		vasonuda	27
		vellerea	27
	Phakellia		
		bowerbanki	18, 21, 27
		connexiva	31, 41
		dalli	18, 61, 67
		folium	31
		lambei	61, 67
		lamelligera	77
		plumosa	71
		robusta	18, 27, 37
		stelliderma	71
		sur	41
		ventilabrum	18, 21, 27, 37
Halichondriidae			
	Spongosorites		
		andamensis	57
		annandalei	27
	Spongosorites	*arenatus*	31

Family	Genus	Species	FAO Major Fishing Areas
		coralliophaga	27
		dendyi	27
		difficilis	21, 27
		placenta	27
		ruetzleri	31
		siliquaria	31

APPENDIX 7

Haplosclerida

Family	Genus	Species	FAO Major Fishing Areas
Chalinidae			
	Cladocroce		
		fibrosa	27
		gaussiana	(48, 88)
		incurvata	71
		osculosa	27
		parenchyma	21, 27
		spathiformis	27
		ventilabrum	27, (48, 88)
Phloeodictyidae			
	Oceanapia		
		aberrans	81
		aerea	27
		amphirhiza	31
		arcifera	81
		ascidia	31
		atlantica	47
		bacillifera	77
		bartschi	31
		cancap	27
		coriacea	27
		elongata	27
		fibulata	31
		fistulosa	57
		kirkpatricki	(48, 88)
		media	27
		nodulosa	27
		putridosa	27, 81
		reticulata	27
		robusta	18, 21, 27
		tuber	21, 27
		vera	71
		viridescens	31
Petrosiidae			
	Petrosia		
		australis	81
		borealis	67
		brachysclera	71
		canariensis	27
		crassa	27
	Petrosia	*pluricristata*	71

Family	Genus	Species	FAO Major Fishing Areas
		punctata	71
		raphida	27, 37
		hartmani	31
		mamillata	71
		stoneae	31
		vansoesti	27, 37

This is the report of the FAO Workshop on Deep-sea Species Identification held in Rome, Italy, from 2 to 4 December, 2009. This meeting was organized in response to the need for a strategy for deep-sea species identification guides. The report includes an overview of the presentations and discussions held during the Workshop, and it presents the conclusions and recommendations agreed upon by participants. The three background documents on deep-sea sharks, corals and sponges drafted for the Workshop are included in Part 2 of this report. The Workshop identified specific activities that will be needed to advance the development of the identification guides.

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