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Report of the

WORKSHOP ON DEEP-SEA SPECIES IDENTIFICATION

Rome, Italy, 2–4 December 2009

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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

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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).

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[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).

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[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.

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

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[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.

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.